ETH zürich

World Food System Conference 2015

Program and Abstracts

Congressi Stefano Franscini | Monte Verità, Ascona, Switzerland

June 21-26, 2015

TACKLING WORLD FOOD SYSTEM CHALLENGES

Across disciplines, sectors and scales.

World Food System Center

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The Organizing Committee gratefully acknowledges the kind support of

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Welcome

Dear Colleagues,

It is a great pleasure to welcome you to the first conference of the ETH Zurich World Food System Center (WFSC) and to the Congressi Stefano Franscini at Monte Verità.

The idea for this conference stems from our Center's vision for "a healthy world through sustainable food systems". We believe that moving closer to this vision requires greater exchange between researchers, practitioners, and other stakeholders who are "tackling world food system challenges" across different disciplines, sectors and scales.

With participants from across the food system and around the world, we are excited to learn from your experiences, and hopeful that the discussions will spark novel ideas and lead to new collaborations and mutual learning about solutions to the challenges our food system faces today.

Each of the sessions and formats has been organized to maximize exchange and discussion between and among those who are presenting and participating in the conference. The combination of keynotes, oral presentations, and poster pitches will be complemented by a workshop that aims to bring your collective knowledge and experience together to tackle the topic of resilience in food systems.

Your presence this week is a sign that you are willing to accept our invitation to take a step (or two) outside your disciplinary boundaries and perhaps your comfort zone as well. We thank you for taking this opportunity and participating in what we hope will be a memorable event!

We are looking forward to an engaging conference and we wish you a wonderful week at Monte Verità.

Your local organizing committee,

Aimee Shreck and Michelle Grant
World Food System Center, ETH Zurich

Rainer Schulin
Institute of Terrestrial Ecosystems, ETH Zurich

Johan Six
Institute of Agricultural Sciences, ETH Zurich

Paolo Demaria
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Keynote Speakers

Erick Boy Harvest Plus, USA
Charlotte de Fraiture UNESCO-IHE (Institute for Water Education), the Netherlands
Jessica Fanzo Columbia University, USA
Jaboury Ghazoul ETH Zurich, Switzerland
John Ingram Oxford University, UK
Alida Melse-Boonstra Wageningen University, the Netherlands
Peter Messerli University of Bern, Switzerland
Urs Niggli FiBL (Swiss Research Institute for Organic Agriculture), Switzerland
Roseline Remans Columbia University, Earth Institute, USA
Sarah Ruth Sippel University of Leipzig, Germany
Pete Smith University of Aberdeen, UK
Ian Roberts Bühler Group
Valerie Schuster GAIN, London, UK
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Tom Tomich University of California, Davis, USA
Fusuo Zhang China Agricultural University, China

Academic Collaborators

UC Davis Agricultural Sustainability Institute University of California, Davis, California, USA
Berkeley Food Institute University of California, Berkeley, California, USA

General Information

The conference takes place at the Congressi Stefano Franscini (CSF), the conference center of ETH Zurich, located at Monte Verità, Ascona, Switzerland. The conference facilities, the restaurant and the bar are located in the main building called the Bauhaus Building.

For further information on Monte Verità and on connections to Ascona, please refer to the white CSF folder included in your conference bag.

Conference Rooms
Most sessions will take place in the Auditorium on the ground floor of the Bauhaus Building or the Balint Room, on the first floor of the Bauhaus Building. Please refer to the detailed program for the location of each session. All posters will be displayed from for the duration of the conference in the Balint Room. We kindly ask you to take your poster with you when you leave. Posters left in the room will be discarded.

Oral Presentations
In the Auditorium, keynote lectures and other oral presentations using power point can be shown on either a Windows or a Mac computer. The beamer/projector has an additional third channel, so the use of own computers is possible, but compatibility with the video system should be tested ahead of time.

In the Balint room, slides will be shown on a Windows laptop and should be prepared on a memory stick. There is no option for presenters to connect their personal computers.

Please be sure to **bring your file on a memory stick 15 minutes prior to the start of your session** so all slides can be pre-loaded before the session starts. Members of the organizing committee will be available to assist you in uploading and testing your presentation. All speakers are kindly requested to stay within their time slot indicated in the program. Discussion facilitators will assist speakers so they can keep to their time allowed.

Poster Presentations
Please refer to the numbered posters list in this book to locate the correct board where you can place your poster. Posters can be displayed in the Balint Room from Monday to Thursday. We have planned two poster sessions: on Monday and Tuesday evenings, after dinner. All poster authors are invited to give a 1-2 minute "flash" pitch about their poster. On Monday, posters 1-10 will give pitches and on Tuesday, posters 11-20 will give pitches. All authors should attend their posters during the session in which they are presenting and be available for discussing their poster during both sessions. Further spontaneous discussions in the poster room are welcome and encouraged at any other time (breaks, after meals, in the evening).

CSF Award
The CSF Award was established in 2009 by the director and the scientific board of the Congressi Stefano Franscini. The Award will be conferred by a jury formed by the Organizing Committee to the best presentation (oral or poster) given by a young scientist during the conference. Please return the form in your conference bag to one of the organizers as soon as possible if you would like to be considered for the award.

Wireless and computer room
There is a free wireless network in the Bauhaus Building and in the Semiramis Building. Please refer to the CSF folder you have received at registration for further information on the use of the wireless (password, settings, etc.).

A computer room with a printer is available for you 24 hours a day. The room is located at the ground floor of the main building, few steps after the Monte Verità hotel front desk.

Meals and refreshments
Lunches and dinners will be served at the Monte Verità Restaurant, on the first floor of the Bauhaus Building. On Wednesday evening the dinner will take place during the excursion to the Brissago Islands.

Breakfast is served in the same place for participants staying at Monte Verità, and in the conference hotels for those staying off-site.

All coffee breaks will be served at the Bar Roccia, on the first floor of the Bauhaus Building. The Bar Roccia will also be open as a cash bar for you every evening from 21.00 to midnight.

Excursion
On Wednesday afternoon there will be an excursion to the Brissago Islands, including a visit to the Botanical Garden and dinner at Ristorante Isole di Brissago, on the island. We will depart from Monte Verità at 15.15 pm and walk to the port of Ascona. From here we will take a boat to the islands and have a guided tour of the garden. After dinner, we will return by private boat to Ascona and arrive back at Monte Verità by 22.00 pm.

The Brissago Islands date back to the Roman time (vestiges of that time have been found on the islands), but became particularly famous thanks to the fascinating Russian Baroness Antoinette de Saint Léger who owned the Islands (1885-1927). She started what has become a unique botanical garden in Switzerland (today the property of the Canton Ticino), with 1500 plant species both indigenous and from sub-tropical zones.

Disclaimer
The conference organizers do not accept any liability for personal injuries sustained, or for loss or damage to property belonging to congress participants (or their accompanying persons), either during, or as a result of, the conference.
Registration fees do not include insurance.

Program Overview

Sunday

16.00	Registration and Hotel Check-in
18.00	Welcome Apéro
19.00	*Dinner*
	Setting the Stage

Monday

8.45	Welcome Address by CSF
9.00	Bridging Science and Practice for Sustainable Food Systems
10.30	*Break*
11.00	Global Change Drivers and Food Systems
13.00	*Lunch*
14.45	Resilience Workshop 1
16.45	*Break*
17.15	Trade-Offs in Rural Landscapes
19.00	*Dinner*
20.30	Poster Pitches

Tuesday

9.00	Organic 3.0?
11.00	*Break*
11.30	Regional and Local Food Value Chains // Managing Agricultural Land
12.30	*Lunch*
14.15	Stories of the Hands that Feed Us
16.15	*Break*
16.45	Resilience Workshop 2
19.00	*Dinner*
20.30	Poster Pitches

Wednesday

8.15	Value Chains for Nutrition
10.00	*Break*
10.30	Biofortification of Staple Crops
12.30	*Lunch*
14.00	Food Systems Approaches in Practice
15.15	Excursion and Dinner, Brissago Islands
ca. 21.45	Return to Monte Verità

Thursday

9.00	Producing More with Less
10.30	*Break*
11.00	Overcoming Barriers to Access // Whose Loss?
12.15	*Lunch*
14.15	Effecting Change in the Food System (Policy and Interventions)
16.15	*Break*
16.45	Resilience Workshop 3
19.00	*Dinner*
20.30	Building New Collaborations

Friday

9.00	Water for Food, Nutrition, and Health
11.00	*Break*
11.30	Making Sense of it All
	Presentation of CSF Award
12.30	Lunch / End of Conference

Conference Program Details

*indicates keynote speaker

Sunday, 21 June 2015

From 16.00 Registration, Hotel Check-in

18.00 Welcome Apéro

19.00 Dinner

Opening Remarks (Monte Veritá Restaurant)

20.30 **Johan Six, ETH Zurich**
Setting the stage: Stepping outside our comfort zones to tackle world food system challenges

Monday, 22 June 2015

Welcome Address (Auditorium)

8.45 **Chiara Cometta, Congressi Stefano Franscini**
Lorenzo Sonognini, Fondazione Monte Verità

Session 1: Bridging Science and Practice for Sustainable Food Systems (Auditorium)

How can we work across disciplines, sectors, and scales to address food system challenges?

9.00 ***Tom Tomich, University of California, Davis**
Global food challenges: Linking knowledge with action
***Ian Roberts, Bühler Group**
Practical contributions to sustainable food value chains
Karen Cooper, Nestlé
Sustainable nutrition: Tools to characterise the nutrition and environmental impacts of meals and diets

10.30 Break

Session 2: Global Change Drivers and Food Systems (Auditorium)

How can we address food and nutrition security in times of rapid global change?

11.00 *__John Ingram, Oxford University__
Environmental change and food and nutrition security: What's coming down the track?
***Pete Smith, University of Aberdeen**
Addressing the joint challenges of climate change and food security
Marta Guadalupe Rivera Ferrè, Polytechnic University of Catalonia
Assessing agri-food systems' interactions to global change: integrated SES and vulnerability frameworks applied to Andean Ecuador
John Choptiany, FAO
SHARP – lessons from developing a holistic and participatory self-assessment of climate resilience for farmers and pastoralists
Christian Schader, Research Institute of Organic Agriculture (FiBL)
The role of human-edible components in livestock feed for future food security, the environment and human diets

13.00 Lunch

Session 3: Resilience Workshop 1 (Balint Room)

14.45 **Jonas Jörin, ETH Zurich and Ruthie Musker , ETH Zurich / UC Davis**
What is "resilience"?

16.45 Break

Session 4: Trade-Offs in Rural Landscapes (Auditorium)

How can we navigate competing priorities for food and nutrition security, development, and the environment?

17.15 ***Peter Messerli, University of Bern**
Producing food in contested rural landscapes: Challenges and opportunities for sustainability science
***Jaboury Ghazoul , ETH Zurich**
The insecurity of ecosystem services
Gurbir Bhullar, Research Institute of Organic Agriculture (FiBL)
Securing the food system together: Innovation development with the farmer, for the farmer, by the farmer

19.00 Dinner

Session 5: Posters and Nightcap 1 (Balint Room)

20.30 **Pitches for posters # 1 - 10**

Tuesday, 23 June 2015

Session 6: Organic 3.0? (Auditorium)

What is the future for organic agriculture?

9.00 *__Urs Niggli, Research Institute of Organic Agriculture (FiBL)__
How sustainable is organic agriculture in the context of food security?
***Pablo Tittonell, Wageningen University**
Agroecology and sustainable food systems: The sociopolitical and technological challenges
Raffaele D'Annolfo, FAO
Social and economic performance of agroecology
Gunda Zuellich, Millennium Institute
Competing agricultural paradigms to feed a growing population in Kenya – An integrated system approach

11.00 Break

Session 7a: Regional and Local Food Value Chains (Auditorium)

What should I eat and where should it come from?

11.30 **Emilia Schmitt, ETH Zurich**
Sustainability assessment: Comparison between local and global cheese value chains in Switzerland
Gaëlle Petit, AgroParisTech, INRA
Sustainable shared value in a French pork value chain
Werner Hediger, Center for Economic Policy Research (HTW Chur)
Resilient structures for the production, processing and marketing of local food products

Session 7b: Managing Agricultural Land (Balint Room)

What are the implications of different farming systems for addressing food security challenges?

11.30 **Marcel van der Heijden, Agroscope**
A comparison of major arable farming systems: an agronomic, environmental and ecological comparison
Andreas Gattinger, Research Institute of Organic Agriculture (FiBL)
Soil organic carbon dynamics and non-CO_2 gas fluxes from agricultural soils under organic and non-organic management – results of two meta-studies

12.30 Lunch

Session 8: Stories of the Hands that Feed Us (Auditorium)

How can we make visible, the invisible?

14.15 *__Sarah Ruth Sippel, University of Leipzig__
Intensive agriculture, rural livelihoods and labour: Social science perspectives on the global food system
Beth Hoffman, University of San Francisco
Driving sustainability or producing anxiety: The use of media in mobilizing consumers
Gail Feenstra, University of California, Davis
Using values-based supply chains to engage communities
Sandy Brown, University of San Francisco
Looking for work: Farm labor and the agrarian imaginary

16.15 Break

Session 9: Resilience Workshop 2 (meet in Balint Room)

16.45 **Jonas Jörin, ETH Zurich and Ruthie Musker , ETH Zurich / UC Davis**
Framing resilience in the context of tef in Ethiopia

19.00 Dinner

Session 10: Posters and Nightcap 2 (Balint Room)

20.30 **Pitches for posters # 11 - 19**

Wednesday, 24 June 2015

Session 11: Value Chains for Nutrition (Auditorium)

How can cross-sector approaches address the challenges of nutrition security?

8.15 *__Howard-Yana Shapiro, Mars, Inc.__
162 million children under age 2 are stunted
***Valerie Schuster, GAIN**
Cultivating nutritious food systems: A snapshot report
Jessica Agnew, University of Guelph
The role of business in sustainably improving the nutritional status of the poor
Kalpana Beesabathuni, Sight and Life
Agricultural value chain analysis for developing affordable nutritious foods for women in Ghana

10.00 Break

Session 12: Biofortification of Staple Crops (Auditorium)

How are the achievements in 2015 tackling the challenges of food and nutrition security?

10.30 *__Erick Boy, HarvestPlus Challenge Program, IFPRI__
Biofortification: Achievements and challenges
***Alida Melse-Boonstra, Wageningen University**
Biofortification of cassava with beta-carotene: Insights from recent studies
Diego Moretti, ETH Zurich
Biofortification of staple foods with iron and zinc
Navreet Bhullar, ETH Zurich
Biotechnological approaches for nutritional enhancement of staple crops
Rainer Schulin, ETH Zurich
Zinc biofortification of wheat through soil organic matter management

12.30 Lunch

Session 13: Food Systems Approaches in Practice (Auditorium)

How can we work across disciplines and sectors to simultaneously foster sustainable agriculture, nutrition and livelihoods?

14.00 *__Jessica Fanzo, Columbia University__
Global trends in food security and nutrition: the importance of food system approaches to making progress
***Roseline Remans, Columbia University / Bioversity International**
Landscape transitions and agriculture-nutrition linkages: Looking back to the future

Excursion to Brissago Islands (with Dinner)

15.15 Depart from Monte Veritá

ca. 21.45 Return

Thursday, 25 June 2015

Session 14: Producing More with Less (Auditorium)

How do sustainable production approaches go beyond the challenge of global food security?

9.00 *__Fusuo Zhang, China Agricultural University__
Producing more with less to ensure food security and environmental sustainability
Emmanuel Frossard, ETH Zurich
Biophysical, institutional and economic drivers of sustainable soil use in yam systems for improved food security in West Africa (YAMSYS)
Elisabeth Fischer, Syngenta
The Good Growth Plan farm network – Measuring resource efficiency of crop production systems
Feriha Mugisha Mukuve, University of Cambridge
Scale variability of water, land, and energy resource interactions in the food system in Uganda

10.30 Break

Session 15a: Overcoming Barriers to Access (Auditorium)

How can we evaluate diverse strategies for improving food and nutrition security?

11.00 **Silas Okech-Ongudi, Egerton University**
Determinants of consumers' choice and potential willingness to pay higher prices for biofortified pearl millet products in Kenya
Conrd Murendo, Georg August University Göttingen
Impact of mobile money technology on household food security in Uganda
Helena Kahiluto, Natural Resources Institute Finland
Response diversity within retail can secure access to food

Session15b: Whose Loss? (Balint Room)

How can broadening our understanding help tackle the challenges of waste and losses in the food system?

11.00 **Tammara Soma, University of Toronto**
Beyond "Farm to Table" to "Farm to Dump": Emerging research and theoretical frameworks on urban household food waste in the global south
Claudio Beretta, ETH Zurich
Environmental impact of food losses from agriculture to consumption in Switzerland
Irene Kadzere, Research Institute of Organic Agriculture (FiBL)
Postharvest Management: Potential challenges for smallholder organic farmers in Kenya

12.15 Lunch

Session 16.1: Effecting Change in the Food System (Policy) (Auditorium)

How can policy foster sustainable food systems?

14.15 **Jean-Marc Faures, FAO**
A common vision for sustainable food and agriculture
Nina Buchmann, ETH Zurich
Policy and research for a sustainable Swiss food system
Patrick Mink, Swiss Federal Office for Agriculture
What knowledge for sustainable food systems?
Stephan Rist, University of Bern
Towards food sustainability: Reshaping the coexistence of different food systems in South America and Africa

Session 16.2: Effecting Change in the Food System (Interventions) (Auditorium)

15.15 **Andi Sharma, Manitoba Department of Aboriginal and Northern Affairs**
Collective impact systems: Collaborating for change
Felipe Roa-Clavijo, University of Oxford
Negotiating country food systems: Colombia's national and subnational agrarian dialogue and negotiation tables
Carmen Torres, Instituto Nacional de Alimentación Uruguay
Development of a national surveillance system for food and nutrition security to strengthen actions aimed at ensuring the right to food in Uruguay

16.15 Break

Session 17: Resilience Workshop 3 (meet in Balint Room)

How can interventions and collective action foster positive change in the food system?

16.45 **Jonas Jörin, ETH Zurich and Ruthie Musker, ETH Zurich / UC Davis**
Modeling resilience across systems, sectors and scales

19.00 Dinner

Building New Collaborations (Breakout Rooms)

20.30 Time and space reserved for meetings and discussions

Friday, 26 June 2015

Session 18: Water for Food, Nutrition, and Health (Auditorium)

How can effective water management practices address world food system challenges?

9.00 *__Charlotte de Fraiture, UNESCO-IHE__
Is a water crisis inevitable? Towards an ecosystems approach to water for food production
Anne Dietzel, Eawag
A national view on managing trade-offs between agricultural production and conservation of aquatic ecosystems
Simone Passarelli, IFPRI
Is reliable water access the solution to undernutrition? A review of the potential of irrigation to solve nutrition and gender gaps in Africa south of the Sahara
Kate Scow, University of California, Davis
Participatory research to identify irrigation technologies for horticulture for women and smallholder farmers in Eastern Uganda
Hong Yang, Eawag
Global water saving through international food trade: what does it mean?

11.00 Break

Session 19: Making Sense of it All (Auditorium)

11.30 **Presentation of CSF Award**
All Participants
Wrap Up – Next Steps – Concluding Remarks

12.30 Lunch / End of Conference

Posters List

Posters are sorted alphabetically by last name of the presenting author. Please refer to this list to locate the board where your poster can be displayed. Pins are available in the poster room.

1. **Dörte Bachmann, ETH Zurich**
   Life cycle impact assessment (LCIA) of soil degradation: Development of a new impact assessment method in LCA

2. **Joel Berard, ETH Zurich**
   Is extensive grazing on subalpine pastures a successful strategy to preserve biodiversity and to produce of meat with special quality?

3. **Elena Boriani, Technical University of Denmark**
   Common metrics across diverse disciplines for evaluating potential risk – benefit of food

4. **Rebekka Burkholz, ETH Zurich**
   Systemic Risk in Maize Trade

5. **Bastian J. Flury, ETH Zurich**
   Living Lab for Sustainable Campus Catering

6. **Jaqueline Garcia-Yi, Technical University of Munich**
   What are the socio-economic impacts of genetically modified crops worldwide? A systematic evaluation of the research evidence available in six languages

7. **Gina Garland, ETH Zurich**
   Phosphorus and nitrogen transfer within maize-pigeon pea intercropping systems of Malawi

8. **Isabel Jaisli, Zurich University of Applied Sciences**
   Food production in smallholder farming systems: Developing a spatially explicit decision-model for trade opportunities

9. **Norman Fraley, NutrAfrica (presented by Jonas Jörin)**
   NutrAfrica - Indigenous Efforts to Address Food Insecurity in Ethiopia through Production Processing and Value Addition of Regional Staple Foods

10. **Helena Kahiluoto, Natural Resources Institute Finland**
    Equity in access to nutrients within the planetary boundaries

11. **Ella Susanne Lawton, Otago Polytechnic**
    Exploring the New Zealand Food Footprint

12. **Gian L. Nicolay, Research Institute of Organic Agriculture (FiBL)**
    Unified Science for Understanding Agriculture and Food Systems. Experiences made in West Africa with an innovative method of research and development

13. **Paul Niyitanga, Uganda Industrial Research Institute**
    Design of a Low Cost Solar Powered Smart Grain Silo

14. **Eleni D. Pliakoni, Kansas State University**
    Training the next generation of agricultural educators to grow local food systems in urban areas

15. **Paolo Prosperi, Bioversity International**
    Sustainability and Food & Nutrition Security: A Vulnerability/Resilience Framework for Food Systems

16. **Cary Lee Rivard, Kansas State University**
    Growing Growers: Facilitating the development of new farmers in order to strengthen local food systems

17. **Cristina Romero Granja, University of Göttingen**
    Supplier dynamics in horticultural export chains:
    evidence from Ecuador

18. **Judith Hecht, Research Institute of Organic Agriculture (FiBL) (presented by Christian Schader)**
    Scarce resources meet growing food demands: Can we continue with -business as usual- land use in the Alpine countries

19. **Pablo Torres-Aguilar, Purdue University**
    A technology-based Incubation Center for establishing food processing enterprises in Niger, a case study

20. **Rattan Yadav, Aberystwyth University**
    Development of pearl millet for health benefits for type-2 diabetes

Abstracts: Oral Presentations

Abstracts for oral presentations are sorted chronologically according to the program. Presenting authors are listed in bold.

Abstracts have been edited for consistency of style but not in their contents, which remain responsibility of the authors.

Global food challenges: linking knowledge with action

Thomas P. Tomich[a], R. Musker[a,b] and C.M. Riggle[a]

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This presentation is intended to provoke discussion on three broad, inter-related questions that are central to meeting global food challenges in the 21st Century.

1) How might universities provide leadership in global efforts to enable the 9 billion people expected to be residing on Earth by 2050 to feed themselves?

2) What does sustainability science have to do with this? Partial answer: a lot, both about WHAT issues need to be tackled and also especially about HOW to tackle those issues in ways that effectively link science and action.

3) Finally, since we cannot tackle everything at once, where do we start? Among dozens of issues, how can we focus coherently? In other words, how do we know we are asking the right questions? And how do we identify credible evidence (indicators) to benchmark those issues?

References:

"An approach for identifying the issues and metrics that define and measure sustainable development in agricultural supply chains." NP Springer, AD Hollander, PR Huber, M Langner, R Musker, C Riggle, S Brodt, JF Quinn, TP Tomich (under review)

"Sustainable sourcing of global agricultural raw materials: assessing gaps in key impact and vulnerability issues and indicators." NP Springer, K Garbach, K Guillozet, VR Haden, P Hedao, AD Hollander, PR Huber, C Ingersoll, M Langer, G Lipari, Y Mohammadi, R Musker, M Piatto, C Riggle, M Schweisguth, E Sin, S Snider, N Vidic, A White, S Brodt, JF Quinn, TP Tomich. (in press) *PLOS ONE*

"Indicators of global sustainable sourcing as a set covering problem: an integrated approach to sustainability." PR Huber, NP Springer, AD Hollander, VR Haden, S Brodt, TP Tomich, and JF Quinn. 2015. *Ecosystem Health and Sustainability* 1(2):7. http://dx.doi.org/10.1890/EHS14-0008.1

"Boundary work in research programs for sustainable development: natural resource management at the Consultative Group on International Agricultural Research CGIAR." WC Clark, TP Tomich, M van Noordwijk, NM Dickson, D Catacutan, D Guston, and E McNie. 2011. *Proceedings of the National Academy of Sciences USA* DOI 10.1073/pnas.0900231108

"UC Davis, one of the world's leading agricultural universities, on the global food system." TP Tomich, AB White, and CM Riggle May 2014. *Sustain Magazine.* Washington, DC: International Finance Corporation of the World Bank/IBRD.

Sustainable Nutrition: Tools to characterise the nutrition and environmental impacts of meals and diets

Karen Cooper[a], N. Espinoza-Orias[b] and A. Roulin[a]

[a] *Nestlé, Switzerland*
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Sustainable nutrition can be defined as 'The physical and economic access to sufficient, safe and nutritious food and water to fulfil dietary and cultural needs to enable an active and healthy lifestyle without compromising the ability of future generations to meet these needs'. Therefore when evaluating the nutrition of food, it is essential to also consider its impact on the environment. To do this with any accuracy, it is important to consider the entire value chain of each foodstuff from the impact of agriculture, through transport, food processing, storage, consumption and end of life. The complexity and multi-expertise nature of sustainability and nutrition requires that new web based tools are developed that can be used by non-specialists in order to carry out these assessments. EcodEX is a software tool that can be used by non-life cycle assessment specialists to model the end to end environmental impact of products (Espinoza-Orias *et al*, 2014)). Concurrently, we are developing a tool based on a unique algorithm which scores the balance of nutrition of meals and diets. Examples of the application of these two tools have been developed, for example, assessing the USA MyPlate recommendations, the DASH diet and the Livewell/WWF diets. We are currently also exploring what can be done to model nutrition and environmental impact from predictive crop data generated via the IMPACT project (Rosegrant *et al*. 2012). This work is important to Nestlé to help improve our products and overall impacts but also these tools are can aid global projects such as ILSI-CIMSANS (Center for Integrated Modeling of Sustainable Agriculture and Nutrition Security) with their goal to define the future metrics of sustainable nutrition security.

References

Espinoza-Orias, N., Roulin, A., Watzke, H. & Cooper, K. 2014. Connecting the dots: Assessing sustainable nutrition at Nestlé. Proceedings of the 9th International Conference on Life Cycle Assessment in the Agri-Food Sector, San Francisco, CA.

Rosegrant, M.W. and the IMPACT Development Team. 2012. International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT): Model Description. International Food Policy Research Institute (IFPRI), Washington, D.C.

We acknowledge Ed Fern, Heribert Watzke, Denis Barclay and Adam Drewnowski for the development of the nutrition algorithms.

Environmental change and food and nutrition security: What's coming down the track?

John Ingram[a]

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This presentation initially discusses the concepts of food system activities and actors, and food system outcomes related to food security and environmental change. Food system *activities* include: (i) producing food; (ii) processing food; (iii) packaging and distributing food; and (iv) retailing and consuming food. These activities lead to a number of food and nutrition security o*utcomes* including access to, and utilisation of food, in addition to food availability; and to other socioeconomic outcomes (e.g. employment). They also contribute substantially to crossing the "planetary boundaries": in relation to climate change, GHG emissions from agriculture are usually the focus of attention from a 'food' perspective, but non-agricultural food system activities account for 40 and 60% of food-related emissions in US and UK, respectively. All food system activities also contribute to crossing all other planetary boundaries, especially biodiversity, biogeochemical cycles and fresh water resources. The presentation will then move to considering how food security for individuals and communities is determined by the access they have to food and their behaviour. This will be discussed in relation to the multiple roles of the 'food chain' (alternatively referred to as the food 'value chain'), and the quantity and quality of food produced. Plausible socioeconomic futures for population, wealth and dietary patterns will then be related to food system outcomes. The need to better understand the nature of food system drivers and feedbacks in order to improve food system effectiveness and efficiency will be highlighted.

Addressing the joint challenges of climate change and food security

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Feeding 9–10 billion people by 2050 and preventing dangerous climate change are two of the greatest challenges facing humanity. Both challenges must be met while reducing the impact of land management on ecosystem services that deliver vital goods and services, and support human health and well-being. Few studies to date have considered the interactions between these challenges. The supply- and demand-side climate mitigation potential available in the Agriculture, Forestry and Other Land Use (AFLOU) sector and options for delivering food security are briefly reviewed. Some of the synergies and trade-offs afforded by mitigation practices are outlined, before an assessment of the mitigation potential possible in the AFOLU sector under possible future scenarios is presented, in which demand-side measures co-deliver to aid food security. I conclude that while supply-side mitigation measures, such as changes in land management, might either enhance or negatively impact food security, demand-side mitigation measures, such as reduced waste or demand for livestock products, should benefit both food security and greenhouse gas (GHG) mitigation. Demand-side measures offer a greater potential (1.5–15.6 Gt CO_2-eq. yr^{-1}) in meeting both challenges than do supply-side measures (1.5–4.3 Gt CO_2-eq. yr^{-1} at carbon prices between 20 and 100 US$ tCO_2-eq. yr^{-1}), but given the enormity of challenges, all options need to be considered. Supply-side measures should be implemented immediately, focusing on those that allow the production of more agricultural product per unit of input. For demand-side measures, given the difficulties in their implementation and lag in their effectiveness, policy should be introduced quickly, and should aim to co-deliver to other policy agendas, such as improving environmental quality or improving dietary health. These problems facing humanity in the 21st Century are extremely challenging, and policy that addresses multiple objectives is required now more than ever.

Assessing agri-food systems' interactions to global change: integrated SES and vulnerability frameworks applied to Andean Ecuador

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Assessing agri-food systems' interactions with global environmental change requires a new integrated approach. Agri-food systems, defined as a set of activities ranging from production through to consumption, can be conceptualized as socio-ecological systems (SES) (Ericksen, 2008). These systems are especially vulnerable to environmental and socioeconomic changes that lead to system's modifications (desirable or not). According to the focus used for the assessment of agri-food systems we distinguish between *official* and *alternative* frames of research. The *official frame* tends to analyze agri-food systems mainly from natural sciences, separating the social and ecological components to study the system, and focusing in developing blueprint approaches. The *alternative frame* tends to integrate natural, social and political sciences to study agri-food systems as SES, giving diverse strategies for supporting policy-design (Rivera-Ferre et al., 2013). Here we propose an integrated framework for assessing the vulnerability of agri-food systems under different policy scenarios, using the alternative frame of research. To achieve our objective we integrate the general conceptual and methodological SES framework proposed by Ostrom (2007; reviewed in 2014) with the framework of vulnerability proposed by Adger (2006) and operationalized by Fraser (2007), which consider vulnerability in reference to characteristics of sensitivity and adaptive capacity generated and influenced by multiple factors and processes. Conceptually, the SES framework provides a common conceptual language to analyze any complex SES; and, the vulnerability framework takes into account context-specific factors and local perceptions. Methodologically, the SES framework as epistemic object allows identifying the boundary and components of a complex SES and understanding how different interactions may produce certain outcomes, such as impacts on livelihoods, affected by internal feedbacks and external forces, e.g. climate patterns and policy, demographic and economic changes. Further, the SES framework allows us to move across spatial levels to analyze the cross-scale interactions, e.g. moving from household-level to national level for analyzing the role of policies. We suggest selecting the particular variables (among the multiple tiers included by the SES framework) relevant to our research objectives in a specific socioeconomic context (e.g. food sovereignty policies in Ecuador) and linked to livelihoods strategies and their vulnerability to climate and policy changes. The integrated framework has been applied to an empirical research in Andean Ecuadorian region to characterize the agri-food system as a SES and later assess the future of local agri-food systems using participatory scenario tools.

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SHARP – lessons from developing a holistic and participatory self-assessment of climate resilience for farmers and pastoralists

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There has been a growing push to better target development interventions in a world of increasing population growth and climate change. To achieve food security and nutrition, there is an understanding that development practitioners need to better combine the academic lessons learned during decades of development work with the needs and priorities of the poor – as expressed by themselves. SHARP has been developed to try to bridge this gap and combine academic understanding of climate resilience with the needs of farmers and pastoralists through a participatory self-assessment. The SHARP tool helps farmers and pastoralists better understand and prioritize areas of high and low resilience of their agricultural system by asking questions spanning environmental, social, economic and practices/knowledge components. The tool is implemented using a dedicated tablet application by farmer field school facilitators over the length of a growing season. It combines academic measures of a resource (e.g. how many livestock heads), a qualitative optional response, and a self-assessment of both adequacy of the resource and importance of the resource to produce a rapid assessment of the participants' climate resilience priorities to encourage discussion and prioritize action.
The development of SHARP has spanned two years and five countries including over 300 farmers and pastoralists and 250 reviewers from different disciplines. The challenges faced in the development of SHARP are multidimensional, including issues of different language, education, literacy, agricultural practices, temporal constraints and diverse stakeholder interests. SHARP has tried to overcome these challenges by matching the 51 questions with 13 resilience indicators identified by Cabell and Oelofse (2012) while designing the application to be as flexible and participatory as possible. Matching questions to the 13 resilience indicators allowed for the streamlining of questions (both content and total number) to include only those that were strictly contributing to a resilience indicator, hence avoiding overloading participants with too many questions. This paper will explore the development of SHARP, outline the trade-offs made in order to create a practical tool for use in sub-Saharan Africa, provide lessons learned during this development process and outline future developments and expected challenges as SHARP is implemented in a variety of contexts and projects.

The development of SHARP has received funding from the European Union through the "Improved Global Governance for Hunger Reduction Programme." The views expressed herein can in no way be taken to reflect the official opinion of the European Union or the Food and Agriculture Organization of the United Nations. The development of SHARP has benefited from the contributions of many collaborators, most notably Jami Dixon & Lindsay Stringer (both University of Leeds).

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The role of human-edible components in livestock feed for future food security, the environment and human diets

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On the one hand, modern, intensive livestock systems are highly efficient in terms of per-animal productivity of meat, milk and eggs (Steinfeld, 2006). On the other hand, they compete for arable land with food crops. A substantial fraction of energy-rich concentrates in animal diets stems from crops grown on arable land. Globally only 33% of agricultural areas are classified as arable land. Hence, a further expansion of livestock production poses a challenge for the sustainability of future food systems(FAOSTAT, 2013).

Against the background of ever increasing demand for livestock products, a strategic discussion of the role of intensive livestock systems using human-edible components is needed. This paper aims to contribute to these discussions by providing quantitative modelling results of scenarios for future food production. In these scenarios we use grassland-based animal diets which consist of reduced fractions of human edible components.

We use a model which builds on FAOSTAT -the food balance sheets-, life cycle inventories from LCA databases and additional scientific literature. It considers 180 plant and 35 livestock production activities for 229 countries. Activity and country-specific defined inputs and outputs allow to model environmental impacts of a wide range of scenarios. As environmental indicators we cover land occupation, energy use, greenhouse gas emissions, N and P eutrophication from a life cycle perspective as well as pesticide use potential, irrigation water use, deforestation and soil erosion potential (Schader et al., 2014).

Our results show that reducing the use of human-edible components in livestock rations can contribute to more sustainable food systems by increasing the energy and protein availability for human nutrition and reducing environmental impacts. However, this change would limit the availability of livestock products for human nutrition.

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Producing food in contested rural landscapes: challenges and opportunities for sustainability science

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Food production in rural landscapes of the Global South is increasingly challenged by a multitude of claims on land-related ecosystem goods and services from actors at higher scales and distant places. As a consequence, these socio-ecological systems often experience negative impacts both in term of human wellbeing and environmental stewardship. Mirroring this phenomenon at the normative goal of achieving food security and promoting sustainable agriculture – as currently defined in the post-2015 agenda – we ask what it means to explore transformations towards sustainable land use and what the role of sustainability oriented research could be. We identify three key challenges related to such knowledge production in terms of time, space, and scale. Using concrete examples of research in Southeast Asia, we will try to illustrate how such challenges could be overcome. We conclude on the implications for sustainability science and future research agendas.

The Insecurity of Ecosystem Services

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Delivering food security in the context of current and future environmental challenges is a central preoccupation of environmental and agricultural scientists. A currently popular approach to addressing this challenge is agricultural development within an ecosystem services framework. Such a framework aims to deliver food security while maintaining healthy ecosystems that provide a suite of valuable services that benefit society. Indeed, the approach argues that the sustainable food production is directly and indirectly shaped by the flows between agricultural and natural ecosystems. I argue that while ecosystem service concepts have gained considerable traction in scientific literature, their practical implementation is beset with problems once exposed to the full complexities of land use and socio-political realities. A failure to heed such complexities could undermine our abilities to respond to the food security challenge and, moreover, might only serve to constrain the livelihood opportunities of many farmers, particularly in the tropics. Thus while ecosystem service approaches have proved highly instructive, we still need to bridge the gap between theory and implementation.

Securing the food system together: Innovation development with the farmer, for the farmer by the farmer

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In recent years, the limitations of top-down approaches for development-oriented research have become apparent. Therefore, scientists have started to explore alternatives such as participatory research. By involving many stakeholders throughout the different stages of innovation development, participatory research helps tackling the multi-faceted challenges the global food system is facing today.

Since almost a decade, the Research Institute of Organic Agriculture (FiBL) has been running a large program called "Farming Systems Comparison in the Tropics" (SysCom) in Bolivia, India and Kenya. Besides maintaining four Long-Term farming systems comparison Experiments (LTE), Participatory On-farm Research (POR) is a strong component of SysCom. In POR, we aim at fostering sustainable agriculture by developing locally adapted solutions for specific challenges of farmers. Researchers, extension agents, private sector and farmers work together from the stage of problem identification to the achievement of results, and finally scaling them. By taking into account local knowledge and available resources, significant achievements have been made in all of the three countries.

In India, we developed a new kind of phosphorous fertilizer for use in organic farming with which farmers substantially increased the yields of their main rotation crops across different types of soils and farms. We also standardized the preparation of homemade organic pesticides from different plants. In addition, we developed a practicable guide for pest monitoring in the small scale farmers' context. In Bolivia, we tested different cocoa varieties. Results showed that some local selections were not only among the most productive, but also presented the earliest maturation and some degree of resistance to the frosty pod rot disease (Moniliophthora roreri). In Kenya, we addressed the lack of organic materials for soil fertility management. By testing different local residues and manures, as well as composting techniques, we brought forward a productivity innovation for local small scale farmers. On a local level, the results were made available in the form of leaflets, brochures and video clips. These were used by farmers, extension workers and other stakeholders.

Combining applied science (LTE) with participatory action research (POR) is a powerful approach which has proven successful in SysCom. The beauty of this approach lies in the fact that it allows for multiple perceptions. However, it also comes with its own challenges which mainly lie in the fact that it requires different mindsets than traditional research approaches, as the whole process is relatively less controlled by researchers. If we teach and assist farmers to carry out research on their own farms, it will be easier for them to appreciate the effects of novel technologies which, in turn, will enhance their adoption.

Acknowledgements: The SysCom program is financially supported by Biovision Foundation, Switzerland, Coop Sustainability Fund, Liechtenstein Development Service (LED) and the Swiss Agency for Development and Cooperation (SDC).

More information on SysCom: www.systems-comparison.fibl.org

Organic 3.0: How sustainable is organic agriculture in the context of food security?

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The overarching challenge of both organic and agroecological agriculture is to minimize trade-offs between food and fiber production on the one hand and non-commodity ecosystem services on the other hand. Best use of human, social and natural capital characterizes organic farmers especially in developing countries as documented by many case studies from Sub-Saharan Africa, but also on organic farms in temperate zones with usually higher external inputs. While the profitability of organic farms is comparable or slightly higher than of conventional ones, the per area food production is lower, in temperate zones averaging 20 to 25 percent. Too restrictive production standards are often mentioned as the cause but also a backlog in the production technique. One of the main approaches of organic agriculture to become more productive is ecological or eco-functional intensification with the goals to maintain the ecological and social qualities of the farms and to increase food output. The future development of organic agriculture can be characterized by a comprehensive culture of innovation embracing social, ecological and technological innovations. Such a concept of innovation includes dynamic interactions between farmers and scientists in order to strengthen system resilience and better uses basic research from a wide range of scientific disciplines.
Keywords: Organic agriculture, eco-functional intensification, innovation

Agroecology and Sustainable Food Systems: The socio-political and technological challenges

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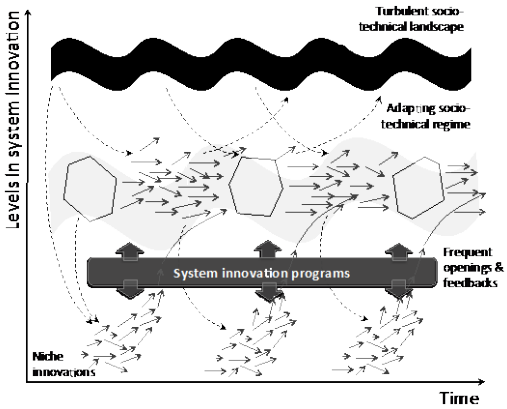
Transitioning towards agroecology and sustainable food systems requires both technical and institutional innovation (Tittonell, 2014). New knowledge systems that merge scientific and farmer wisdom, and new knowledge brokerage are needed to develop, test and deliver the necessary technological innovations. New value chains, policies and transition governance systems need to be in place to create conducive conditions and mitigate possible risks and transaction costs. In the light of transition theory, this implies shaking up current innovation landscapes and socio-technical regimes (Geels et al., 2008) (Figure). Transitions are often described in terms of three necessary and sequential steps (Grin, 2010): (i) contesting the current system, (ii) validating alternatives, and (iii) convergence. Agricultural research can certainly contribute at these three steps. Yet the results of most international research projects on agroecological management show very promising results in technical terms (e.g. more than doubling crop yields in 53 projects in Africa – Pretty et al., 2011) but equally disappointing results in terms of adoption once the project is over. This implies that, to provoke permanent change, transitions might no be sufficient and that rather thorough transformations and/or regime ruptures would be necessary. This is particularly the case when shifting from prediction-control regimes (industrial farming) to integrated, adaptive regimes (agroecology) (Pahl-Wostl et al., 2007). Examples from different parts of the world will be used to illustrate such dynamics and the necessary mechanisms to support change, either through transition or transformation. Where and under which (socio-political) circumstances or regime characteristics has one or the other model worked? A key lever in supporting change is the implementation of multi-actor system innovation programs to facilitate (i) reflexive testing and adaptation of technical innovations, (ii) social learning and (iii) openings and feedbacks to and from the sociotechnical regime. A framework for assessing regime characteristics will be proposed based on dimensions such as agency, awareness raising, type of governance, cooperation structures, policy development and implementation, information management and risk management.



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Social and economic performance of Agroecology

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FAO along with numerous recent reviews has emphasized that future needs of food and nutrition will have to be addressed by transitioning agriculture to regenerative systems of food production based on an effective and enhanced use of ecosystem services that minimize negative externalities while improving or at least stabilizing yields. Agroecology offers such a transformative path to agricultural development as it integrates ecological principles as well as social and economic concerns into agricultural production and the wider food system. Agroecology is the integrative study of the ecology of the entire food system, encompassing ecological, economic and social dimensions.[1]

The present analysis represents a first attempt to build the basis for providing a general overview on the socio-economic effects of adopting selected agroecological practices at farm level. Eight indicators have been identified: yield, farm profitability, labor demand, labor productivity, income inequality, income stability, transition costs and level of empowerment.

In order to observe the general effects and trends of the agroecological practices with respect to certain socio-economic areas, a vote count methodology has been selected to analyze the available quantitative data: the number of positive studies (showing improvements of one of the indicators by using agroecological practices) have been compared with the number of negative studies (showing worsening of one of the indicators by using agroecological practices); therefore absolute, relative and cumulative frequency is computed to compare and integrate the results of multiple studies and to draw general patterns. With the intent to also include qualitative information, and to provide a more comprehensive overview, a narrative review has been included in the analysis. Scientific literature has been selected from the Scopus database according to specific word combinations: 42 papers have been reviewed.

Evidence based on the data collected suggests that adopting agroecological practices increases the yield (60% of comparisons, 24/40), labor productivity (100% of comparisons, 3/3) and farm profitability (56% of comparisons, 22/39), the only indicator which exhibits a decreasing value is the labor demand (75% of comparisons, 3/4). The relative frequency of comparisons in terms of synergies or trade-off between the farm profitability and yield shows: 54% of comparisons demonstrate a synergy between farm profitability and yield (Win Win scenario) and only 15% of the comparisons confirm a trade-off between farm profitability and yield (Lose Lose scenario). Additionally the social organization aspects of Agroecology can also be considered as a positive externality by building social capital and empowering food producers and their communities. In rural areas characterized by marginalization and autonomous organization, the empowerment process related to Community-Based Forest Management represents an important mechanism for addressing environment health as well as the well-being of forest inhabitants.

Agroecology has the potential to improve the livelihood of farmers. In order to do that, more efforts are required to better study Agroecology and its socio-economic effects. We acknowledge that our effort is only a first, incomplete step in that direction.

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Competing agricultural paradigms to feed a growing population in Kenya – An Integrated System Approach

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Achieving and sustaining food and nutrition security continues to be a huge challenge for the global community. The tragedy of hunger still persists for more than 800 million people today. Addressing this intolerable situation calls for reversing the vicious cycle of poor nutrition, poor health, lost productivity, persistent poverty, and stagnating economic growth. Against the background of growing food demand the need for effective, coordinated and sustainable intervention remains. Developing coherent plans to achieve food and nutrition security is complicated by the multi-disciplinary, interconnected and complex nature of the food systems that must be managed. To support such a planning process in Kenya, we analyze the impact of alternative interventions targeting food security through an integrated socioeconomic-environmental framework (the Millennium Institute's Threshold-21 model) that takes into account the multiple direct effects as well as the long-term, indirect consequences of the policies being simulated. Our framework is implemented with the System Dynamics method, which is well suited to capture the elements of dynamic complexity, such as feedback loops, delays, and non-linearity that make public policy analysis in this area particularly difficult. In a country such as Kenya, where the majority of the population depends on agriculture and livestock, either directly or indirectly, for their livelihoods, agriculture plays a key role in food and nutrition security with regard to the availability dimension and also the access dimension. Our study explores and evaluates two scenarios representing two competing paradigms in agricultural policy and farming practices. In the first scenario government support is mainly directed towards subsidizing the intensive use of high external inputs and large-scale farming, while in the second scenario the government mainly supports a transition towards high agro-ecological knowledge intensity, less intensive use of external input and small-scale farming. Results indicate that, in terms of food availability, the first scenario yields better results in the short term while the second scenario shows more desirable results in the long run. This behaviour is even more pronounced for crops production in terms of value added due to higher intermediate consumption in the first scenario. The policy in the second scenario is also more sustainable in the sense that the positive impact sustains even if the governmental support is discontinued. In addition, the agriculture system that emerges from the second scenario creates less environmental pollution, while maintaining the natural fertility of the soil and leaving the biodiversity of the farm intact. Finally, the patterns of social indicators and consequently access to food are also substantially better in the second scenario, which supports more equitable socio-economic progress. In summary, our work highlights how a failure to account for the interconnected and complex nature of the food-development nexus can lead to sub-optimal strategies. Further research is in progress on the applications of our framework to other Sub-Saharan African countries characterized by different social, economic, and environmental challenges.

Sustainability assessment: comparison between local and global cheese value chains in Switzerland

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The common belief that local food is a priori more sustainable has been called the "local trap" by Born and Purcell (2006) mainly because local food systems are equally likely to be unsustainable than other systems. In order to better understand the trade-offs between local and global scales, a scientific comparison is needed. This paper is presenting the comparison between a local and a global cheese value chain (VC) in Switzerland applying a multi-dimensional sustainability assessment adapted from the SAFA guidelines (FAO, 2013).
The assessment covers five dimensions of sustainability: environmental, economic, social, ethical and health. In these dimensions, eight attributes characterized by 23 indicators have been identified from literature and stakeholders' interviews. Le Gruyère cheese is a global chain (GC) because it is produced on an industrial scale with more imported inputs, and is more widely exported than L'Etivaz, the cheese identified as the local chain (LC) which is produced on alpine farms of a small region through an artisanal process. Data has been collected through interviews with a representative number of respondents for each stage of the two VCs (inputs, production, processing, and retail) and a focus group discussion has been conducted with consumers. Sustainability scores were calculated for each indicator on a percentage scale by using benchmarks and then compared.
Results show that the LC gets higher scores in two thirds of indicators. It is especially the case for the three animal welfare indicators (ethics) as cows in the LC spend longer times on pasture, have more space and live longer. The LC also reaches higher scores in all four health indicators as the local cheese contains less salt, a little less fat and saturated fat and more calcium. In the environmental indicators, the LC performs better in five out of eight indicators (soil, materials, processing management practices, diversity of production and greenhouse gas mitigation from processing), but the GC performs better in waste reduction, landscape management and greenhouse gas mitigation at the farm level. In the social dimension, the LC has higher scores in the distribution of the price and for the good communication along the chain, but the GC performs better in providing information to the consumer. In the economic dimension, the GC provides a more affordable price for consumers while contributing to a higher income for farmers and cheesemakers. The LC, however, has a higher contribution in terms of jobs provided. Overall, the difference is the most clear in "non-traditional" sustainability dimensions like ethics and health and we can argue that including a broader perspective in sustainability assessments can support differentiation between local and global chains.

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Sustainable shared value in a French pork Value Chain

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In 2014, United Nations Food and Agriculture Organization defined sustainable food value chains (SFVC) as following: full range of farms, firms and their successive coordinated value-adding activities that produce and transform raw agricultural materials into food products sold to final consumers and disposed of after use. SFVC has to be profitable throughout, has broad-based benefits for society, and does not permanently deplete natural resources. Moreover, there are more and more publications that directly deal with the subject under its triple bottom line: (Linton, Klassen et al. 2007, Brasili, Fanfani et al. 2008, Wognum, Bremmers et al. 2011, Esnouf, Jean et al. 2012, Irz, Leroy et al. 2013, Schiefer and Deiters 2013, Allen, Prosperi et al. 2014, Prosperi, Allen et al. 2014) We understand that SFVC should be creating shared value, that is to say maximizing benefits for all stakeholders over one or more of the three pillars of sustainable development : environmental, economic, social/societal. This is about proposing an offer that is safe and acceptable to the consumer (high nutritional quality, fitting cultural codes), at the right price (and this includes a fair consideration for all economic actors), and with lower and monitored environmental impact.

This study aims to characterize the sustainable value which can be expected by different actors of a French pork value chain. With this goal, two sources of information were considered. Firstly a literature survey has been conducted to identify the major issues associated with this industry in the national and European context. Secondly we carried out about thirty interviews with various players along the whole value chain and indirect stakeholders such as independent labels and public authorities. From these two inputs, we therefore provide a set of indicators based on the three dimensions of sustainable development, broken down into three levels: society (including consumer, and public policies), the whole value chain and each player of it. In a next step this synthesis will be used as a framework to define the common information sharing needed to support a process of sustainable value co-creation in a French pork value chain.

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Resilient Structures for the Production, Processing and Marketing of Local Food Products

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Climate change and the liberalisation of agricultural markets as well as short-term shocks like unpredicted price variations, weather variability and food crises (e.g. BSE) constitute huge challenges on the resilience of the agri-food system, that is, the ability of farmers and down-stream industries (processing, trade, gastronomy and tourism) to resist and adapt to such impacts (El Benni & Hediger, 2014).

Key strategies toward resilience in the business realm are self-organisation and cooperation (Berkes, 2007; Darnhofer, 2010; Folke et al., 2002). The former primarily applies to the individual firm or farm, whereas cooperation supports the creation of resilient structures through various forms of organisation between different partners along the value chain. In the New Institutional Economics, the various forms of organisation locate between the market and hierarchical integration. This also includes hybrid forms between the two extremes (Ménard, 2007; Williamson, 1991).

Our research is to identify optimal strategies and forms of organisation that increase the resilience of value chains in the agri-food economy, particularly with regard to local food products in Alpine regions. To this end, we investigate distinct and differently organised value chains with regard to their resilience against external shocks and their value-adding (income) potential to the various actors in the chain.

Given the increasing demand of tourists for products with regional characteristics (Bosshart & Frick, 2006), the interface between the tourism industry and agriculture grows and opens new synergy potentials for the participating actors in touristic areas (Simon & Kuhnhenn, 2013). Those potentials have not been investigated yet. Thus, by linking the concept of resilience with the theory of the new institutional economics, the present research aims at closing a research gap and identifying strategies to maintain or even increase income local.

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A comparison of major arable farming systems: an agronomic, environmental and ecological comparison

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One of the primary challenges of our time is develop sustainable farming systems that can feed the world with minimal environmental impacts. Some studies argue that organic farming systems are best because they have minimal impact on the environment and are positive for biodiversity. Others argue that no-tillage systems are better because they save energy and preserve soil structure and quality. A third group argues that conventional farming systems are best because yield per hectare is highest. However, so far, systematic comparisons of major arable farming systems are rare and often it is difficult to compare the advantages and disadvantages of farming systems in a systematic way due to differences in soil/site characteristics and management. Here we present data of the Swiss Farming Systems and Tillage Experiment (FAST), a long term experiment where the main European arable farming systems (organic and conventional farming, reduced tillage and no tillage) are being compared using a factorial replicated design. We also test whether cover crops can be used to enhance the sustainability of each the four arable farming systems. A multidisciplinary team of researchers from various disciplines and organizations use a broad range of approaches including standard agronomic measures, state of the art high throughput sequencing tools and modeling to measure a wide range of variables including plant yield, disease, above and belowground biodiversity, soil quality, soil aggregation, soil erosion, nutrient cycling, plant root microbiomes, life-cycle analysis and economic variables. We show the advantages and disadvantages of the various farming systems and present data on plant yield, life cycle analysis including global warming potential, soil quality, plant root microbiomes and above and below ground biodiversity. First results indicate that no farming system is best and the choice of the "best" farming system depends on economic, ecological and environmental priorities.

Soil organic carbon dynamics and non-CO_2 gas fluxes from agricultural soils under organic and non-organic management – results of two meta-studies

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It is anticipated that organic farming systems provide benefits concerning soil conservation and climate protection. Therefore, meta-studies on soil organic carbon (SOC) and soil-derived greenhouse (GHG) fluxes, respectively, were conducted to proof this assumption. Datasets from organic vs. non-organic farming system comparisons from 74 studies were subjected to meta-analysis to identify differences in SOC (Gattinger et al., 2012). We found significant differences and higher values for organically farmed soils of 0.18±0.06 % points (mean±95% confidence interval) for SOC concentrations, 3.50±1.08 Mg C ha^{-1} for stocks, and 0.45±0.21 Mg C ha^{-1} y^{-1} for sequestration rates compared to non-organic management. When restricting to a sub-sample representing systems without external inputs and retaining only the datasets with highest data quality, the mean difference in SOC stocks between the farming systems was still significant, whereas the difference in sequestration rates became insignificant. Meta-regression did not deliver clear results on drivers, but practices typical of mixed farming seemed important. It has to be pointed out, that enhanced top soil carbon stocks under organic farming is not equated with climate change mitigation (Gattinger et al., 2013; Leifeld et at., 2013), but the higher organic matter returns to soils under organic farming are system immanent as they assure plant nutrition apart from SOC reproduction accumulation (Leithold et al., 2015).

Skinner et al. (2014) revealed in a second meta-study, that area-scaled nitrous oxide emissions from organically managed soils are 492±160 kg CO_2 eq. ha^{-1} y^{-1} lower than from non-organically managed soils. However, yield-scaled nitrous oxide emissions are higher by 41±34 kg CO_2 eq. t^{-1} dry matter under organic management. Furthermore, a higher methane uptake of 3.2±2.5 kg CO_2 eq. ha^{-1} a^{-1} for arable soils under organic management could be observed. All 19 retrieved studies were conducted in the northern hemisphere under temperate climate.

Summarizing, the two meta-studies reveal a GHG mitigation potential for organic farming. But there is also a great knowledge gap on the performance of organic farming systems particularly in the southern hemisphere.

Acknowledgments

These results have been achieved in the project *Carbon Credits for Sustainable Land Use Systems (CaLas)* funded by the Mercator Foundation Switzerland.

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Intensive Agriculture, Rural Livelihoods and Labour: Social Science Perspectives on the Global Food System

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Intensive agriculture in the Western Mediterranean is highly dynamic. Within only three decades, it has developed from small-scale family farming to become an industrialised part of the global agri-food complex while changing retail patterns and consumer demand for year-round supply has caused relocation of the industry within Europe. In order to have an earlier harvest and supply supplementary produce, production sites have moved more and more southwards and even jumped across to North Africa. The emergence and recent development of the Mediterranean agri-food system is deeply intertwined with, and constituted by, the exchange of capital, labour, and agricultural commodities. Within this context, the legal and illegal recruitment of cheap seasonal labour has become a crucial means to further reduce production costs, particularly in France and Spain. In Morocco, in turn, intensive agriculture has been accompanied by a substantial transformation of rural social landscapes, income structures, and livelihood systems. There have been two major axes of intertwinement between intensive agriculture and rural development: the highly unequal access to natural resources has led to a widespread process of 'depeasantisation' while the new wage labour markets that emerged due to the massive labour demand have sparked internal migration flows.

Thus, a host of social costs are inscribed into intensive Mediterranean agriculture. While there are (monetarily) measurable costs of industrial agriculture, materialising, for example, as financial loss, debts, economic decline or environmental damage, there are also less visible costs, such as the undermining of rural livelihoods and the shifting conditions of social reproduction. Moreover, there are costs that are unfolding widely beyond economic measurement, such as those manifested both physically and emotionally, including stress, fear, alienation, and loneliness. Nevertheless, intensive agriculture and related labour markets remain ambivalent. On the one hand, they rely on the exploitation of (foreign) workers, thereby bringing about widespread changes in rural areas. On the other hand, they have come to constitute significant income sources and, hence, secure livelihoods.

Based on empirical examples from France, Spain, and Morocco (cf. Gertel and Sippel 2014, Sippel 2014a, 2014b), this keynote will address the following questions: How are intensive agriculture, rural livelihoods, and seasonal labour mutually intertwined and how does this change the social face of rural areas? Given the multifaceted dimensions of social costs involved, can the intensive productions in the Western Mediterranean be regarded as a 'model for development' and what would be the alternatives?

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Driving sustainability or producing anxiety: The use of media in mobilizing consumers

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This paper explores the role of popular media in promoting food systems sustainability and equity. We consider how mainstream news, food blogs and activist media respond to and shape consumer perspectives and government policies. We focus on the ways an exploding transmedia landscape "helps" consumers learn of food issues, but tends to cast sustainability in narrow ways. Finally, our conclusion analyzes if and how sites, articles and images convey issues of sustainability and social justice and if such media accurately represents the problems at hand. Our research focuses on three ways invested groups and the media portray and connect consumers to sustainability issues by linking food choices to 1) community and personal identity, 2) local or global environmental issues and 2) the health and well being of families. Yet often such imagery plays on consumer emotions, fears and desires much like advertising, with little attention to the material realities of food production.

We use the case of regulation and use of agro-chemicals in the global strawberry industry to explore these questions. Since adoption of the Montreal Protocol in 1991 -- a multi-lateral international agreement banning ozone-depleting substances – government and civil society actors (industry and NGOs) have engaged in a variety of regulatory and legal debates about how to phase out and replace these substances. Among them is methyl bromide, a soil fumigant long used by strawberry growers to sterilize soils against a host of pathogens, nematodes, and weeds and, thus, ensuring ongoing viability of commercial production. The phase-out of methyl bromide and has sparked broader media and activist attention to the use of soil fumigants and their effects on human and environmental health. This has in turn caused the industry to invest in researching alternative production regimes.

Given the potential to reduce the use of highly toxic agro-chemical inputs, these shifts can be read as a positive development towards strawberry supply chain sustainability. However, our research suggests that, although ample attention has been paid to the phase-out of methyl bromide in strawberry fields and the potential for alternative fumigants as replacements, much of this attention has been focused on food safety concerns and consumer health, while ignoring worker exposure to toxins and environmental impacts, which are much more critical to soil fumigant use and regulation. Through analysis of media content, activist framings, and public hearing transcripts, we argue that campaigns targeting consumer "fork voting" have curtailed discussion and activism in these important arenas, turning positive associations of food, family, and health into consumer anxieties.

Using Values-based Supply Chains to Engage Communities

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Consumers are increasingly interested in understanding "values" associated with the food they eat that go beyond its economic cost. Often, consumers are willing to pay more for foods for which there is a "story" that links the farm to the fork. "Values" associated with these foods may be that they are local or regionally produced, produced by family farms, use production practices that enhance the environment or those that provide farm labor with safe working conditions and fair wages. The challenge is to communicate those values throughout the supply chain.
Wholesale channels that provide additional marketing options for small and mid-sized, producers, increase consumer access to their products, and participate in 'farm to fork' efforts are increasingly referred to as **values-based supply chains (VBSCs).**

SAREP has been researching food VBSCs to help develop marketing channels that provide greater economic stability and viability to small- and mid-sized farmers and food producers as well as fresh, high-quality food to consumers. Through case studies of California VBSCs, a farmer toolkit about how best to engage with VBSCs, and farmer wholesale market tours, SAREP has developed insights and lessons about these VBSCs in California. This presentation will highlight the opportunities and challenges for farmers, distributors, and consumers that emerge from these new marketing channels, and how we have used this information to strengthen local food systems.
Specific examples to illustrate the ways in which farmers and communities are engaged in values-based supply chains in California will include:
Farm-to-school and farm-to-institution procurement from regional farmers
New marketplace exchange forums (like "speed dating") for farmers and institutional buyers
Wholesale market tours for small, beginning and immigrant farmers
The presentation will also share outcome-oriented results over time (farmer sales, numbers of farmers and buyers that have participated, new connections with buyers, changes in children's consumption patterns at participating schools), as well as the processes needed to build these new supply chains. We will focus on practices that are most important in effectively engaging participants throughout the supply chain, from producers to consumers.

Looking for work: Farm labor and the agrarian imaginary

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This paper examines the role of alternative food movements and labeling initiatives in advancing farm labor rights and protections. A burgeoning interest in "knowing where our food comes from" has entailed the enrollment of citizen consumers in the governance of agrifood value chains and the concomitant growth of ethical food markets. However, the agrarian imaginaries animating contemporary food politics belie the lived realities of farmworkers. While hired workers are central to the valorization of agricultural landscapes, across multiple production scales and contexts, food activism and research has largely sidelined labor questions in favor of an arguably idealized vision of smallholder or family-scale farming, one set in contrast to the exploitive practices of large-scale farming and corporate agribusiness. Drawing on research conducted at multiple sites in the global food economy, from California's organic fields to Latin American Fair Trade operations, I interrogate the implications of such idealized, dualistic representations for those who do the vast majority of work in commercial agriculture, including certified sustainable, ethical, and local. I argue that the preoccupations of consumers, activists, and (increasingly) public policy makers may undermine possibilities for meaningful and effective labor/consumer solidarity to redress social/environmental injustices. I further suggest that activist and regulatory landscapes should be more fully opened to include workers and their representatives in order to develop a different imaginary – one focused on an ethic of collective action and workers' empowerment, rather than individualized consumption choices on their behalf.

Cultivating Nutritious Food Systems: A snapshot report

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The food system, it is said, is broken. While significant progress in raising agricultural productivity has been made, 2 billion people still suffer from vitamin and mineral deficiencies. Health and nutrition tend to focus on individual populations and single nutrients. In fact, both agriculture and nutrition need to recognize all people need diverse and affordable diets to chip away at the 2 billion. Somewhere we lost the connection between our food and our health. Despite the sensibility that agriculture and nutrition must work together, the practitioners of the two camps scarcely wave at one another as they pass on opposite sides of the street. But this is changing. Initiatives across the world – including GAIN's Marketplace for Nutritious Foods – are bringing improved agriculture and nutrition together in creative and successful ways.

Just as agriculture moves along a value chain—from seed to harvest and on to storage, transport, wholesale, retail and, ultimately, the plate—so we look at examples of successful initiatives. Starting at seeds, where they are breeding nutrients into them via biofortification. In terms of soil, the Green Revolution taught us that fertilizer can play an important role in raising productivity. It can also play a role in human nutrition. And we can address the scourge of aflatoxin (a naturally occurring toxin produced by a fungi), thereby putting a dent in stunting.

Beyond the field, post-harvest loss is arguably the area of the value chain where nutrition-oriented agriculture and food industries should concentrate their energies. Worldwide, approximately 1.4 billion tons of food is lost after leaving the farm. Unlike in the developed world, where most of this loss occurs at retail level or in the home, loss in the developing world happens along the whole value chain due to lack of infrastructure and less in the home where poor consumers can afford little waste.

At consumer level, a healthy diet is directly linked to income (and knowledge). But those at the bottom of the pyramid tend not to have the means for good nutrition: starchy staples can be up to 80% of what they eat. The ultra-poor are mostly served by government and public-feeding programs. And yet, few of these programs focus their efforts on effective food delivery systems. Companies — from multinational corporations to national companies to small businesses — have proven that they can shape demand when it comes to eating habits. Why not channel that knowledge toward improving nutrition at scale? Via the GAIN Marketplace for Nutritious Foods, a business incubator operating in Kenya, Tanzania, Mozambique, and Rwanda, we foster nutritious innovations targeted at poor people. We see new business and delivery models shaping markets for diverse diets. We also work with innovations happening in the financial world to enable these business owners to get their nutritious products to a larger public. These investments depend on the will of agriculture, health and other supporting systems to continue the conversations and stay connected. Complex, but not impossible.

The Role of Business in Sustainably Improving the Nutritional Status of the Poor

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There has been increasing interest in the use of value chain interventions to address the problems of malnutrition amongst the poor. It is now widely accepted that increasing incomes, particularly those of agricultural producers, is a necessary but not sufficient condition for improving micronutrient intake. This is a direct result of the vast number of rural and urban poor who procure their food through markets. Since many households rely on food purchases for all or part of their nutrient intake, increasing attention is now being given to the ability to re-arrange agri-food value chains and food systems for better nutrition.

This raises the need to understand two primary issues. The first issue is the ability and willingness to pay of the poor for nutritionally dense food products (including naturally nutrient dense, bio-fortified or nutritionally fortified). The second issue is the need for value chains and food systems to be based around sustainable models to ensure consistent and reliable access to safe and nutritious foods. While each of these issues may be addressed separately there are considerable challenges in integrating the two; particularly due to high costs associated with delivering to such thin markets. To date there has been a lack of in-depth analysis on the ability of sustainable business models to contribute to the sustained and regular consumption of nutritionally dense foods. Our research aims to conduct such an analysis through a case study of Grameen Danone Foods Limited (GDFL). GDFL is a social enterprise operated in Bangladesh which offers an inexpensive fresh yogurt product (designed to target children) which is fortified with 30% RDA of Vitamin A, zinc, iodine and iron. A choice experiment was conducted with 1,000 randomly sampled rural mothers and 600 randomly sampled school children to assess the willingness to pay for nutritional benefit. A subsequent interview was also conducted to determine factors which contribute to, or detract from the regular and sustained consumption of the yogurt.

Analysis is still ongoing, however results will be ready for presentation by the date of the conference. Initial findings suggest that willingness to pay for nutritional benefit may exist amongst rural mothers; however a lack of consistent ability to pay may inhibit sustained and regular consumption of the yogurt. It is also suspected that it may be households with a higher diet diversity score who purchase the yogurt. This emphasizes the need to determine the capacity of a sustainable business model to assist those who are micronutrient-deficient in overcoming barriers to consumption, such that nutritional status will ultimately be improved. The case study of Grameen Danone will be used to assess this capacity, though further in-depth analysis of multiple models will be required in the future.

Agricultural Value Chain Analysis for Developing Affordable Nutritious Foods for Women in Ghana

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In keeping with Germany's value of having sustainable, healthy food systems, the overall goal of the "Affordable Nutritious Foods for Women (ANF4W)" is to increase the local supply of and demand for affordable nutritious foods which are currently lacking in many markets in developing countries. ANF4W fulfils part of the 2011 Memorandum of Understanding between the Bill and Melinda Gates Foundation and the German Federal Ministry for Economic Cooperation and Development (BMZ). In particular, it covers public health with a focus on Millennium Development Goals (MDGs) 4 and 5, better leveraging private sector competencies in nutrition and health, the agricultural focus on small farms in rural areas, enhanced food security, and innovative agriculture approaches.

In Ghana, ANF4W supports local food processors in the development of supplementary fortified food products. In identifying different elements that play a role in a local food processors ability to create an affordable nutritious product, an agricultural value chain analysis (AVC) was one study that was conducted. The AVC's goal is to identify affordable agricultural commodities in Ghana, and understand how agricultural practices affect the quantity and quality of food supply available to local food processors. This evaluation also aids understanding of value chain constraints, and opportunities to encourage local production of commodities which improve the nutrition of vulnerable groups. In so doing, the agricultural value chains traditionally developed to improve farmer incomes and food security are now assessed with human nutrition as a key criteria.
A mix of qualitative and quantitative criteria was used to evaluate more than 31 commodities. Major indicators include affordable nutrition, commodity quality, accessibility, and value chain dynamics. A relative ranking of commodities was provided for three processed food concepts.

Acknowledgements for invaluable contribution and support: Jedidah Tetteh (Independent Researcher), Till Ludwig (GIZ), Leonie Vierck (GIZ). This study was funded by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH Sector Project on Agricultural Policy and Food Security.

Biofortification: achievements and challenges

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Food should be nutritious. The world produces more than enough food to feed its entire population. Still undernutrition, including vitamin and mineral deficiencies, affects and constraints the potential for proper health and development of millions of children and women, despite a global declining trend in undernutrition. Overweight is on the rise with 42 million children under 5 years affected. The underdeveloped world lives off monotonous diets based on 1 or 2 staple crops, typically cereals or roots/tubers rich in starch and little else. So, is their food really nutritious? While dietary diversity is the ultimate goal for improvement and maintenance of good nutrition and health, too many social, cultural, political factors need to be sustainably addressed for sustained, population-wide progress in dietary diversity in rural and urban poor settings. How do we improve the nutrient density of staple-based diets in the meantime and thus contribute to improved, if not diversified, diets? The addition of essential minerals and vitamins to food can be done industrially or at household level during transformation of grains and other staple crops into flour and other processed products. The contents of essential nutrients in edible plants and animal tissues can also be enhanced by biofortification, which in general entails any of the following methods: selective "conventional" breeding, genetic bioengineering, and agronomic/zootechnological management of crops/livestock (i.e. fertilization & selective feeding, respectively). This talk focuses on the concept, progress and challenges for biofortification by conventional plant breeding of the major staples (rice, wheat, corn, pearl millet, cassava, orange sweet potato, and dry beans) by HarvestPlus and a consortium of plant scientists, food and nutrition researchers, economists, among other disciplines working together to increase the concentration of vitamin A, iron and zinc in these crops.

Given the encouraging results from efficacy trials with orange sweet potato, maize, pearl millet, beans and cassava, it is apparent that biofortification with provitamin A carotenoids or iron may contribute significantly to improving nutritional status in children under 5 years and women of child bearing age. To determine whether the latter findings are applicable in other low-medium income country settings, context specific estimates of potential impact must be made on the basis of average food intake, diet composition, storage and cooking practices and the population prevalence of iron deficiency. In future studies that are undertaken in malaria endemic settings with iron-biofortified foods for children under 2 years of age the underlying causes of malaria transmission (and other infections potentially enhanced by increased colonic iron levels) should be addressed. Moreover, target crop zinc concentrations had to be increased in accordance with the intake reference values from the Institute of Medicine, which are higher than those used to estimate the original target levels. For iron and zinc biofortified crops, it is recommended that lower phytate levels also be included in the traits pursued by plant breeders in order to increase bioavailability and biological impact in vulnerable population groups, particularly in the common bean. Biofortification of staple crops with folate is feasible and should be pursued for populations where most folate-deficiency neural tube defects take place. Exploration of biofortification with antioxidants for populations in nutrition transition is also encouraged.

Biofortification of cassava with beta-carotene: insights from recent studies

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Biofortified yellow cassava has great potential to alleviate vitamin A deficiency in sub-Saharan Africa and can be used as a complementary approach to other interventions. However, direct evidence whether yellow cassava can significantly contribute to the vitamin A intake and status of populations is required. The overall aim was to provide proof of principle whether biofortified yellow cassava can improve vitamin A status of schoolchildren in Kenya. The research was conducted in Kibwezi district, Eastern Kenya. First the effect of daily consumption of yellow cassava was assessed in 342 primary school children in Kenya in a randomized controlled feeding trial with serum retinol concentration as primary outcome. Furthermore we investigated the sensory and cultural acceptability of yellow cassava in a cross-sectional study (n=140) in three primary schools for children as well as their caretakers. And last we used the dietary intake data of children in the randomized controlled trial to model the potential contribution of yellow cassava and additional dietary recommendations to the nutrient adequacy using linear programming. The randomized controlled feeding trial collected complete data for 337 children with a compliance of 100%. Primary analyses (per protocol) showed that serum retinol concentrations in the yellow cassava group, increased with 0.04 µmol/L (95%CI: 0.00–0.07 µmol/L) compared to the white cassava group and secondary analyses showed that serum ß-carotene concentration increased with 121% (109%–134%). No evidence of effect modification by initial vitamin A status, zinc status, or polymorphisms in the ß-carotene monooxygenase gene was found. In the acceptability study 72% of caretakers and children were able to detect a significant difference in taste between white and yellow cassava and indicated to prefer yellow cassava because of its soft texture, sweet taste and attractive colour. Adding yellow cassava to the diet as a school lunch improved the nutrient adequacy of the diet of schoolchildren, however, even with the addition of nutrient dense foods such as fish, nutrient adequacy could not be ensured for riboflavin, niacin, folate, vitamin B12, and vitamin A. Consumption of yellow cassava is acceptable and improves the serum retinol concentrations of primary school children in Kenya. Yellow cassava contributes to a better nutrient adequacy but should be accompanied by additional dietary recommendations and interventions to fill the remaining nutrient gaps.

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This research was conducted within the framework of the INSTAPA Project, funded by the European Union's Seventh Framework Programme [Fp7/2007-2013] under grant agreement nr 211484 (www.instapa.org).

Bio fortification of staple foods with iron and zinc

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Iron and zinc deficiencies are major micronutrient deficiencies worldwide affecting a large proportion of the population. Staple foods constitute a dominant portion of the diet, but are often poor sources of micronutrients such as iron and zinc. This is also due to milling practices reducing the level of micronutrients in flours but also to the presence of phytic acid - the phosphorous storage form in seeds - a barrier to mineral absorption in humans. Food fortification by addition of iron and zinc to cereal flours can be a viable and sustainable approach to prevent these deficiencies, but requires a central processing facility and high initial investment. As an alternative approach, Bio-fortification aims at using agronomic, breeding and genetic improvement approaches to increase the natural mineral content of the edible portions of food staples, by specifically selecting practices and cultivars which maintain high mineral levels in the edible portions of the grains. Zinc bio-fortified wheat has been produced containing 40-50% higher zinc levels and these cereals and are currently being tested for their nutritional viability in small scale and large scale human nutrition trials; similar research programs have been successfully conducted in recent years showing proof of concept and improved iron bioavailability in humans for high iron containing beans and pearl millet.

Biotechnological approaches for nutritional enhancement of staple crops

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Micronutrient deficiencies are prevalent all over the world and are most commonly associated with monotonous staple food based diets of the affected populations. Iron deficiency anaemia, vitamin A deficiency and iodine deficiency are recognized as three most common forms of micronutrient malnutrition, followed by zinc, folate, calcium, proteins and other vitamins. Improvement of plant-based diets is therefore critical and of high economic value in order to achieve a healthy nutrition of a large segment of the human population. Nutritional enhancement of crops through conventional breeding is often faced by the low genetic variability for the target traits. Biotechnological approaches are therefore being increasingly used for effective crop biofortification. Among the cereals, rice (*Oryza sativa. L*) and wheat (*Triticum aestivum*) contribute a major share to human diet and we target these crops for iron (and ß-carotene) biofortification. Our strategies to improve iron content in these crops include key genes involved in the phytosiderophore biosynthesis, various iron transporters, chelators as well as iron storage proteins, used either alone or in combination (Wang *et al*, 2013). Previously, our lab developed high iron rice lines (NFP) expressing *A. thaliana nicotianamine synthase gene* (*AtNAS*) together with endosperm-specific expression of *Phaseolus vulgaris ferritin* and *Aspergillus fumigatus phytase* [Wirth et al, 2009]. Continuing the work, we have developed rice lines with even higher iron contents and as well the lines expressing the iron and ß-carotene traits from a single construct (Paine *et al*, 2005). In addition, we are testing other novel iron biofortification strategies that focus more on iron trafficking into the rice grain. Utilizing our knowledge and experiences from the rice work, we have also biofortified wheat endosperm for its iron content. These newly generated rice and wheat lines are under evaluation and the data will be presented.

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Acknowledgements: We thank Prof. Rainer Schulin (Soil protection group, ETH Zurich) for providing access to ICP-OES and Björn Studer for his kind assistance with metal measurements.

Zinc Biofortification of Wheat through Soil Organic Matter Management

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Agronomic biofortification is an approach to tackle Zn deficiency in human nutrition and in crop plant production simultaneously. Insufficient zinc (Zn) supply has been recognized as one of the most widespread problems in human mineral nutrition worldwide. It is particularly frequent in populations depending on cereal-based diets and with little access to meat products, as cereal grains are relatively poor sources of readily absorbable Zn in human nutrition. Similarly, Zn deficiency in crop plants is of widespread concern, as it reduces crop yields and many soils are naturally low in plant available Zn, due to a variety of conditions.
In agronomic biofortification, agronomic methods are used to enhance the accumulation of a nutrient in the edible parts of crop plants in order to increase their nutritional value. While application of Zn fertilizers is a straightforward strategy to achieve this goal, at least in the short term, the problem with most soils on which crop plants suffer from limited Zn supply is not lack of soil Zn per se, but lack of plant available Zn in soil . This is in particular found in soils with high alkalinity such as calcareous and saline soils. Adding soluble mineral Zn sources is generally not a sustainable solution here, as only a small fraction of the added Zn will remain available, while most of it will become fixed within short time in the same way as the majority of the Zn already present in the soil. In the long run this approach may create more problems than it solves through the accumulation of excessively high soil Zn loads.
A biofortification strategy that is better suited for soils with sufficient Zn but insufficient Zn availability is to increase Zn availability and to limit external Zn inputs to what is needed for compensation of Zn exports with harvest. Given that organic matter sources are usually available on farms of smallholders with little access to mineral fertilizers, we are exploring ways to achieve this goal by improving or adapting the organic matter management of such soils. Comparing different types of soil and farming systems, we are studying in particular how grain Zn density in wheat could be increased through soil application of pre-crop residues or green manure, with a special focus on the role of soil microorganisms, including arbuscular mycorrhizal fungi and zinc solubilizing bacteria.
The results show that the application of pre-crop residues or green manure can indeed be an effective measure to increase soil Zn availability and enhance Zn accumulation in wheat grains, especially on calcareous soil. Thus, we conclude that organic matter management is an approach to agronomic Zn biofortification of wheat that should be particularly attractive for farmers in semi-arid to arid regions, where soils are often not only rich in carbonates but also low in organic matter.

Global trends in food security and nutrition: The importance of food system approaches to making progress

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One of the great dilemmas of our time is how we will secure and provide plentiful, healthy and nutritious food for all, and to do so in an environmentally sustainable and safe manner while addressing the co-existing double burden of under- and over-nutrition, such as nutrition-related infectious and chronic non-communicable diseases. This in turn can lead to poor health into adulthood, which affects not only individual well-being but also the social and economic development of nations.

We are witnessing multiple burdens of malnutrition, with some countries, communities and households suffering from undernutrition, overweight and obesity, and micronutrient deficiencies. An estimated 162 children are stunted, which reflects chronic undernutrition during the early stages of life, causing children to fail to grow to their full genetic potential, both mentally and physically. Although stunting in children under five years of age has declined from 40 to 26% since 1990, an estimated 162 million children remain moderately or severely stunted. Wasting in children under five years of age has decreased 11% since 1990, but still, 52 million children suffer.

A staggering 2.1 billion people suffer from overweight and obesity globally and of that an estimated 43 million children under five years of age are overweight, and two-thirds of those children reside in low- and middle-income countries. These growing rates of overweight and obesity worldwide are linked to a rise in chronic diseases such as cancer, cardiovascular disease and diabetes—life-threatening conditions that are overburdening health systems. Deficiencies of essential vitamins and minerals (micronutrients) continue to be widespread and have significant adverse effects on child survival and development, as well as women's health.

Changes in the types of food we eat are driving a new demand for certain types of food, grown and processed in particular ways. Diets are shifting more towards higher quality, nutrient-dense products such as meat, dairy products, and oils—but also towards more ultra-processed foods. At the same time, there are profound inequities both globally and within countries, with respect to access to, and affordability of, nutritious foods. There is no ethically simple way to reconcile these competing demands that impact economies, trade and globalization, and ultimately nutrition.

In an increasingly globalized world and interconnected food system, subjected to the pressures of growing populations, inequity and conflict, climate variability and food price volatility, no country or population is immune to the challenges that lay ahead. While unsettling, we now have more information, both in science and in practice, on how to improve the global food system. The solutions are inherently trans-sectoral, engaging practitioners and experts across agriculture, rural development and public health. Improvements can be driven by resilient food system approaches to ensure better utilization of food and dietary diversity and quality.

Landscape transitions and agriculture-nutrition linkages: Looking back to the future

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Demographic, socio-economic and dietary changes are rapidly occuring in Sub-Saharan Africa. Over the last five years, large areas of land have been targeted for agricultural intensification, whilst other areas are undergoing rapid urbanization. These transitions are paired with changes in local food systems—from reliance on local markets and production systems to increased access to global markets. The way such agricultural developments impact nutrition is strongly dependent on its local context and dynamics. Varying across locations and time, agriculture can have multiple functions, e.g. income generation, employment, local empowerment, biodiversity habitat, and supplier of nutritious food. Understanding potential synergies and trade-offs between nutrition-related and other functions from agricultural systems, is therefore critical to identify leverage points for win-win scenarios, determine trade-offs, and understand the drivers and implications of change in these systems over time.

We are piloting an innovative landscape approach to address agriculture-nutrition linkages as part of a socio-ecological system. The methodology includes four main modules. A first module assesses dietary patterns and nutrient gaps. A second module explores the potential of the landscape to fill these gaps while considering the social, economic and agro-ecological context. A third module assesses trade-offs and synergies between multiple food system objectives for different scenarios, while a fourth module implements and evaluates best-bet interventions.

Results for a pilot site in the Barotse floodplain in Zambia are discussed. A combination of biodiversity, agricultural management, and market-based options, all with specific gender sensitivity, are identified as solutions to address dietary deficiencies in a sustainable way.

Producing more with less to ensure food security and environmental sustainability

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Agriculture faces great challenges to ensure global food security by increasing yields while reducing environmental costs, especially in some fast developing countries (Guo et al., 2010; Zhang et al., 2013). However, the dominant agricultural paradigm still considers high yield and reducing environmental impacts to be in conflict with one another. Here we examine a Three-Step-Strategy of past 20 years to produce more with less to ensure food security and environmental sustainability in China. The first step is technology for in-season root-zone nutrient management, which has been made to reduce N fertilizer input by 30- 50% without sacrificing crop yield (Ju et al., 2009; Cui et al., 2013). The second is technology for integrated nutrient management to increase both yield and N use efficiency by 15-20% (Zhang et al., 2012). The third is technology for integrated soil-crop system management to increase yield by 30-50% and N use efficiency simultaneously, significantly reduce environmental pollution (Zhang et al. ,2013; Chen et al., 2014). A total of 153 site-year field experiments covering the main agro-ecological areas for rice, wheat and maize production in China reported the integrated soil–crop system management increases average yields for rice, wheat and maize from 7.2 , 7.2 and 10.5 Mg ha^{-1} to 8.5, 8.9, and 14.2 Mg ha^{-1}, respectively, without any increase in nitrogen fertilizer. If farmers in China could achieve average grain yields equivalent to 80%of this treatment by 2030, over the same planting area as in 2012, total production of rice, wheat and maize in China would be more than enough to meet the demand for direct human consumption and a substantially increased demand for animal feed, while decreasing the environmental costs of intensive agriculture (Chen et al., 2014). These advances can thus be considered an effective agricultural paradigm to ensure food security, while increasing NUE and improving environmental quality.

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Biophysical, institutional and economic drivers of sustainable soil use in yam systems for improved food security in West Africa (YAMSYS)

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Yams (Dioscorea sp) are tuber crops essential for food security in West Africa. They are an important source of income for the actors involved in the yam value chain as well as an essential part of West African culture. Traditionally, yams are grown without external inputs as the first crop after a long-term fallow with very negative impacts on the environment. Moreover, traditional cropping systems have very low tuber productivity. Given the high prevalence of food insecurity, poverty and environmental degradation in West Africa, measures to improve the sustainability of yam cropping systems should be developed and implemented as soon as possible. YAMSYS aims at developing sustainable methods for soil management that will allow settling yams in long-term crop rotations, in order to increase tuber yields and to increase income of the actors working along the yam value chain.

To reach these goals the YAMSYS research project team (6 research partners in West Africa and 2 in Switzerland) will study on one hand the effects of management options on soil fertility, yam yield and tuber quality, and on the other hand, the institutional and economic drivers of soil use and yam production. The project will be conducted in 4 sites located in Côte d'Ivoire and Burkina Faso that are representative of the West African yam belt. Innovation platforms gathering the most important stakeholders of the project will be set-up at each of the 4 pilot sites. Based on continuous discussions of the project outputs, these platforms will elaborate and validate innovations that will increase the sustainability of yam farming systems in the region.

Expected impacts of the research are: improved soil management practices, decreased need for new farmland, increased and stabilized yam production, improved food security and income at household level and improved income of actors involved in the yam value chain. YAMSYS will also have a strong capacity building component including the training of 5 PhD students and 20 MSc students from West Africa.

The Good Growth Plan farm network – Measuring resource efficiency of crop production systems

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The FAO estimated that food supplies need to increase by 70% to feed a growing population of 9 billion people by 2050. Given constraints in available water, land, fertilizer, and other inputs, this is a major challenge of global scale. Required changes in agricultural practices tend to exert higher demand on resources and put eco-system services at risk of degradation.

Innovation in agriculture can be a key contributor to the solution of this dilemma. Syngenta – a world leading company marketing seeds and agrochemicals – invests in research and development to bring forward agricultural innovations that drive long-term agricultural productivity, rural development and environmental sustainability. In 2013, the company launched The Good Growth Plan and set six global targets to be met by 2020 with regard to resource efficiency, soil and biodiversity protection, smallholder inclusivity, agricultural labour safety and labour standards. A global monitoring and evaluation system was implemented to monitor, assess, and manage progress on these targets.

To measure resource efficiency at the farm-level, a new global network of over 3500 farms in 41 countries was established. The network covers 23 different crops in different market segments, including smallholder farmers in developing countries. The sample includes treatment and control farms. Treatment farms use one or more Syngenta products or optimized crop protocols and receive agronomic advice from Syngenta field experts. Control farms were randomly selected within the same market segments.

On farm surveys are carried out independently by Market Probe, an agricultural market research company. Data was collected on farm activities, soil management and safe-use practices, use of chemical and organic fertilizers, pesticide quantity by application, seed variety and seeding rates, labor and machinery hours, input costs, pest pressure, abiotic stress, crop yield, quality and post-harvest losses. 2014 is the baseline year. Data will be collected annually until 2020.

Current analysis is focusing on exploring the relationships between technology adoption and resource efficiency within and across the different market segments. Preliminary results indicate partial adoption of optimized crop protocols and variation in resource efficiency. With the second wave of the data collection and beyond, panel techniques and time series analysis will be used to assess trends and performance in resource efficiency.

In this paper, we describe the research design, sampling structure, data collection process, available farm-level data, and analytical methods, and discuss possible areas for further analysis and application. It is planned that the data sets and full documentation will be made available to academic institutions to conduct independent research in the area of sustainable agriculture.

Scale variability of water, land, and energy resource interactions in the food system in Uganda

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Despite efforts to achieve food security in Sub-Saharan Africa since the 1970's, food insufficiency continues to plague the region. As of 2014 over 220 million people – more than a fifth of Sub-Saharan Africa's population – remain food insecure according to the United Nations Food and Agricultural Organisation (FAO). The food security challenges in Sub-Saharan Africa are linked to economic, agro-ecological, technological/agronomic, institutional and related factors. These causes however overlay complex interactions and constraints within the key physical resources of Water Land and Energy (WLE), which are necessary for food production, processing, distribution and consumption. The relationship between the WLE interactions and the performance of SSA's food systems and the impacts of interventions at different scales are not yet fully understood, particularly regarding the implications of national policy interventions on resource constraints at local levels.

This study employs an integrated *Food System* resource analysis approach involving a combination of geo-spatial analysis, calorific-demand analysis and Source-to-Service resource transformation modelling to analyse Uganda's WLE resource constraints vis-à-vis 2012 and 2050 food demand at national, district and local scales, as a test case for Sub-Saharan Africa. The results are visualised using Sankey diagrams and resource stress maps. The analysis reveals the current competing demands and constraints at different scales, and helps to identify the critical resource intervention points to resolve resource stress in Uganda's food system. The inferences highlight differences in resource stress at the different analytical resolutions and overall constraints across all the WLE resources. Overall, the analysis helps to inform food security policy and the resource context for the present and future management of Uganda's food system.

Acknowledgements
Special thanks go to the Foreseer team at the University of Cambridge, Department of Engineering for their support and technical assistance in this research.

Determinants of consumers' choice and potential willingness to pay higher prices for biofortified pearl millet products in Kenya

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Globally, micronutrient deficiency is a major health concern as more than 2 billion people suffers iron deficiency; 1.75 billion at risk of low zinc intakes while 127 million preschool children suffers vitamin A deficiency. However, bio-fortified staple pearl millet crops which are adaptable to the harsh dry-lands hold the potential for reducing the impacts malnutrition. Nevertheless due to the changes in product traits, consumers' acceptance for these improved varieties is not clear. Using a double hurdle model, this paper determined consumers' willingness to pay premium prices for the newly introduced bio-fortified pearl millet products and what determines such willingness amongst rural consumers in Kenya. Findings indicate that consumers were willing to pay a 42 percent premium price above finger millet market price. Important factors affecting consumers' willingness to pay were age of consumers, number of children below 12 years in a household, gender of household head, income and awareness. Important recommendations are contained in the main documents.

Impact of mobile money technology on household food security in Uganda

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Mobile money technology is growing rapidly in Sub-Saharan Africa. However empirical studies of the broader welfare effects of the technology on smallholder farm households are limited. Using household survey data, we analyse the impact of mobile money on household food security in Uganda. Unlike previous studies that rely on a single outcome measure of food security, we measure food security using two indicators - Household Food Insecurity Access Scale and monthly per adult equivalent food expenditure. To account for selection bias in mobile money use, we estimate maximum likelihood treatment effects models. In the absence of selection bias, we estimate regression adjustment and ordinary least squares models. Our results show that mobile money reduces food insecurity and increases food expenditures. Based on our results we derive policy recommendations on how to foster the diffusion of mobile money technology in rural areas in East Africa.

Acknowledgement
This research was financially supported by German Research Foundation (DFG) and German Academic Exchange Service (DAAD). We are grateful to Grameen Foundation for support in fieldwork coordination. The views are those of the authors.

Response diversity within retail can secure access to food

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Diversity is considered to be a determinant to resilience and adaptive capacity, response diversity being the key. We posed the question, whether response diversity in marketing channels could provide benefits for food security. Avoiding disturbance in access to food and ensuring stability in consumer prices when facing market volatility, could represent such benefits. Such stability would be in the interest of both consumers and the retail sector. We studied two types of disturbances, a domestic disturbance represented by expanding strikes in the Finnish food industry during the spring 2010, and a disturbance caused by volatility in global market prices 2006-2011. The hypothetical relation between the supplier diversity of the retail stores and the inter-annual stability in sales and prices was investigated. We used data adopted from a retail chain and official statistical data. The data of the retail chain consisted of weekly purchase, sales and price information covering six years (2006-2011) for 30 retail stores, the supplier diversity of which varied. The analysis was performed using mixed models, which allowed accounting for random variation among the retail stores. The case product in the domestic crisis was pork, and the case product under the influence of the global price volatility was food oil. We found that a greater supplier diversity was related with greater sales during the strike and immediately thereafter, in comparison with the same weeks of the other five years. Similarly, a higher share of domestic suppliers was related to larger sales especially in 2011, but also in 2008 and 2010 when the global market price was high. In 2006 and 2009 when the global price level was relatively low, such a relation did not occur. We conclude that diversity in responses to critical factors of change or disturbance represents a useful means for food system actors to enhance resilience also within the retail sector, in order to secure consumer access to affordable food.

Beyond "Farm to Table" to "Farm to Dump" Emerging Research and Theoretical Frameworks on Urban Household Food Waste in the Global South

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In the established field of food studies, scholars have mainly addressed food issues within the boundaries of "farm to table" considerations. This article transgresses said boundaries by engaging the narrative of "farm to dump." The authors argue that the emerging field of food waste studies is an important yet understudied arena. Existing literature on food waste is focused on the context of consumer or post harvest food waste in the Global North. The few articles that exist on food waste in the Global South are focused on food loss at the farm-stage due to what scholars have perceived as a "lack" of agricultural technology. The current food waste literatures have not addressed the potential impact of food wasting practices by the growing number of urban (middle to upper class) consumers in the Global South. Through an elucidation of the multiscalar nature of food waste, and an analysis of questions regarding who can afford to access and waste food, this paper outlines emergent conceptual frameworks for food waste research. This paper begins by broadly exploring the concept of food waste and exploring the use of theoretical frameworks such as practice theory to expand the boundaries of food waste research in the Global South.

Environmental Impact of Food Losses from Agriculture to Consumption in Switzerland

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Twenty to thirty percent of the environmental impact of consumption are caused by food consumption (Tukker et al., 2006). A key element to make our food system more efficient and sustainable is the reduction of food losses across the entire food value chain (Quested and Johnson, 2009). However, for the implementation of measures against food losses it is important to know which losses are environmentally most relevant.

We quantified the amount of food losses at the various levels of the Swiss food value chain (agricultural production, postharvest handling and trade, processing, food service industry, retail, and households) in terms of mass and energy (Beretta et al., 2013). About one third of the food available for Swiss consumption (production and imports) is lost in terms of metabolisable energy. However, the environmental impact of food losses do not only depend on the amount of food loss, but also on the type of food, the degree of processing, the level in the food chain on which the losses occur, and the method of treatment (incineration, composting, anaerobic digestion, feeding). Therefore, we also quantified the environmental impact of food losses at the various stages of the food value chain in Switzerland. Based on the mass and energy flow analysis, twenty-two food categories are modelled separately, representing the whole food basket. Data on food production and processing is mainly based on the Ecoinvent database, on available literature, and on data from other research institutions. For the impact assessment the categories climate change, water, and land use are considered.

The results show that the food losses at the end of the food value chain, mainly the losses from human consumption and the food service sector, cause the main environmental impacts. This is relevant in a global view, since food losses in developing countries are mostly arising at the beginning of the food value chain, while food losses in the industrialised world mainly arise at consumer level. This could lead to the conclusion, that food waste in rich countries contributes more to the environmental impact of global food wastage than its quantitative share.

The results are intended to help public and private decision makers in Switzerland to prioritize their strategies for preventing food losses and for optimizing the treatment methods of the remaining food losses. It shows hotspots of environmentally relevant food losses and evaluates the potential environmental benefits from prevention and optimization measures.

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Postharvest Management: Potential Challenges for Smallholder Organic Farmers in Kenya

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Postharvest losses (PHLs) from pest and disease infestation, poor handling and lack of suitable storage facilities offset the nutritional and economic gains (Affognon *et al.* 2015) from higher crop yields among smallholder households. Although organic farming shows potential to enhance smallholder yields and incomes (Te Pas and Rees, 2014), associated PHLs are barely a research topic currently in Sub Saharan Africa. In 2014, a qualitative survey on the postharvest management, estimated PHLs and related problems for maize (MA), potatoes (PO), bananas/plantains (B/P), dry beans (DB), climbing beans (CB) and vegetables (VEGs), i.e. cabbage (CAB), carrots (CAR), onions (ON), kale (KA)) was conducted with 47 respondents in Kenya. The respondents comprised smallholder organic and conventional farmers from the *Long-term Farming Systems Comparison in the Tropics* project's participatory technology development trial sites, extension staff and local traders. Close to 90% of the respondents indicated that PHLs occurred. The PHLs varied among the crops (Fig. 1). Stored MA losses as high as 50% or more and caused by weevils, rodents and mould were reported by the farmers. Nearly all farmers stored MA and DB for 6 months or longer and protected them from pests by storing in nylon bags and applying agrochemicals which were reportedly often used in higher doses to increase effectiveness. Proper drying, using traps, applying crushed pepper, dry ash, herbal leaves were also mentioned. These are suitable for organic farming although general indications were that postharvest treatments and techniques for organic farming were less readily available or known. The farmers estimated lower VEG and B/P PHLs probably due to low volumes produced, immediate consumption or sale at farm-gate and/or markets without any need for storage. VEGs were largely not being treated. To reduce postharvest chemical pesticides use, the respondents mentioned the need for alternative treatments and access to better storage facilities such as containers and silos. While more detailed follow-up assessments are proposed, the preliminary findings suggest the need to develop new and test existing low-cost postharvest treatments and technologies as well as improving their access by organic farmers and traders for improved postharvest management and reduced food spoilage. Such measures, and also enhanced capacity in their use, must be integrated in activities aimed to improve smallholder food security.

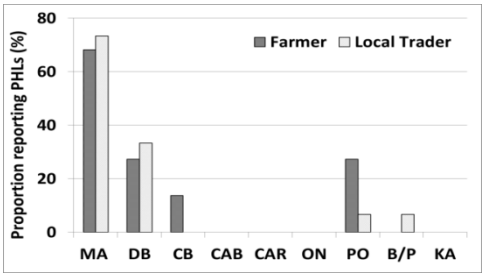

Figure 1: Percentage of farmers (n=22) and traders (n=15) reporting PHL(s) during storage

Acknowledgements: We thank the SYSCOM Project, N. Adamtey[a], K. Fiaboe[b], A. Muriuki[c], M. Musyoka[b], H. Affognon[b], farmers, Ministry of Agriculture extension staff and local traders.

A common vision for Sustainable Food and Agriculture

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Over the coming 35 years, agriculture will face an unprecedented confluence of pressures, including a 30 percent increase in the global population, intensifying competition for land, water and energy resources, changing diets, urbanization, and climate change. Food production will need to increase from 8.4 to almost 13.5 billion tonnes a year. Boosting food, fodder, fibre, and fuel production from an already depleted natural resource base will mean drastically changing food and agriculture systems worldwide. While many countries have started to sustainably improve the productivity of food and agriculture systems, much remains to be done.
To support and accelerate the transition to sustainable food and agriculture systems, FAO developed a Common Vision for Sustainable Food and Agriculture (SFA). SFA builds on cross-sectoral integration to foster synergies and minimize negative externalities. Based on a two-winged strategy, SFA supports countries through complementary activities at national (policy advisory) and local (field implementation) levels. SFA is based on five principles that are valid across sectors and balance the social, economic and environmental dimensions of sustainability:

1. Improve efficiency in the use of resources. Modifying current practices can improve the productivity of many food and agricultural production systems.
2. Conserve, protect and enhance natural resources. Food and agricultural production depends on natural resources and therefore the sustainability of production depends on the sustainability of the resources themselves.
3. Protect rural livelihoods, improve equity and social well-being. Ensuring that producers have access to and control of productive resources, and addressing the gender gap, can contribute to reducing poverty and food insecurity.
4. Enhance the resilience of people, communities and ecosystems. Extreme weather events, market volatility and civil strife impair the resilience of producers to agriculture, and adapted policies and practices are needed.
5. Encourage efficient governance. The transition to sustainable production can only take place when there is the right balance between private and public sector initiatives, accountability, equity, transparency and the rule of law.

In 2014, three countries started partnering with FAO on the SFA approach: Bangladesh, Rwanda, and Morocco. They will serve as pilot to test how to better operationalize the five principles of sustainability proposed by FAO. SFA is currently helping them to:

1. Identify the main issues in agricultural production systems, and set priorities for action along the above five principles;
2. Promote dialogue amongst key national stakeholders across sectors to encourage a common vision of a sustainable future;
3. Implement initiatives, programmes or projects that address priority areas.

Policy and Research for a Sustainable Swiss Food System

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Developing policies and identifying research needs towards a sustainable Swiss food system will be critical to react to the many challenges the Swiss society will be facing in the future. Here, we define the Swiss food system (SFS) as all food (and feed) products produced, but also consumed in Switzerland, while considering national actors and national economic, political, societal, environmental boundary conditions. Although the Swiss food system is clearly embedded internationally, in this foresight study, we mainly focussed on Switzerland. We carried out semi-structured interviews with Swiss policy-makers to identify their views on the main challenges the SFS will be facing in the future, but also to detect gaps between the implications of global trends on the SFS and current Swiss policies. Moreover, we used an on-line survey to ask decision-makers and stakeholders across the entire SFS to identify the most critical challenges, the most relevant research topics and research approaches to achieve a sustainable SFS within the next 20 years. Based on both the interviews and the on-line survey, the most critical challenges were identified across the entire SFS, ranging from scarce resources and climate change to demographic changes and food quality to the overall competitiveness of the SFS. However, according to the interviews, a coordinated, multi-stakeholder strategy to address these system challenges at the national level is lacking, partly due to sectorial policy priorities, partly due to the lack of political and societal pressure and urgency. Furthermore, a coordinated knowledge and communication platform was missed, and targeted research towards a SFS was asked for. The on-line survey resulted in a very large, solid dataset, with respondents across the entire SFS and on average 490 answers per question. The top 10 research topics (out of 88) were (in decreasing order): soil health and fertility in agricultural production systems, resistance to antibiotics, energy-use efficiency along food value chains, reducing food waste, sustainable diets, nutrient-use efficiency along food value chains, impact assessment of local vs. global food production, reducing losses in food value chains, nutrient cycling in agricultural production systems, and policy development for sustainable food systems, clearly reflecting the importance for a system´s approach in research. The same was found for the 10 lowest scored research topics. Respondents did not favour their own sector or working area within the SFS. Even excluding researchers from the respondents and re-running the same analysis resulted in the same top and lowest scored topics. No research approach was favoured over the others; education and outreach were considered as important as e.g. disciplinary or applied research. Thus, the diversity within and the complexity of the SFS were clearly recognized, supporting the results from the interviews with policy-makers. Overall, this foresight study provides a unique dataset to contribute to the development of policies and research strategies towards a sustainable Swiss food system.

What knowledge for sustainable food systems?

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Improving knowledge collection and sharing is essential to progress towards more sustainable food systems (defined as food systems that ensure food security and nutrition for all without compromising the environmental, economic, and social basis of the food security and nutrition of future generations (HLPE, 2014)). Improving the sustainability of food systems requires the involvement of a multitude of actors along the food chain - from production to consumption - including governments, private sector and civil society. FAO and UNEP, with the support of Switzerland, have created in 2011 a program for sustainable food systems, aiming for its inclusion in the 10-year framework of programs on sustainable consumption and production (SCP) established in 2012 at Rio+20. An Agri-food SCP Task Force (ATF) was created to promote the implementation of the Program, bringing together representatives of governments, international organizations, private sector and civil society. The ATF has identified four key areas to achieving SCP in food systems: effective information platforms; reliable communication; enabling conditions; and market based approaches. These call for knowledge that is comprehensive and actionable, and adapted to the needs and perspectives of the different actors - from input and service providers to primary producers, transformers, retailers and consumers. The ATF has further emphasized the need to better identify the requirements and perspectives of the various actors in terms of data and means to access it; to identify and assess existing data and gaps; and to identify and assess existing knowledge-sharing tools and mechanisms. It also underlined the need for indicators to measure all impacts of food production and consumption, as otherwise there is a risk of prioritizing the most easily measurable. To be better integrated in decision-making, such indicators should link and integrate input/impact with output. Actors in the food systems need to know the impacts of their own decisions/practices. They also need to be able to compare them both to a benchmark and to what others do, as well as to the impacts of other practices, be it for the same output or for a comparable one. Such knowledge often needs to be transmitted to other categories of actors, and therefore must be transformed to meet their respective needs. For instance, detailed information about agricultural practices is mainly oriented towards farmers. The information transmitted to other food chain actors, e.g. consumers and public authorities, will be that the farm is aiming for environmental performance, as measured by available tools and communicated through voluntary standards or labels. It shows that in some cases readability and efficiency of the information can benefit from using different types of information/indicators, adapted to the needs and capacities of the various actors.

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Towards food sustainability: Reshaping the coexistence of different food systems in South America and Africa

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To feed nine billion people by 2050 is possible, but it requires a reorientation of global food policies: their focus must extend beyond merely increasing productivity. This in turn makes it necessary to analyse food security as an outcome of the complex interactions between diverse food systems with different actors and different ways of producing, processing, packaging, distributing, and consuming food. Viewing food security as an outcome of food systems provides a basis for investigating the interrelations between food systems, and how they are linked with the right to food and other human rights. Moreover, it enables analysis of different food systems' environmental and social-justice outcomes. All these aspects combine to form the emerging concept of food sustainability – a concept which has been strongly acknowledged in food-related science and policy debates. It is widely recognized that these debates would greatly benefit from scientific contributions that are based on the integration of social and natural sciences; such integration is expected to enable a better understanding of both the conceptual and the empirically determined factors defining food sustainability within and between food systems. However, empirical research that takes the concept of food sustainability as a reference is largely lacking to date. This project, therefore, focuses on empirical research into the factors that influence food sustainability within and between different food systems coexisting in selected regions of Bolivia and Kenya, two countries with the right to food in their constitution. The general objective is to provide evidence-based scientific knowledge for the formulation and promotion of innovative strategies and policy options that improve individual and aggregate levels of food systems' sustainability. The emphasis is on finding ways to enhance collaboration within and between food systems.

Collective Impact Systems: Collaborating for Change

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When thinking about changing whole food systems to address food insecurity there is a tendency to compartmentalize the various determinants of food security in order to treat them in isolation of one another. Agricultural innovators, food and nutrition literacy promoters, poverty reductionists, garden/livestock developers, policy advocates, political actors and non-profit organizations all largely operate in isolation of one another thereby fragmenting both the human and fiscal resources dedicated to addressing food insecurity. What we end up with is a plethora of agencies, spanning the spectrum of the public, non-profit and private sectors, all working in isolation toward the same goal. The need for a cohesive and coordinated movement that brings all of these stakeholders together has been identified as a model for what is known as collective impact. The ethos of collective impact is predicated on the notion that inter-sectoral and cross-functional collaboration has the potential to increase the impact, and broaden the reach, of social sector programming. Collective Impact brings together these seemingly disparate groups and focuses expertise and funding towards achieving a singular goal.

While collaboration is not a new concept in the social sector, collective impact models differ in that there is a centralized infrastructure, a dedicated team and a formalized platform for sharing information that combine to ensure a common agenda, shared measurement system, continuous communication and a mutually reinforcing plan of action that utilizes the unique aspects of the diverse collaborative members[2]. Pooling resources in this deliberate and structured way strengthens the overall organizational impact to affect social change.
My research examines the viability of such a collaborative funding model to address food insecurity in the farthest reaches of Manitoba's northland. Using this research to inform the presentation, the proposed session will provide the audience with a practical perspective on operationalizing the principles of collective impact by tying theory to practice. It will first provide theoretical perspective through a brief tour of the current literature on collaborative funding models couched in the collective impact context and then will highlight my primary research to furnish conference participants with a practical assessment of the model's efficacy to create lasting positive change in community development.

Using a case study of a collective impact system that has been operational in the Manitoba food security movement for the past three years the presentation will also include a comprehensive process review delineating the genesis and initial development phases of the funding collaborative. The result of this process review will be an instructional component designed to provide structure and detail for replicating the model. It will also provide an evaluation of the projects that were funded which has a twofold benefit of assessing the efficacy of the model to make decisions and determining if those decisions allocated funds efficiently and effectively to produce the widest and deepest impact. These success stories will also highlight how well the model operates at the community level. The challenges and benefits of working out the inner mechanisms of the model, from both the funder and community perspectives, will be highlighted to provide cautionary direction for organizations currently navigating the nuanced dynamics of a collective impact system.

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Negotiating Country Food Systems: Colombia's National and Subnational Agrarian Dialogue and Negotiation Tables

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The current world agri-food system has been described by many as having perverse trends and outcomes that exclude poor and marginalized communities while providing support to those who need it less (Pimbert et al 2001, Thompson & Scoones 2009, Millstone et al 2009). But who represent these poor communities and what are they doing about such outcomes? How have these groups created alternatives to overcome such inequalities? This paper provides empirical information and analysis from Colombia and the cross-scale negotiations that were established after the 2013 national agrarian strike. The country is witnessing an unprecedented period of dialogue and negotiation. While most of the media attention is centred on the peace talks between government and guerrilla group FARC in Havana, little attention has been given to the national and subnational agrarian negotiations between government and indigenous, peasant and African-Colombian movements.

The 2013 national agrarian strike showed an historic mobilisation of thousands of people marching on the countryside with a huge urban solidarity in the main cities. During 15 days the main national roads such as the Panamericana Highway were blocked by protesters who were claiming significant transformations for Colombia's rural inhabitants. Aspects such as the inequality in land distribution, rural poverty and the negative effects of the recently signed free trade agreements were some of the elements that sparked the protests. All in all the agrarian strike showed not only the historical debt with the Colombian countryside which has been neglected for years, but arguably, it was also a protest against the outcomes of the current world food system.

As a result of the agrarian national strike, both government and rural movements agreed to establish agrarian dialogue and negotiation tables aiming to find joint solutions to the rural problems in the agricultural sector. A number of these tables have now been installed including a National Agrarian Table as well as direct dialogue tables with indigenous communities, departments and policy debates. In this context the main questions this paper asks are: to what extent can the cross-scale agrarian negotiations between government and rural social movements shape the understanding and approach to food security and food sovereignty? What are the competing visions and their implications for the national food system? The paper documents and analyses the way in which different visions of the agri-food system collide based on empirical information from the negotiation tables collected in two subnational spaces of Colombia (Nariño and Meta) and in the national level (Bogota). Having interviewed a wide range of actors including local and national public officials as well as representatives from rural movements, the paper offers a perspective of rural movements' perspective and core vision of food sovereignty and its implications for local and subnational spaces as well as the national government's approach of agricultural chains, efficiency and export oriented agriculture. The analysis shows that while both parties have decided negotiate agrarian issues they are far from reaching agreements in terms of food production, distribution and consumption.

Development of a National Surveillance System for Food and Nutrition Security to strengthen actions aimed at ensuring the right to food in Uruguay

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This project proposes the establishment of a National Food and Nutrition Surveillance System (SVSAN) for Uruguay. Its purpose is to improve the decision making process of Food and Nutrition Security (SAN) in the country, to reduce food and nutritional insecurity (INSAN) and the vulnerability of the population. The proposal is part of national and international commitments to guarantee the Right to Food in the country that began with the SAN concept issued by the United Nations Food and Agriculture Organization (FAO) at the World Food Summit in 1996.

The proposed SVSAN is based on the national situation and recommendations from FAO (2000) and WHO (2008) for establishing information systems. They should allow proper and timely assessment of situations in the food chain that must be addressed through policies, specific programs and projects.

The establishment of four computerized subsystems is proposed: one of Food Availability (SVSAN-D), one of Food Access (SVSAN-A), one of Food Consumption (SVSAN-C) and one of food use and nutritional state of the population (SVSAN-N). Such subsystems are respectively under the Ministry of Livestock, Agriculture and Fishing (MGAP), the Ministry of Social Development (MIDES), the National Food Institute (INDA) and the Ministry of Public Health (MSP). Multidisciplinary Working Groups (GTM) will be the think-tanks for each subsystem functioning. Key indicators of SAN were selected by these think-tanks (workshops in June 2011, with more than 30 institutions and 60 national experts), and are proposed as the starting point of the SVSAN. The system has a defined management scheme for data, the products thereof, and the mechanisms of dissemination and use of the information generated. The outline suggests that a coordinating body of the SVSAN, the SAN Observatory (OBSAN), collect the information of the four subsystems. The OBSAN would be in direct contact with the National Commission for SAN to support decision making and to identify the information needs of decision makers.

Co-financing the project would be from equal parts government (50%) and FAO (50%) with a total projected budget of 856,000.00 USD. Efficiency, quality, and other indicators of project evaluation will be monitored according to a monitoring and evaluation plan. To ensure knowledge sharing, communication and visibility, the project has a communication plan and will develop social marketing by hiring an advertising agency. The SVSAN must derive from a highly participatory process and focus on consistent contribution to its sustainability. It is necessary to ensure proper institution and communication mechanisms that allow decision makers access to system products. All information generated becomes knowledge that guides action. Once implemented, the SVSAN project would ensure Uruguayan population that their political decision-making agencies are properly informed about the conditions of the SAN in the country, so they may take effective action to ensure a sustainable Right to Food for the entire population.

Is a water crisis inevitable? Towards an ecosystems approach to water for food production.

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Food production takes enormous quantities of water. Over the past years several international institutes warned that population growth combined with higher living standards, changing diets and inefficient resource use will lead to a global water crisis. The World Economic Forum recently ranked water crises as top global risk. Water withdrawals for irrigation from rivers, reservoirs, lake and groundwater are often associated with, among others, degradation of aquatic ecosystems, drying of wetlands, disrupted flows by dams and water pollution. Since it is unlikely that the food demand will reduce any time soon, is a water crisis inevitable?

Several approaches have been advocated to reduce the water footprint of food crops. An obvious way to minimizing adverse environmental impacts of water used in agriculture is to reduce the amount withdrawn for crop production. Improvements in water use efficiency and productivity are necessary to attain food security goals while at the same time safeguarding the environment. There is considerable scope for improving water productivity through water harvesting, supplemental irrigation, deficit irrigation (including the partial root drying method), subsurface and precision irrigation techniques and soil–water conservation practices. However, reducing the water footprint and getting 'more crop per drop' is not always appropriate and could lead to undesirable outcomes.
Proper management of water in agriculture can enhance multiple ecosystem services (defined as benefits to humans provided by natural ecosystems, or in this case agro-ecological systems). For example, irrigated rice fields provide food but can also act as flood retention basins and help mitigating flooding in downstream areas. Terraces in irrigated areas (eg sawa's) increase crop production but also reduce soil erosion. Small reservoirs (tanks) in India initially built for irrigation act as groundwater recharge structures that help restore groundwater levels. Irrigated fields can also generate wetlands habitats that enhance biodiversity and have positive effects on water quality. Rather than maximizing a single ecosystem service (agricultural productivity) an ecosystems approach to water for food incorporates a broader range of ecosystem services, of which crop production is one. There are several examples where proper water management in crop production significantly contributes to the enhancement or restoration of ecosystems services. These examples show that the economic value of ecosystems benefits is generally high, sometimes exceeding the value of agricultural products. The presentation during the workshop will illustrate these examples.

A national view on managing trade-offs between agricultural production and conservation of aquatic ecosystems

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Worldwide, the production of food has a high impact on natural resources resulting in the challenge to produce food of sufficient quantity and quality to feed a growing world population while keeping ecosystems in a good status.
As one aspect of this challenge, agricultural production and the protection of water resources have considerable potential for conflicts: For example, farmers may use ground and surface water to irrigate their fields and abstract water beyond limits of ecological demands. In situations of wet soils unfavourable for agricultural production, drainage systems are installed, affecting ground water recharge and the hydrological regime of surface waters. Typically, drainage systems also elevate the input of nutrients and pesticides into the water bodies. In general, applied fertilizers, plant protection products, veterinary drugs and phytohormones of cultivated plants are introduced into the ground and surface waters through different processes such as drift, leaching, runoff, preferential flow or erosion. They influence the nutrient cycles and ecological health of aquatic systems. The nutrient and pesticide loss processes themselves can be altered by tillage operations and other agricultural practices. Furthermore, the competition for space can lead to additional conflicts between agriculture and the protection of aquatic ecosystems. For example, channelized or otherwise morphologically changed rivers often impair the local aquatic flora and fauna; but naturally meandering rivers need space that cannot be used for agriculture.
In a highly industrialized and densely populated country like Switzerland, all these potential conflicts are of importance. To tackle this challenge, Swiss agriculture is legally committed to fulfil several, partially conflicting goals such as agricultural production on the one hand and the conservation of natural resources on the other hand. In the context of the research project AProWa ("Agricultural Production and Water"), the relationships between the production aspect and the conservation of aquatic ecosystems is analysed with a holistic approach.
The project attempts to elucidate trade-offs of national goals for water protection and agricultural production in Switzerland by involving stakeholders from agricultural administration (Federal Office for Agriculture, FOAG), agricultural research (Agroscope), water research (Swiss Federal Institute of Aquatic Science and Technology, Eawag) and environmental protection (Federal Office for the Environment, FOEN). Multi-criteria decision analysis is used as a methodological approach for facilitating consensus regarding goals and possible activities and alternatives to reach these goals. This is followed by an evaluation of main conflicts and prioritized research gaps. We present results from workshops and interdisciplinary discussion groups that encompass an objectives hierarchy reflecting agricultural production and water conservation goals. Furthermore, an exemplary evaluation of agricultural practices and water protection measures by means of these goals is presented.

Is reliable water access the solution to undernutrition? A review of the potential of irrigation to solve nutrition and gender gaps in Africa south of the Sahara

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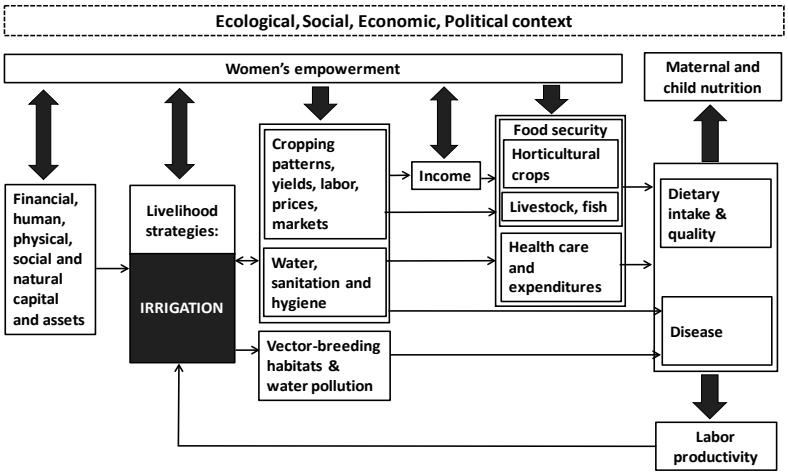
Interventions aimed at increasing water availability for livelihood and domestic activities hold great potential to improve determinants of undernutrition, such as the quantity and diversity of foods consumed within the household, income, and women's empowerment. Furthermore, recent evidence[1] highlighting the importance of water, sanitation and hygiene (WASH) in predicting child stunting demonstrates the need to consider the quality and uses of water in and around the household in order to impact nutritional outcomes. Thus, small-scale irrigation should be considered as a nutrition-sensitive intervention based on its direct relationship with WASH, nutrition, agriculture, and income generation. However, current evidence on the topic is limited. This paper aims to connect the dots and review the literature available on the linkages between irrigation and food security, improved nutrition and health. We conclude that the evidence remains insufficient to draw conclusions due to the low number of rigorous studies assessing linkages. Based on the limited evidence, six factors that should be taken into account in irrigation development to address nutrition in Sub-Saharan Africa are identified: 1) food security and nutrition gains should be stated goals of irrigation programs; 2) training programs and awareness campaigns should accompany irrigation interventions to promote nutrient-dense food production and consumption and minimization of health risks; 3) the multiple-use of irrigation water should be recognized in order to improve access to water supply and sanitation and livestock and aquatic production; 4) women's empowerment and participation in irrigation programs should be promoted; 5) homestead food production should be encouraged; and 6) policy synergies between different sectors (agricultural, nutrition, health, water supply and sanitation, education) should be sought.



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Participatory Research to Identify Irrigation Technologies for Horticulture for Women and Smallholder Farmers in Eastern Uganda

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Dry season vegetable production has been identified as a high priority in the largely rainfed (>97%) agricultural systems of Uganda. Off-season vegetable supplies are currently inadequate to meet human nutritional needs. As rainfall patterns become increasingly unpredictable and rapid population expansion places more pressure on food systems, demand for vegetables will further outstrip supplies. This spin-off project convenes stakeholders from public and private sectors to develop innovations in small scale dry season vegetable production for women farmers in East Africa. We are using a participatory approach to research, design and implement dry season vegetable production and marketing schemes and our project builds on local capacity for irrigation and water management among farmer, university, extension, non-governmental, and private industry stakeholders in Eastern Uganda.

The project is working at 5 'innovation sites' throughout Eastern Uganda with a multi-disciplinary research team (farmers, research partners, district staff, NGO partners, and university students) to co-develop technologies that will impact horticultural production, particularly by smallholder women farmers who are often excluded from irrigation and marketing developments. Innovations build on existing farmer knowledge as a foundation and combine with it in novel ways that are appropriate for small scale horticulture in the region (e.g. on-farm water storage, improved conveyance systems, drip irrigation, moveable sprinklers, managed infiltration/drainage, and irrigation strategies/schedules). In addition a framework is being developed for local public and private sector organizations to create, expand, and disseminate small scale irrigation systems. We are assessing agronomic, economic, market, nutrition, and gender impacts of different innovations and developing scale-out options for the most promising technologies. Development of a co-innovation systematic approach for assessing and supporting innovations in dry season vegetable production will strengthen small scale farmer enterprises targeted to both local markets and family consumption.

Global water saving through international food trade: what does it mean?

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Food production is the largest user of water resources. International food trade entails virtual water flows across countries. A better understanding of food and water relations in the context of international trade and water management is important for developing appropriate water, food and trade policies.

For a given country, a virtual water inflow can effectively reduce the amount of the domestic water use. This reduced water use has often been regarded as domestic water saving. However, a caution is needed in the interpretation of the term 'water saving'. In extremely water scarce countries, a substantial percentage of domestic food supply relies on import, which carries an amount of virtual water up to several times their own total water resources availability. For water abundant countries where the quantity of water is not a limiting factor, viewing virtual water trade from the water saving perspective is little meaningful. For low income countries with abundant water resources, an influx of food can even undermine local food production as farmers cannot compete with the cheap and often subsidized food from the major exporting countries.

At the global level, international food trade generates an overall saving of water. This is because of the generally high water productivity in the major exporting countries, such as the USA, Canada, Australia and France, compared with most of the importing countries. When food is produced in the areas of high water productivity and exported to the areas of low water productivity, less water is used globally for the production of food than if there were no trade, holding other factors constant. It is estimated that the volume of the reduced water use as a result of the global trade of crops ranges between 400 km^3/year and 600 km^3/year, or about 5% of the global total water use for crops. However, if the importing countries (most of them are not water scarce) improve their water productivity, the gap with the exporting countries will be narrowed, leading to a reduction in the volume of global water saving through trade. This reduction would be a positive move in terms of efficient utilization of global water resources.

Poster Abstracts

Poster abstracts are sorted alphabetically by presenting author, whose name is listed in bold.

Abstracts have been edited for consistency of style but not in their contents, which remain responsibility of the authors.

Life cycle impact assessment (LCIA) of soil degradation: Development of a new impact assessment method in LCA

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Soil degradation due to agricultural mismanagement causes losses in food productivity and therefore affects food security worldwide [1]. One method to estimate human impact on the environment, e.g. through agricultural production, is life cycle assessment (LCA). LCA was developed to quantify the impacts of different products, processes or services on the environment and to help improving production processes in order to reduce their environmental impact [2]. Within LCA the impact, for instance, on climate change, eutrophication or land use can be quantified, while methods assessing the impact on soil quality are still lacking or are not compatible with other methods in LCA [3]. Therefore, we aim to develop a new life cycle impact assessment method to quantify the impact of different agricultural management types and crops on soil quality. Our method is intended to consider different aspects of soil degradation such as soil erosion, soil compaction, nutrient depletion and desertification. Yield loss due to soil degradation will be quantified, which complements existing methods that address biodiversity loss. Furthermore, the method considers regional differences and should be applicable in different countries to account for the increasingly globalized food production system. We will present the framework of our method and the integration in LCA illustrated on case studies.

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Is extensive grazing on subalpine pastures a successful strategy to preserve biodiversity and to produce of meat with special quality?

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Subalpine pastures differ from lowland pastures by their rough climate, variable topography and high plant biodiversity. Under these conditions, intensive production systems are impracticable. Recent estimations showed that the number of animals in the mountain regions will decrease in the next decades. Flury et al. (2012) reported that in entire Switzerland, the area destined to agricultural purpose is expected to decrease by up to 5%. Subalpine areas provide the society with food of special quality, unique species diversity and attractive open landscapes. Because of the difficult economic situation these services are threatened by ongoing transitions in mountain agriculture and the subsequent abandonment of marginal sites and depopulation of entire areas. Extensive grazing, using robust domestic species and breeds could be a successful strategy to manage marginal pastures. However, the degree to which natural succession is ideal for conserving biodiversity at a particular site is unclear and it is unknown how this affects the quality of animal-source foods. A new project funded under the umbrella of the Mercator Research Program of ETH's World Food System Center therefore aims at quantifying effects of varying levels of shrub cover on the vegetation of subalpine pastures in dependence of geologic, climatic and topographic conditions. Moreover, a grazing experiment will be carried out to investigate how shrubby pastures affect movement and feeding behaviour of robust breeds of cattle, sheep and goat and how efficient they are in controlling shrub cover. The animals will be studied on site by state-of-the-art techniques, namely high-frequency GPS tracking, behavioural sensors and physiological indicators. This experiment will also provide information on how grazing on sites with and without shrub encroachment influences growth rate, carcass and specific meat quality. Vegetation surveys along gradients of shrub cover in the Swiss Alps indicated a generally negative impact on plant species richness, albeit intermediate levels of shrub cover are occasionally favourable. The identity of the dominant shrub species seems to be more important for vegetation composition than geology or topography. Preliminary results showed that the selected cattle breed (Dexter) is very well adapted to rough alpine and subalpine conditions, displaying a rather high meat quality, especially concerning tenderness and water holding capacity. This project is an example of interdisciplinary synergy between two different institutions, ETH Zurich and Agroscope, and aims at long-sought advice on site-specific desirable degrees of shrub cover of subalpine pastures and efficient modes for their control. Moreover, the project will help to quantify the potential for a sustainable valorisation of underestimated forages resources for ruminants by producing meat with special nutritional quality in due consideration of the environment and of animal well-being.

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Common metrics across diverse disciplines for evaluating potential risk – benefit of food

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Overall, food is linked to a number other research areas, such as, health, economics, environment, transport, infra-structures. The objective of this work is to lay the foundation of an innovative, and in our opinion, promising holistic approach to food-related decisions at, production, processing and consumption levels.

The assessment of risk-benefit trade-off of food intake and/or production is essential to the process aimed at identifying analogies between metrics to compare potential risks and benefits and to be able to communicate in a clear and concise way the outputs of the analysis to the various stakeholders (e.g. authorities, NGO, consumers, ...).

In this study an initial map of comparable indicators to make a holistic assessment of food considering human health risks (infectious agents, contaminants), benefits (nutritional values), environmental impacts, and social impacts (in particular vulnerable population) is designed.
A healthier diet joined as well as better health can be achieved through a multi-disciplinary approach.

State-of-the-art methodologies, guidelines or agenda (e.g. millennium developmental goal) suggest indicators of food sustainability, food security and food production. These, in turn, are assessed using a SWOT (strengths, weaknesses, opportunities and threats) analysis. The SWOT approach allows for a structured comparison of the indicators and provides a guide to acceptance or rejection of the indicator vis-a-vis different stakeholders. Indicators taking into considerations, among others, the burden of foodborne disease and the environmental, ethical and social impacts of food are prioritized.

Uncertainty and reproducibility are part of the SWOT analysis as significant criteria to define the robustness and transparency of the indicators and methodologies.

Systemic Risk in Maize Trade

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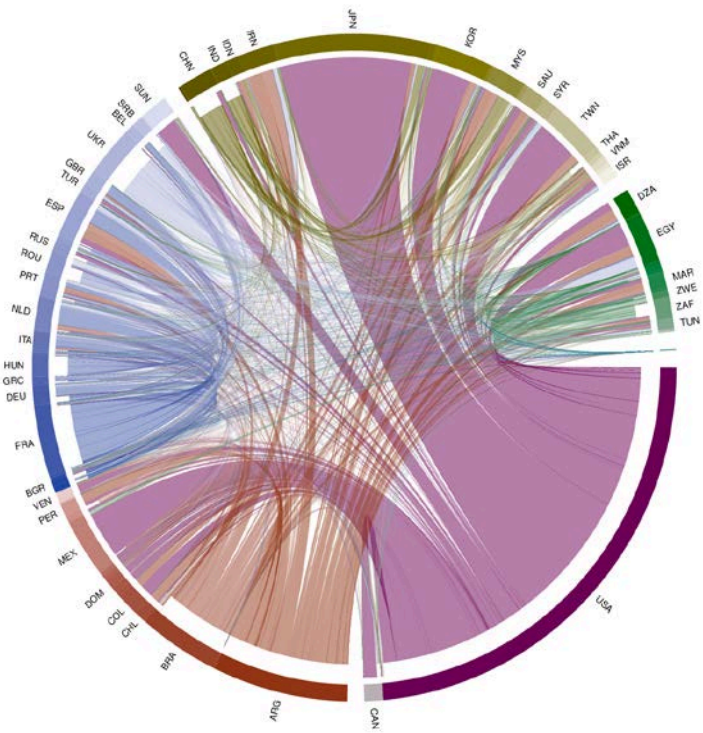
The international trade of food can either improve or decrease food security at the country level. Improvement is related to better distribution of surplus production. Decline of food security results from dependencies on imports that might be at risk because of shocks in a different part of the world. That means local shocks might cascade from country to country until they become global.

We address the question how prone the international maize trade is to such cascading events by following a network approach.

The trade dataset provided by the FAO can be interpreted as a series of time dependent, weighted directed networks. Each node represents a country and a weighted link from country i to country j is defined by the export volume from i to j in a given year.
The weights' averages from 1986 to 2011 are illustrated in the figure below, where different color palettes are associated with geographic regions and the link color is determined by the exporter.
At first glance, the world relies highly on American maize exports, i.e. there is a high risk concentration that could be mitigated by higher production diversification.

Our empirical network analysis demonstrates the existence of a backbone, consisting of links that are stable over long time. We find that it also relates to higher import prices. This means, stability, in particular in times of crises, results in a higher price on average, but it can also lower prices during crises (1996).
Additionally, we define a cascade model on the basis of our analysis to estimate the exposure of the trade network to systemic risk.
This reveals further dependence structures that go beyond an identification of main trading partners.



The authors acknowledge support by the ETH48 project and the EU-FET project MULTIPLEX 317532.

Living Lab for Sustainable Campus Catering

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When it comes to our lunch, a large share of the world's population relies on some form of system catering - large-scale catering services such as canteens, staff restaurants and dining halls - that churn out an impressive number of meals during a short "lunch hour" peak period. As society grows increasingly conscientious about the scope of impact of their daily meals, the demand on catering services has evolved as well. Nowadays catering services are expected to provide a choice of appealing high quality, balanced, diversified, and healthy meals that are sustainably produced and sold at an affordable price. Many caterers have started reducing their environmental impact by optimizing processes and by installing new appliances. However, around half of the environmental impact is caused by the "shopping basket", i.e. qualities of ingredients and overall menu composition. That is where different initiatives to reduce environmental impact in recent years have focused on, by, for example, eliminating meat components. Diets are cultural assets and food choices can be highly emotional, as controversial debates around such initiatives indicate. We argue that since universities pioneer innovation for society in many fields campuses could be an ideal breeding ground for innovation in sustainable catering. Lunch guests in campus canteens are researchers after all who may embrace experiments taking the shape of social and institutional learning and transformation processes. For that reason, the World Food System Center and ETH Sustainability launched the project "sustainable catering at ETH Zurich" in 2013. The project adopts a "living lab" approach, which intrinsically acknowledges change not as unilateral action but as a transformation process. By doing so, the project initiated an inclusive process that brought together all stakeholders in campus catering at ETH Zurich. In collaboration with a catering service company, the project engaged students in the development of real-world solutions and interdisciplinary, research-based learning by transforming canteens on ETH Zurich-campus temporarily into "living labs". Promising interventions were developed and canteens were used as "labs" to test the interventions in a controlled, but real, environment. Interventions were accompanied by consumer behaviour-research, impact- and performance-assessments, and life cycle assessments. They were chosen to better understand opportunities and limitations of demand-side-measures aimed at improving the environmental footprint of catering services, including scientific evidence on key factors that are often neglected, such as acceptance and choice. The "living lab" approach has recently received new attention but its application has been focused on sustainable urban development or specific product design processes. The application of the "living-lab"-approach to sustainable catering by using canteens as real-world laboratories is new and promising. Its potential application for transformations in food systems has yet to be explored.

What are the socio-economic impacts of genetically modified crops worldwide? A systematic evaluation of the research evidence available in six languages

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Massive increases in the quantity of studies are making possible progresses in analyzing and understanding major societal issues, such as the socio-economic impacts of genetically modified (GM) crops. Governments and stakeholders display a growing interest for evidence-based policy-making. Policy decisions based on flawed single research may affect millions of people. Decision-makers do not access to sufficient information to comprehensively evaluate key societal issues. Doing so requires a review of the available evidence across an entire range of socio-economic effects.

We are systematically evaluating research evidence to determine what sorts of studies have been conducted related to the socio-economic impacts of GM crops, what sorts of outcomes the studies have been assessed, in which populations, and using which methods. We are analyzing the evidence issued from 1996 to-date available in Chinese, English, French, German, Spanish, and Portuguese; based on standardized systematic review methods as specified in our research protocol, which was published in a peer-reviewed journal [1]. The objective of the research protocols in systematic reviews and evaluations is to minimize biases that could arise during the research conduction.

Our review focuses on six pre-defined areas of socio-economic research: farm-level impacts, impacts of co-existence regulations, impacts along the supply chain, consumer-level impacts, impacts on food security, and environmental economics impacts. This research is being conducted under the scope of the project called "GMO Risk Assessment and Communication of Evidence" (GRACE, 2012-2015), funded by the European Union. It is expected that this work will allow to ascertain the current structure of the evidence related to the socio-economic impacts of GM crops and changes on the global food systems, identify research gaps, and guide the allocation of future research resources.

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Phosphorus and nitrogen transfer within maize-pigeon pea intercropping systems of Malawi

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Maize is the key staple crop in Malawi and supports the majority of livelihoods in the country. However, continuous maize cropping and low nutrient inputs have caused yields to decline, keeping smallholders in poverty. The crucial nutrient lacking in many parts of Malawi is phosphorus (P), an important and non-renewable mineral that is dwindling in supply worldwide. While most tropical soils contain a relatively large amount of P, it is primarily in a form unavailable for plant uptake. The goal of much current research is thus to develop methods which can transform soil P into plant-available forms in order to meet the increasing food demand with less reliance on external inputs.
One potential method to increase plant-available P is to intercrop maize with pigeon pea. Studies show that pigeon pea, a protein-rich legume, has a unique ability to access soil P pools less available to maize. Since the majority of studies on this plant focus on nitrogen (N) cycling, little is known about how it affects P availability, what type of P is accessed, and if it is transferable to maize. The goal of this project was to compare crop yields and aggregate-associated P pools between intercropped and sole maize to elucidate the mechanisms involved in P transfer between maize and pigeon pea. This study consisted of both on-farm field trials in Malawi as well as a controlled greenhouse study.
Soils were separated into aggregate fractions and then assessed for total-, organic-, microbial biomass-, and plant-available-P. In the greenhouse trial, atmospheric N2 fixation and phosphatase activity was also measured. After six weeks of field crop growth, differences in aggregation were minimal, yet the organic P pool was higher in the intercropped plots, indicating that pigeon pea may contribute to increased P availability by influencing soil microbial biomass. In the greenhouse study, we found that soil aggregation increased by 54% in the intercropped treatments, indicating that this system may stabilize soil nutrients and prevent their rapid fixation or loss. We also found that pigeon pea contained 8% more fixed N2 when intercropped with maize. Furthermore, the maize was able to take up a portion of this fixed N2, thus showing a direct and positive influence on maize production. However, P uptake in maize was slightly lower in the intercropped treatments, indicating that the pigeon pea does not provide a source of P to maize as originally predicted. Overall, this project shows that pigeon pea may provide N to the intercropped maize plants, but this may be at the expense of P nutrition, and thus more information must be gathered before countrywide recommendations can be made to farmers.

Food production in smallholder farming systems: Developing a spatially explicit decision-model for trade opportunities

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Growing pressure on land and other resources is threatening the security of supplies for agribusinesses and jeopardizes the sustainability of agricultural production. The integration of smallholder farmers into the value chain presents an opportunity for agribusinesses to secure future supplies and offers farmers new income opportunities.
This paper reports about work in progress on the development of a framework to foster new trade relations and assessing the feasibility of new production initiatives. The three year project is funded by the Syngenta Foundation of Sustainable Agriculture (SFSA), which also acts as a consulting partner and contributes ongoing case studies to the project. The CONSUS framework shall function as a decision-support system for agribusinesses and for rural development. The model underpinning CONSUS is composed of two parts: In the suitability model the general suitability of a site for a selected crop is evaluated based on biophysical conditions and available infrastructure. This process is based on the method of land evaluation (Manna, Basile, Bonfante, De Mascellis, & Terribile, 2009). In the decision model, predictions regarding the farmers' decisions whether or not to adopt the suggested crop will be modelled. This step includes -but is not limited to- the profitability of production.
The implementation of the above modelling process will be carried out using spatial databases and Geographic Information Systems (GIS). Both parts of the models will be implemented as spatially-explicit multi-criteria analysis processes (MCA, Mendoza & Martins, 2006). In CONSUS these criteria are defined by the production and trading of a given crop. As part of the decision model a crop model will be integrated to allow for yield predications. The output of the model will present estimations on the land viable for production and production potential. The process will also allow the assessment of the sustainability impact of the new production intentions and its overall feasibility and limitations.
At the time of the workshop, the project will be in its second year. As a strong focus lies on the applicability of the model, different case studies in Asia, Africa and Latin America will be conducted with SFSA and partners from industry to design, test and validate the model before completion of the project in 2016.

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NutrAfrica - Indigenous Efforts to Address Food Insecurity in Ethiopia through Production Processing and Value Addition of Regional Staple Foods

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Imagine the food demands within one of the world's fastest growing economies. Couple this demand with limited access to education, technology and expertise within a framework of high bureaucracy, poverty and unemployment. Population and GDP throughout Africa are currently rising at substantial rates. As both increase, the demand for food generally as well as higher qualities and more variety, rises. At the same time, much of the fertile land in Africa is unutilized or underutilized because of subsistence farming with little to no agricultural inputs. Additionally, what production is available for resale is inefficiently processed, moved and marketed.

This increasing demand and systemic inefficiencies have not gone unnoticed by African governments. These governments wish to accelerate development and increased incomes for the farming population that represent a huge majority of almost all African nations. Most countries and trans-African institutions, often supported by aid from the international community, have turned to creating the legal and financial institutions necessary to support increased agricultural production amongst farmers. Greater productivity, in turn, requires additional investments in agricultural assets, including: equipment, inputs, institutions, infrastructure and mainly technology know-how. These assets are now widely unavailable or prohibitively expensive throughout the continent.

One solution currently underway in Ethiopia is NutrAfrica, an indigenous operation that engages practical experts throughout the world to create Ethiopian-owned businesses directly tied to enhancing food production, added value processing and sustainable employment. By avoiding the complexities of international partnerships, while using available international development resources, NutrAfrica is building an exciting new model for external investment in the East African region.

This presentation will challenge current beliefs, share relevant history, current operations, and long-term strategies for the NutrAfrica business model.

Equity in access to nutrients within the planetary boundaries

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Anthropogenic nutrient flows have transgressed the planetary boundaries. The boundaries and the current excess may vary spatially. We explored the spatial variation of the boundaries and the excess applying a bottom-up approach. Finland and Ethiopia served as cases with contrasting ecological and social contexts. We found that not the spatial variation in ecology, but the historical variation in nutrient use causes most variation in the excess. The accumulated use per capita is for Finland 3400 kg nitrogen (N_r) and 690 kg phosphorus (P), globally 2300 kg Nr and 200 kg P and for Ethiopia 26 kg N_r and 12 kg P. The critical N boundary in Finland is exceeded even more than globally on the average, while in Ethiopia even the accumulated N flow could still be increased without exceeding the critical boundary downscaled for Ethiopia. The critical P boundary is exceeded both in Finland and in Ethiopia but for contrary reasons. In Finland the excess is caused by the excessive past inflow to the food system, while in Ethiopia the excessive outflow from the food system is rather triggered by deficits in the inflow. Finnish marine systems set tighter and freshwaters broader boundaries than the global average. The shift to dominance of internal loading in the watercourses seems to represent a tipping point. We conclude that food security within the safe boundaries requires global redistribution of the nutrient reserves in residues, soils and sediments. Enabling financing mechanisms are also required. Bottom-up assessments may change the estimates of planetary boundaries and are a precondition for identifying and implementing appropriate remedies.

Exploring the New Zealand Food Footprint

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New Zealand (NZ) is a 'food basket' in the South Pacific. Primary production strongly influences its economic backbone and drives much of its environmental policy. However results of recent research highlight that NZ's drive for increased primary production has tipped it into ecological overshoot (Lawton, 2013). Although food export is an important part of NZ's food story the aim of this research is to highlight the opportunities for communities to move towards using the Ecological Footprint (EF) to guide their development and as a measure of progress. This paper presents a breakdown of the NZ food system, quantities by production sector, what the main impacts are and the behaviour change required to make a real difference. It also introduces the current project which will provide a template for redesigning regional food systems. Completed in early 2013, the NZ Footprint Project highlighted the variations between different NZ lifestyles and urban forms. The EF tool was used to estimate the resource consumption and waste assimilation requirements of a defined human population or economy in terms of corresponding productive land area 'biocapacity' (Rees & Wackernagel, 1996). The calculation used is: EF = Production + Import – Export. In 2007 the average New Zealander had an EF of 2.5 NZ hectares (NZha) whilst the 'fair earth share' was 1.21NZha. The food and drink category required 56% of the total NZ EF. When fishing land is removed from the breakdown food required 31% and other consumer goods are responsible for 35%. The EF calculation of food uses a range of different resources and land types. Energy land captured non-renewable energy sources. The majority of the land required for food is the physical land to grow it, making up 76% of the total food EF. The fertility of land can be altered, for example by using on-farm fertilisers and irrigation which requires borrowing land from elsewhere. Of the remaining 24% of the EF not required for 'growing land', 22% was for on-farm energy and 25% was for processing energy. Processing energy was high, considering that in 2007, 67% of NZ electricity was produced from renewable sources. The largest component of the food transport EF was domestic transport, followed by personal transport required when purchasing food.

Interviews were carried out in five communities across the country in order to compare diets and consumption preferences, and to explore the impact of urban form on the food EF. Perhaps not surprisingly, this EF was lowest in rural communities where people had access to land on which to cultivate and graze animals. They were also in close proximity to hunting NZ pest and game species that were included in their diet. Alternatively there were a few individuals within the peri-urban and urban areas who also grew as much as 40% of their annual food consumption. Eating less fish and meat also greatly decreased individual EFs. Discussion and publication of the project's results highlighted the opportunity for local food production to greatly reduce a community's EF. As a result, funding has been secured to carry out the Otago Food Economy Project that will map the Otago food system from producers to consumers, comparing the social and economic benefits of the local and conventional food systems. The project will present the findings to the community where collaboratively we will aim to identify the opportunities to create a flourishing local food economy.

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Unified Science for Understanding Agriculture and Food Systems. Experiences made in West Africa with an innovative method of research and development

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Food systems include all processes from production to processing, transport, marketing and consumption. Larger societal sub-systems, like nations, industry, laws, politics, culture and civil society embed each of these processes. Each society is based and dependent on natural environments, and existence and behaviour of people. Food systems and the phenomenon of food security have not only become complex issues, but they have become global. No single national society today is independent from the newly emerged world society. When dealing with complex issues within the food and agriculture system across sectors and scales on complex or wicked problems, covering local to global dimensions, theoretical and methodological difficulties prevail in applying a whole systems approach. Relations between soil, plant, animal, economics, farmer behaviour, policies, technologies, consumption, culture and social dynamics remain undiscovered. While practical experience tells that rational relations and patterns between these "sub-systems" exist, scientific knowledge remains silent or provides only partial answers.

We are developing and testing a scientific method to integrate normally separated disciplines (inter-disciplinarity) and other knowledge cultures like "local", "farmer", "practitioners" (trans-disciplinarity) in order to develop solutions for societies and their related constituencies. The 5-year project started in 2011. The cotton system of West Africa, characterized by small and medium scale farmers competing on the world market with highly industrialized farming (USA, Brazil, Turkey etc.) embeds it. The method applied uses theories and concepts from sociology mainly. The three main new theoretical concepts are (i) social systems theory (Luhmann); Actor-Network Theory (Latour) and Social capital/social fields (Bourdieu). The well- known farming systems approaches and to economics are added to them. The useful outcomes from this action-research are applied, and they generate refined methods with improved applicability. This pragmatic iterative method has led after 4 years to a methodology which we believe can be applied for any complex phenomenon (problem) dealing with the contentious parameters food insecurity, soil deterioration, poverty, low productivity, technology development, low adaptation rates, low attractiveness of family farming, social instability and impact of agricultural research for development and change (solution). The issue is always to make the role of social systems transparent.

The main challenge for non-sociologists in the research team is to grasp the (invisible) social dimension of food systems. Social systems tend to be seen by non-(social) scientists as psychological realities instead. The poor representation of social sciences in the national and global agriculture research systems leads then often to inappropriate research boundaries and scopes, hence to unfruitful research protocols. Unreflective use and perception of scientific and other forms of knowledge prevents appropriate and cost-effective links with the relevant function systems like economics, politics, law, culture, media and civil society. Inclusion of social and cultural science may lead to a unified science for a meaningful understanding of globalized food systems.

Design of a Low Cost Solar Powered Smart Grain Silo

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Sub-Saharan Africa experiences post-harvest food losses that exceed 30% of total crop production representing more than US$ 4 billion in value annually, furthermore, these annual food losses far exceed the amount of international food aid provided (World Bank, 2011). In Uganda small holder farmers are big contributors to food production. Poor storage facilities used by these farmers are one of the main causes of post-harvest losses. Although relatively simple and inexpensive to construct and maintain, traditional storage systems used by small holder farmers in Uganda lead to substantial grain quality deterioration through infestation by pests, fungi and microbes. Temperature is a key parameter in prolonging the shelf life of grain. We are therefore proposing the design of a low cost solar powered smart grain silo capable of preserving the quality of grain to improve on its shelf life. A microcontroller based unit monitors the temperature of the silo and records the temperature readings at intervals of 6hours. The system activates a cooling system once the temperature reaches an upper threshold.

A grain silo structure is fitted with the designed temperature monitoring and control unit. Design and testing is carried out with a modular approach. The modules included temperature monitoring, temperature control, temperature display, temperature logging and user interface. The firmware design consisted of algorithms for each module which were subsequently tested using MPLAB simulation tools and Proteus software. Thereafter each subsystem was bread boarded, tested, debugged then re-tested. A Printed Circuit Board (PCB) was designed and developed with components placed and soldered onto the PCB. The firmware was again tested and debugged with the final PCB hardware. The final PCB is powered by a solar charged battery power supply.

Temperature readings were observed over the range of 10 to 30 Degrees Celcius and were found to be within +/- 1 Degree Celcius in comparison to standard thermometer readings. The recorded temperature readings were analysed and found to be consistent with expected temperature recordings. The fan from the cooling system was automatically switched on when the grain temperature rose above the threshold temperature and switched off when it fell below. The unit drew 0.01A and 7A from a battery rated 25Ah when the fan was off and on respectively which was acceptable in terms of power conservation.

Based on our findings, temperature monitoring and control is a reliable, efficient and inexpensive option to improve on the shelf life of grain stored in silos. Future considerations for the designed unit include the ability to determine the amount of grain in the silo and wireless connectivity to mobile devices to enable remote viewing of real time and historical temperatures.

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Training the next generation of agricultural educators to grow local food systems in urban areas

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Continuing population growth leads to increasing demand for food, particularly in urban areas. According to the 2010 U.S. Census Bureau, 80.7 percent of the United States population lives in urban areas. Given that the growth rate of the urban population between 2000 and 2010 was 12.1 percent, it is projected that the majority of the United States population will continue to live in metropolitan centers. As cities grow, the role of urban agriculture will be increasingly important. Furthermore, the ability to educate and train those that are interested in the growing, processing and distribution of food crops and animal products within the urban environment, as Bailkey and Nasr define urban agriculture, will positively contribute towards food security. Urban agriculture is being recognized as a critical component for feeding the growing population, as an economic revival strategy in blighted areas of many cities, as a public health strategy to improve nutrition, as an educational opportunity for the public to become more familiar with food production, and as a strategy for community development. The growth of urban agriculture initiatives in the Kansas City area over the past 15 to 20 years reflects this national and international trend. In response to the demand for educating, training and engaging more young people into food production, distribution, and consumption in urban areas, the Department of Horticulture, Forestry and Recreation Resources at Kansas State University launched a new horticulture M.S. specialization in 2010 called Urban Food Systems. The goal of this program is to provide inter-disciplinary training for the next generation of educators and practitioners of Urban Agriculture. This includes a new paradigm for food production in the United States, which combines the integration of food production and community development. For example, knowledge and skills in not-for-profit management, food justice, community development, and food policy are crucial in addition to those associated with production. The purpose of this presentation is to identify the role of urban agriculture in the global food system and discuss how a new M.S. program is addressing the needs of the next generation of agricultural educators.

Sustainability and Food & Nutrition Security: A Vulnerability/Resilience Framework for Food Systems

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Recurrent food price crises and climate change, along with habitat loss and foodborne and zoonotic disease outbreaks, have placed sustainability with food and nutrition security at the top of the political agenda. Analyses of the dynamic inter-linkages between food consumption patterns and environmental concerns recently received considerable attention from the international community. Sustainable diets and food systems have emerged as a critical policy and consumer issue and a promising area for research. Complex food systems involve multiple interactions between human and natural components and present several conditions of vulnerability related to food insecurity and unsustainability.

Metrics are essential in informing action for policy and decision-making, but concepts, methods and indicators need to be linked in a coherent and systematic way for a multidimensional joint analysis of food and nutrition security and environmental sustainability. Using the lens of a wide sustainability approach and recognizing the systemic dimension of sustainability, this research initiative developed a multidimensional framework to identify context-specific metrics of sustainable diets and food systems.

Derived from natural disaster and sustainability sciences, the framework developed followed two lines: a vulnerability/resilience-based approach and an analysis of the key issues of food and nutrition security. This coupled issue/vulnerability approach results in a coherent structure that disentangles exposure, sensitivity and capacities to respond to specified disturbances or drivers of change. Resilience helps further framing of coping, adaptation and transformation strategies, and provides the concepts to capture these by selecting proxy indicators. Acknowledging the systemic dimension of sustainability, the approach allows the consideration of causal factors dynamics. A Delphi technique was applied in order to select the reduced cluster of indicators. Use of a participatory approach and rigorous expert-based elicitation techniques allows implementing assessments beyond subjective and individual considerations and thereby reaching consensus. The framework allows for the design of information systems or metrics to assess the joined environmental, economic, social and health dynamics of food systems.

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Bioversity International's work was supported by The Daniel & Nina Carasso Foundation and the Agriculture for Nutrition and Health Research Programme of the CGIAR.

Growing Growers: Facilitating the development of new farmers in order to strengthen local food systems

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In the central United States, a shift is occurring in the way that food is being produced, distributed, prepared, and valued by the public. In particular, specialty crops including organic produce have been dramatically affected and consumer-demand for locally-grown organic produce is at an all time high. This transition has afforded the engagement of new growers and development of small local businesses surrounding food production. Additionally, there is a strong need to develop new growers. Although there are a number of opportunities for emerging growers, numerous challenges exist including limited experience by extension agents and other farm consultants with commercial organic vegetable production. The Growing Growers Farmer Education program (www.growinggrowers.org) was established in 2004 to address the need for new growers and to train these farmers on effective growing practices. As a partnership program between K-State Research and Extension, University of Missouri Extension, Lincoln University Cooperative Extension, the Kansas City Food Circle, Cultivate Kansas City, and the Kansas Rural Center, we are able to leverage our limited resources to function effectively as a multi-state, multi-institution team. We set the goal of providing educational opportunities to help new growers get started and existing ones get better at what they do. We do this by providing apprenticeships for new growers at established organic vegetable farms. Apprentices work on a local farm during the growing season to get first-hand, practical experience; they attend monthly workshops; and they get direct one-on-one training from their host farmer. The monthly workshops address many of the skill sets required to run a local farm, from soil management to production planning to marketing to farm business management. We've also developed the [GrowersKC] listserv for area networking, which includes more than 500 area growers, restaurateurs, grocery stores, and others interested in the local farming. Finally, we organize special events to help develop the local farming industry. As local food networks continue to grow, vegetable grower education and mentoring programs will be instrumental to the development of a stable local food system. This is particularly true in areas where farmers may be resource-limited in their ability to access information and growing expertise. One of the ways that Growing Growers overcomes this challenge is by cultivating relationships among growers and facilitating peer-to-peer mentoring. This is an invaluable aspect to the success of this program, where the commercial fruit and vegetable production industry is relatively small and university/extension programs are limited. This presentation will discuss the Growing Growers program and how it can be utilized as a model for increasing the number and productivity of organic vegetable growers in areas that are resource-limited.

Supplier dynamics in horticultural export chains: evidence from Ecuador

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Linking small farmers to global markets through contract farming has become an important policy recommendation aiming to increase farm´s income and foster rural development. Nevertheless, some of the arrangements involving small farmers loose participants or collapse over time showing lack of sustainability. In this paper we study the dynamics of smallholder participation in export value chains focusing on the example of small-scale broccoli producers in the highlands of Ecuador. A double hurdle model and a multi-spell cox duration model are used to explain the extent of participation and the hazards of dropping out of the export chain. The empirical results from an 11 year data base obtained from a farmers´ association suggest that small farmers´ withdrawal from the export sector is in fact accelerated by hold-ups experienced in the past and that family ties play an important role in farmers' marketing decisions. Negative external shocks – such as the bankruptcy of the main buyer in our case study – represent a major threat towards the sustainability of smallholder inclusion in high-value chains, given the low resilience capacity of farmers´ organizations.

Acknowledgements: The financial support of the German Research Foundation (DFG) is gratefully acknowledged.

Scarce resources meet growing food demands: Can we continue with -business as usual- land use in the Alpine countries?

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Soil is the most sensitive and valuable natural capital of mankind (Haber and Bückmann, 2013: 1 ff.). It is a scarce resource and the basis for growing food. In order to meet increasing food demands, the Alpine region is exposed to two major challenges. Firstly, topographical conditions in the Alpine region constrain the area, which can be used for agricultural production. Secondly, the Alps have suffered a dramatic loss of biodiversity in the last few decades. This loss is to great extent caused by a) increasing nitrogen depositions, and b) intensified use of agricultural soils in higher yielding areas (BAFU 2015). In the context of a globally growing population and a changing climate, it is increasingly important to preserve eco system services including soils in fragile ecological zones.

In order to find anchor points which help to tackle the multiple challenges a qualitative system analysis (Scholz and Tietje, 2002) was conducted to identify and analyse the factors which influence agricultural land use in the countries Austria, Lichtenstein and Switzerland. Based on a qualitative content analysis and a workshop with experts from Austria and Switzerland, 30 variables were identified and the degrees to which these variables impact each other were assessed. The variables and their interrelationships (impact matrix) were modelled and analyzed with the software SystemQ. This software allowed analysing the system grid, the system feedback and assessing the effectivity of achieving specific goals under the assumption that -business as usual- land use will continue in the Alpine Region.

Results suggest that our Alpine land use system exerts an enormous pressure on the level of specific variables. If current land use practices and trends are continued, the level of the "ecological status of the agricultural areas" and "attractiveness of landscapes" is likely to decline. Contrarily, the level of "land use intensity on crop- and grassland" will further increase. This shows an imminent need to substantially change land use especially if we seek for long-term food security and conservation of natural resources. In a forthcoming step, we will use these results in a global land use model (Schader et al., 2014) to quantitatively assess effects of several -more sustainable- land use scenarios in the Alpine region.

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A technology-based Incubation Center for establishing food processing enterprises in Niger, a case study

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Sorghum and millet are the major staple food crops and play a central role in food security for the majority of smallholder farmers who live in the West African Sahel. While they have limited capacity to invest in or to access new agricultural technologies for higher productivity and utilization, development of market-based solutions to link farmers to markets is vital to ensure agricultural development, economic growth, and sustainability of the food value chain. Our research explores the concept of technology-based Incubation Centers, developed in a participatory manner with entrepreneurs and government, to establish food processing enterprises using local crops in West Africa. Our collaborative work in Niger began over 15 years ago with the objective of finding a mechanism to effectively transfer technologies and processing know-how to local entrepreneurs, help farmers meet their needs for quality grain, and to grow their businesses. An urban technology-based Incubation Center was established at INRAN, Niamey to trained entrepreneur groups (primarily women) in aspects of food processing. Entrepreneurs are permitted to use the Incubation Center in 3-4 day shifts to process and sell products that include: agglomerated products (sorghum and millet couscous, degue), composite flours, baking flours, grits, and biscuits. Approximately 5 metric tons of high-quality agglomerated products were initially processed, packaged in 500 g bags, and sold in open markets, small stores, and supermarkets. Agglomerated product was subjected to sensory tests and willingness-to-pay surveys. Market potential was assessed through major redistribution channels in Niamey. Moreover data on market movement, business growth, and ability to pay loans was measured by researchers. Results showed that 80% of buyers found the price (500 CFA/500g), product quality, package type and label acceptable. Buyers perceived sorghum couscous as a safe, and an easy to prepare food that promotes satiety. The Incubation Center concept was also implemented at rural sites in Niger to enhance market access for women farmers. A study on development of processed millet foods at village level sites was conducted to learn more about the potential rural women to process grain for markets. More than 79% saw millet and sorghum grain processing activities as a good initiative to pursue at the village level. Currently more than 100 rural families per site (3 in total) are benefiting from introduced grain threshing and milling equipment. Moreover, development of rural incubation centers has helped maintain and reinforce the dynamic of contracting partnership between processors and smallholders farmers. More than 30 tons of consistent quality sorghum and millet grains were supplied to urban processors in Niger through the incubation activities. Rural women processors groups in Niger have now started to market processed sorghum and millet packed and label products at their local weekly markets Local food crops have good potential to enhance economic growth through integration of farmers into local, regional, and global markets. The incubation concept offers an avenue for this integration by using available and newly developed technologies to assist the private sector to create demand and maximize market opportunities for farmers.

Development of pearl millet for health benefits for type-2 diabetes

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Type 2 diabetes (T2D) is highly prevalent on a global scale causing 1.5 million deaths in 2012 alone. Although medicinal products exist, changes in lifestyle and diet are known to regulate insulin in affected individuals. Amongst many of its benefits, the cereal crop pearl millet is known to be rich in starch and essential amino acids that are directly involved in the pathways which confer insulin resistance and, therefore, has a direct role in the management of diabetes. We are exploring genetic variation of starches and amino acids in pearl millet germplasm accessions to develop superior pearl millet cultivars that are both high yielding and have characteristics that provide better control over blood sugar. Availability of such grains, and food products made of such grains, will provide better glycaemic control benefits to both the growers as well as to consumers.