

A close-up photograph of a woman in traditional African clothing, including a green top with colorful embroidery and a red and yellow headwrap. She is holding a bowl of green leafy vegetables. The image is partially obscured by a white box containing the SLU logo.

*Agri4D*

**Zero hunger by 2030,  
our shared challenge!**  
Drivers of change and  
sustainable food systems

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Agricultural Research for Development Conference, Agri4D 2019 | 25-26 September 2019  
Swedish University of Agricultural Sciences, SLU | Uppsala, Sweden



**Zero hunger by 2030, our shared challenge!**  
Drivers of change and sustainable food systems  
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# About

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**According to the FAO, there is more than enough food produced in the world to feed everyone. However, close to 1 billion people are hungry or undernourished. In order to feed another two billion people in 2050, food production will need to increase by 50 % globally. At the same time, about 1.5 billion suffer the effects of malnutrition being overweight or obese.**

To improve food security and nutrition, the role of the small-scale farmers in the South and particularly in Africa will be crucial. Assisting a transformation of the small-scale farming systems to produce more and the development of value addition opportunities for small scale farmers will be crucial. Agenda 2030 focuses on eradicating poverty by 2030, and on “Leaving no one behind”. A crucial focus must be the rural poor who depend on agriculture and related services for their livelihoods.

We will face a tremendous pressure on these small-scale farming systems to produce more, and the question will be how to do this in a sustainable manner, and at the same time supporting those not able or ready to transform. The key challenge is therefore on how to raise productivity, while protecting the environment and supporting those losing out social support systems.

It is in this complex context that Swedish University of Agricultural Sciences (SLU) and Swedish International Agriculture Network Initiative (SIANI) are organising the Agri4D Conference 2019 taking place at SLU, Uppsala on 25–26 September 2019. The main aim of the conference is to promote knowledge exchange for improved sustainability and resilience in food systems.

This is a two day event for researchers and professionals working with and/or interested in agriculture research for development. PhD students, senior scientists, experts from social, political, soils, crops, natural resources and animal science, economy, forestry, horticulture, veterinary medicine etc. are encouraged to participate.

## Keynote speakers

- **Lennart Olsson.** Professor, Lund University Centre for Sustainability Studies (LUCSUS), Lund University, Sweden
- **Fred M. Dzanku.** Research fellow, Institute of Statistical, Social & Economic Research (ISSER), University of Ghana, Ghana
- **Rohana Subasinghe.** Senior researcher, WorldFish; former FAO Fisheries and Aquaculture Department, Sri Lanka
- **Eric Malézieux.** Director Agroecological functioning and Performances of horticultural systems research unit (CIRAD), France
- **Laura Hammond.** Professor, SOAS Food Studies Centre, University of London, United Kingdom
- **Aslihan Arslan.** Senior Research Economist, Research and Impact Assessment Division, International Fund for Agricultural Development (IFAD), Italy
- **Anne Larson.** Team leader for Equity, Gender and Tenure, Center for International Forestry Research (CIFOR), Peru
- **Moses Osiru.** International Centre of Insect Physiology and Ecology (ICIPE); former member of RUFORUM; member steering committee AgriFoSe2030, Uganda

We will have four thematic sub-sessions on the first day of the conference, and three on the second day. The poster session will open after lunch on the first day. For those not able to physical come to the conference, we will hold a webinar session on the first day of the conference.

For more information, visit us at:  
<https://www.siani.se/event/agri4d2019/>

 #Agri4D19

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# Program

# Day 1

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## Wednesday 25 September

- 08.15–08.45**    **Registration and coffee**
- 08.45–09.15**    **Welcome and opening**
- 09.15–10.15**    **Keynote speeches**
- **Is the future of agriculture perennial?**  
*Lennart Olsson, Lund University*
  - **Social and economic correlates of yield gaps in sub-Saharan Africa: What lessons for rural development?**  
*Fred Dzanku, University of Ghana*
- 10.15–10.45**    **Coffee break**
- 10.45–11.45**    **Keynote speeches**
- **Nourishing the World: The Role of Fish.**  
*Rohana Subasinghe, WorldFish*
  - **Diversified agroecological cropping systems: a solution for food security in Low Income Countries?**  
*Eric Malézieux, CIRAD*
- 11.45–12.45**    **Lunch**
- 12.45–13.15**    **Keynote speech**
- **Food Insecurity, Mobility and Displacement in the Horn of Africa**  
*Laura Hammond, University of London*
- 13.15–14.15**    **Poster session**
- 14.15–15.15**    **Thematic sub-sessions and webinar**
- **Food security and migration governance**  
*Session leader: Jesper Bjarnesen, NAI*
  - **Aqua-agro farming system: A sustainable solution to food security and nutrition?**  
*Session leaders: Kartik Baruah, Anders Kiessling, SLU*
  - **Diversified agro-ecological cropping systems for sustainable food systems**  
*Session leader: Erik Steen Jensen, SLU*
  - **Yield Gaps – causes of yield gaps and how can they be smaller/closed?**  
*Session leaders: Ingrid Öborn; Magnus Jirström; Sigrun Dahlin; Håkan Marstorp, SLU*
  - **Webinar: Soil degradation and the SDG's**  
*Moderator: Matthew Fielding, SEI*
- 15.15–15.30**    **Coffee Break**
- 15.30–17.00**    **Continue thematic sub-sessions and webinar**
- 17.00–19.00**    **Reception (mingle)**

# Program

# Day 2

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## Thursday 26 September

- 08.15–09.00**    **Registration and coffee**
- Thematic sub-sessions**
- 08.30–10.15**    **Translating science into policy and practice for food security**  
*Session leaders: Magnus Jirström, Lund University; Madelene Ostwald, GMV and Linköping University*
- 09.00–10.15**    **Tenure reforms for inclusive rural development and food security**  
*Session leaders: Jenny Friman; Lasse Krantz; Maria Ölund, Focali and LARRI*
- 09.00–10.15**    **Resilient landscapes**  
*Session leaders: Anna Tengberg, Malin Gustafsson, SIWI/SWH, Nighisty Ghezae, IFS*
- 10.15–10.45**    **Coffee break**
- 10.45–12.00**    **Continue thematic sub-sessions**
- 12.00–13.00**    **Lunch**
- 13.00–13.15**    **Welcome to Day 2**
- 13.15–14.15**    **Keynote speeches**
- IFAD Rural Development Report 2019: Creating opportunities for rural youth.  
*Aslihan Arslan, IFAD*
- Formalizing community tenure: for rights, conservation or livelihoods?  
*Anne Larson, CIFOR*
- 14.15–14.45**    **Coffee break**
- 14.45–15.15**    **Keynote speech**
- Building skills for delivering Africa's Agenda 2063: The role of science and policy.  
*Moses Osiru, Icipe*
- 15.15–16.15**    **Panel discussion with keynote speakers**
- 16.15–16.45**    **Closing of the conference**

# Short bios of keynote speakers

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## **Lennart Olsson**

Professor, Lund University Centre for Sustainability Studies (LUCSUS), Lund University, Sweden.

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Lennart Olsson, professor of Geography at Lund University in Sweden, was the founding Director of Lund University Centre for Sustainability Studies (LUCSUS) between 2000 and 2017. His current research focuses on the politics of climate change in the context of poverty, food insecurity and ill-health in sub-Saharan Africa, and on the transition from annual monocultures to perennial polycultures in agriculture. He was Coordinating Lead Author for the chapter on Livelihoods and Poverty in IPCC's 5th Assessment Report 2011–2014 and for the chapter on Land Degradation in the special IPCC report on Climate Change and Land (SRCCL), 2017–2019.



## **Fred M. Dzanku**

Research fellow, Institute of Statistical, Social & Economic Research (ISSER), University of Ghana, Ghana.

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Fred Dzanku is a development economist whose research focuses principally on the economics of household behaviour in sub-Saharan Africa. He currently holds the position of Research Fellow at the Institute of Statistical Social and Economic Research (ISSER) at the University of Ghana. He obtained his PhD in Agricultural Economics from the University of Reading in 2012. His current research areas include the analysis of yield differentials in sub-Saharan Africa and implications for rural economic development; impact evaluation of real world projects and programs using randomized controlled trials and quasi-experimental methods; ex ante evaluation of biotechnology; household welfare analysis; poverty reduction policy analysis; natural resource governance and applied econometric modelling.



**Rohana Subasinghe**

Senior researcher, WorldFish; former FAO Fisheries and Aquaculture Department, Sri Lanka.

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Rohana Subasinghe is a specialist in aquaculture development and aquatic animal health management. He retired from FAO in October 2015, while serving as the Chief of the Aquaculture Branch. During his 25 years of carrier at FAO, he designed and implemented many aquaculture programmes and projects all around the world. Rohana is a strong advocate of sustainable, responsible and equitable aquaculture and improving its contribution to poverty alleviation and food and nutrition security. Currently working as a senior scientist at WorldFish, his passion is to increase fish consumption among rural poor, especially among childbearing women and young children, towards improving their health and wellbeing.

**Eric Malézieux**

Director Agroecological functioning and Performances of horticultural systems research unit, (CIRAD), France.

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Eric Malézieux is an agronomist and researcher at Cirad, in France. He holds a PhD in Agronomy from AgroParisTech, France and an HDR from the University of Montpellier. His main research experience and field expertise covers the agronomy of tropical cropping systems, with a focus on horticultural and agroforestry systems in the tropics. His main research interest is on agroecology and links with food security. He has 35 years' experience in West Africa, Caribbean, Indian Ocean, Pacific, and Central America. He has been leading the HortSys research unit "Agroecological functioning and Performances of Horticultural Cropping Systems" from 2008 to 2019.



**Laura Hammond**

Professor, SOAS Food Studies Centre,  
University of London, United Kingdom.

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Laura Hammond is Professor of Development Studies at SOAS University of London. She has been conducting research on conflict, food security, migration and diasporas in and from the Horn of Africa since the early 1990s and working for the UN Emergencies Unit for Ethiopia (the precursor to UNOCHA). She is currently Challenge Leader in Security, Protracted Conflict, Refugees and Forced Displacement for the Global Challenges Research Fund, head of the London International Development Centre-Migration Leadership Team, and Team Leader of the EU Trust Fund's Research and Evidence Facility on migration and conflict in the Horn of Africa. She has consulted for a wide range of organisations such as UNDP, USAID, Oxfam, Médecins Sans Frontières, the International Committee of the Red Cross, and the World Food Programme. She authored the book 'This Place Will Become Home: Refugee Repatriation to Ethiopia' (2004).

**Aslihan Arslan**

Senior Research Economist, Research and  
Impact Assessment Division, International  
Fund for Agricultural Development (IFAD), Italy.

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Aslihan Arslan is a Senior Agricultural Development Economist at the Research and Impact Assessment Division of the IFAD. She leads multiple research projects related to agricultural productivity, climate resilience, rural out migration and climate change mitigation potential of agricultural practices promoted by IFAD and others. She conducts impact assessments of IFAD projects related to these themes. She co-led IFAD's flagship publication the Rural Development Report 2019 on "Creating opportunities for rural youth." Prior to joining IFAD in 2017, Aslihan worked as a Natural Resource Economist at FAO, focussing primarily on Climate-smart Agriculture. She holds a PhD and MSc in agricultural and resource economics from the University of California at Davis; and a BSc in economics from the Middle East Technical University, Ankara.



**Anne Larson**

Team leader for Equity, Gender and Tenure, Center for International Forestry Research (CIFOR), Peru.

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Anne M. Larson is currently the Team Leader for Equity, Gender and Tenure and has been a Principal Scientist at the Center for International Forestry Research (CIFOR), based in Lima, Peru, since 2012. She obtained her PhD in 2001 from University of California, Berkeley in Wildland Resource Science, with an emphasis on resource policy and institutions. Her current research priorities include opportunities for and challenges to forest tenure reforms; multilevel governance and multi-stakeholder processes to address climate change and support “low emissions” development; and environmental justice and human rights, such as indigenous rights and gender.



**Moses Osiru**

Former member of RUFORUM; Member steering committee AgriFoSe2030, International Centre of Insect Physiology and Ecology (icipe), Uganda.

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Moses Osiru is Manager of the Regional Coordination Unit of the Regional Scholarship and Innovation Fund of the Partnership for skills in Applied Sciences, Engineering and Technology (PASET) based at icipe, Nairobi, Kenya. PASET is a partnership of African governments that aims to train 10,000 African PhDs over the next 10 years. Dr. Osiru holds a PhD in Agriculture (Plant Pathology) and has published widely in over 50 scientific publications. Moses’s wide experience includes working closely with the World Bank, Governments, international agencies, Non-governmental Organisations and the African Union Commission. He sits on the AgriFose 2030 Steering Committee.

# Short bios of conference moderators

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## **Annika Åhnberg**

Annika Åhnberg is a former minister of agriculture and has been a member of the parliament in Sweden.

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She has for more than ten years been a consultant within the area of agriculture and food production in relation to sustainability. She is an experienced project leader and facilitator. Prior to being a consultant, she was vice president at DeLaval Holding and heading its division for Public Affairs. She has been the chairperson of Save the Children Sweden. She has a bachelor degree of social work.

She is now the chairperson of the steering committee of SIANI, Swedish International Agricultural Network Initiative and also the chairperson of the board of f3 (“fossil free fuels” is a networking cooperation between universities, research institutes and industry companies). She is a member of the steering group of Axfoundation. She is a fellow of the Royal Swedish Academy of agriculture and forestry and of The Royal Swedish Academy of Engineering Sciences (IVA) and of the Royal Physiographic Society of Lund. Annika Åhnberg is an honorary doctor at the Swedish University of Agricultural Sciences



## **Simon Stanford**

Simon Stanford is a South African documentary film director / cinematographer and journalist who has filmed and produced news reports, documentaries and films from virtually every corner of the world with primary focus on Africa, his home continent.

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He has worked for many of the world's major television newsrooms, including BBC, American NBC, Canadian CBC and Swedish SVT. He now focuses on directing and producing feature documentaries as well as teaching documentary film production.

Session leaders: Jenny Friman, University of Gothenburg; Ylva Ran, SEI; Caroline Augustsson, SIANI  
Lecture room: Aula

## Poster No

- 1 **Correlates of Hunger Severity and Food Intake among Rural Households in Nigeria: Facing the Key Challenges of the 21st Century**  
*Presenter: Abiodun Olusola Omotayo*
- 2 **Hydrologic impact of winter cover cropping with reduced tillage for sustainable farming in California's San Joaquin Valley**  
*Presenter: Anna Gomes*
- 3 **Cleaner cooking while producing biochar: factors affecting adoption of gasifier cookstoves in rural areas**  
*Presenter: Cecilia Sundberg*
- 4 **Neither modern nor traditional: Farmer-led irrigation development in Kilimanjaro Region, Tanzania**  
*Presenter: Chris de Bont*
- 5 **Identification of production constraints by the implementation of herd health management in smallholder pig farms in Uganda**  
*Presenter: Elin Gertzell*
- 6 **Description of the production and management system of the Creole cattle from Pasorapa, Bolivia. Farmer perceptions and vulnerability to climate change**  
*Presenter: Gabriela Bottani Claros*
- 7 **Killing Them Softly: Moral Practices in Modern Livestock Farming**  
*Presenter: Hanna Wernersson*
- 8 **Infectious diseases in Indian ruminants as potential causes of reduced productivity**  
*Presenter: Johanna Lindahl*
- 9 **Perceptions and practices of Zambian sheep and goat traders on small ruminant health and disease**  
*Presenter: Jonas Johansson Wensman*
- 10 **Entrepreneurship as empowerment? Gendered opportunities and challenges in entrepreneurial urban and peri-urban agriculture in Tanzania**  
*Presenter: Karolin Andersson*
- 11 **How and when does agriculture in South American and African countries depend on rainforests for their rainfall?**  
*Presenter: Maganizo Kruger Nyasulu*
- 12 **Modelling of potential biochar production capacity and bioenergy generation in Kenya and its impact on climate change from a life cycle perspective**  
*Presenter: Md Aquif Rahman*
- 13 **Future scenarios of land use change in southwest Russia**  
*Presenter: Nataliia Pustilnik*
- 14 **Food consumption and nutrient deficiencies trends in the Democratic Republic of Congo**  
*Presenter: Patrice Mirindi*
- 15 **Factors limiting maize yield in two Ghanaian villages vary with field age**  
*Presenter: Sigrun Dahlin*  
  
**Nutrient imbalances in two Ghanaian regions: from nutrient mining to excess**  
*Presenter: Sigrun Dahlin*
- 16 **The endurance of olive Biocultural Heritage in Sicily: long-term patterns of intercropping systems for sustainable futures.**  
*Presenter: Vincenza Ferrara*

## **Correlates of Hunger Severity and Food Intake among Rural Households in Nigeria: Facing the Key Challenges of the 21st Century**

*Abiodun Olusola Omotayo<sup>1</sup>*

<sup>1</sup> North West University, South Africa

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Nutritional deficiency and hunger are long-standing challenges in the developing nations where majority of people suffer from one of the heaviest burdens of hunger and malnutrition. Interventions aimed at increasing food availability and hunger reduction hold great potential for improving nutrition status through increasing food production in a developing nation such as Nigeria.

We present a novel approach to explain the correlates of hunger severity and food intake among the rural households in Nigeria. Indicators of hunger severity and food intake were computed with coping options due to hunger and dietary diversity scores. Data were analyzed using descriptive statistics (percentage, standard deviation etc.) and inferential statistics, such as Principal Component Analysis (PCA), and Ordinary Least Square Regression (OLS). In the study, the descriptive results show that the rural respondents captured in the survey were 81.19% male, with an average age ( $53 \pm 11.44$  years) and ( $9.20 \pm 4.83$  years) of education. On the other hand, the regression results of the factors that affect the households' hunger severity and the composite food intake diversity indices (generated from the PCA) were well fitted ( $p < 0.01$ ). Ageing, large household size and poor credit facilities, among others were identified as major problems among the rural dwellers.

It was therefore concluded that hunger and poor diversity of food intake among the rural households were problems in the study area. It was however recommended that considerable investment in rural household's human capital should be encouraged since nutrition education and food diversity enhances households' wellbeing.

**Keywords:** Dietary diversity scores, Food intake, Hunger severity index, Ordinary Least Square Regression, Principal Component Analysis, 24 Hours Recall Period.

## **Hydrologic impact of winter cover cropping with reduced tillage for sustainable farming in California's San Joaquin Valley**

*Anna Gomes<sup>1</sup>*

*Alyssa DeVincentis<sup>1</sup>, Jeff Mitchell<sup>1</sup>*

<sup>1</sup> University of California, Davis, USA

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The future of food production will require the use of farm practices that simultaneously improve soil health, reduce greenhouse gas emissions, and utilize water efficiently. Winter cover cropping and conservation tillage are two farm practices that may help to meet these needs, but uncertainties remain around their impacts on pre-season irrigation demands, on-farm logistics, and overall soil water content. This study fills a gap in the research by investigating how cover crops and conservation tillage influence water management at the field level. We investigate this question using three years of robust data from a 20 year long-term field experiment in Five Points, California, comparing standard tillage to conservation tillage and fallow fields, or no cover cropping, to winter cover cropping. Treatment plots have been in place since 1999, providing a robust data set of the long term effects of these practices. Our research questions explore the impact of winter cover crops and conservation tillage on soil water content at varying depths of the soil profile, in addition to quantifying the soil carbon addition by biomass and canopy cover through time. We are currently working to analyze weekly neutron probe data, collected over three winter seasons from 2016 to 2019. This work may suggest that the use of conservation tillage and winter cover cropping on farms with similar climatic conditions and cash crop rotations could offer water-smart strategies that can achieve multiple ecosystem services and climate benefits, contributing to building a climate resilient agricultural sector in California.

## **Cleaner cooking while producing biochar: factors affecting adoption of gasifier cookstoves in rural areas**

*James K Gitau<sup>1, 2</sup>*

*Mary Njenga<sup>1, 2</sup>, Ruth Mendum<sup>3</sup>, Jane Mutune<sup>1</sup>, Yahia Mahmoud<sup>4</sup>, Cecilia Sundberg<sup>4, 5</sup>*

<sup>1</sup> Wangari Maathai Institute for Peace and Environmental Studies, University of Nairobi, Kenya

<sup>2</sup> World Agroforestry Centre (ICRAF), Kenya

<sup>3</sup> Office of International Programs, College of Agricultural Sciences, Pennsylvania State University, USA

<sup>4</sup> Department of Energy and Technology, Swedish University of Agricultural Sciences Sweden

<sup>5</sup> KTH Royal Institute of Technology, Sweden

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A majority of households in developing countries use biomass energy for cooking and heating due to its affordability and accessibility. However, unsustainable biomass use leads to deforestation, environmental degradation and climate change. The pollution from open burning of biomass is a major health concern especially for women and children as they spend a lot of time in the kitchen. Biochar-producing gasifier cookstoves offer an opportunity to address many of these problems, while also producing biochar, which can be used as a soil amendment. A study was carried out in order to investigate factors influencing the adoption of these cookstoves in three sites in Kenya (Kwale, Embu and Siaya). After an introductory training, 150 households received cookstoves and were asked to use them to produce biochar for upcoming field experiments. User experiences were collected through surveys after 2–3 months and about 2 years, and at workshops. The main benefits of the cookstove identified by the users were fuel saving with significant impacts on household economies, reduced smoke and production of biochar for either cooking or soil amendment. Challenges were related to lighting, a need to refill the fuel canister, fuel preparation and different suitability for different types of meals and meal sizes. The gasifier use frequency and biochar production rates differed between the sites, which had different climate, socio-economic conditions and fuel accessibility. The results will be of relevance for inclusion of user participation in cookstove designing and performance assessment as well as for stakeholders involved in marketing. They can also give guidance on the relevance of gasifier cookstoves for production of biochar for use on farms.

## **Neither modern nor traditional: Farmer-led irrigation development in Kilimanjaro Region, Tanzania**

*Chris de Bont<sup>1, 2</sup>*

*Hans Komakech<sup>2</sup>, Gert Jan Veldwisch<sup>3</sup>*

<sup>1</sup> Department of Human Geography, Stockholm University, Stockholm, Sweden

<sup>2</sup> African Centre of Excellence for Water Infrastructure and Sustainable Energy Futures, Arusha, Tanzania

<sup>3</sup> Water Resources Management Group, Wageningen University, Wageningen, The Netherlands

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While there is a consensus that irrigation can contribute to closing yield gaps in dryland areas in Africa, the debate around what kind of irrigation, large- or small-scale, modern or traditional, best contributes to food security and rural development is ongoing. In Tanzania, the irrigation categories of ‘modern’ and ‘traditional’ are dominating irrigation policies and are shaping interventions. In this paper, we explore what these concepts really entail and how they relate to a case of farmer-led groundwater irrigation development in Kahe ward, Kilimanjaro Region. For our analysis, we rely on three months of qualitative fieldwork in 2016, a household questionnaire, secondary data such as policy documents and the results of a mapping exercise in 2014–2015. In the early 2000s, smallholders in Kahe started developing groundwater. This has led to a new, differentiated landscape in which different forms of agricultural production co-exist. The same set of groundwater irrigation technologies has facilitated the emergence of different classes of farmers, ranging from those engaging with subsistence farming to those doing capitalist farming. The level of inputs and integration with markets vary, as does crop choice. As such, some farms emulate the ‘modern’ ideal of commercial farming promoted by the government, while others do not, or to a lesser extent. We conclude that the policy concepts of traditional and modern irrigation do not do justice to the complexity of actual irrigation development in the Kahe case, and obfuscate its contribution to rural development and food security. We also argue that a single irrigation technology does not lead to a single agricultural mode of production, and that smallholders do not benefit equally from irrigation technology due to lack of financial capital and ability to take risks.

## **Identification of production constraints by the implementation of herd health management in smallholder pig farms in Uganda**

*Elin Gertzell<sup>1</sup>*

*Ulf Magnusson<sup>1</sup>, Michel Dione<sup>2</sup>, Kokas Ikwap<sup>3</sup>, Magdalena Jacobson<sup>1</sup>*

<sup>1</sup> Department of Clinical Sciences, Swedish University of Agricultural Sciences, Sweden

<sup>2</sup> International Livestock Research Institute, Ouagadougou, Burkina Faso

<sup>3</sup> College of Veterinary Medicine, Animal Resources and Biosecurity, Makerere University, Uganda

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Smallholder pig production in Uganda has been in focus to improve food security and relieve poverty. Disease burden has previously been identified as one of several production constraints, but earlier studies on health have focused on selected individual diseases. Herd health management is a more holistic approach to improve livestock health and productivity in the long term perspective. It includes several aspects of the production; e.g. the animals and their care-taker, the environment, the management and biosecurity.

Twenty smallholder pig farms in Lira district, Uganda, were included and visited monthly during one year. During the visits, interviews and observations regarding several aspects of the production, clinical examinations and relevant laboratory tests were performed.

Four major areas of production constraints were identified; inadequate feeding, poor reproductive performance, disease burden, and lack of biosecurity. The conditions varied considerably amongst farms due to differences in knowledge, management, resources and facilities. Inadequate feeding due to lack of funds, knowledge and feed availability resulted in poor growth and body condition.

The poor reproductive performance was due to long farrowing intervals and low number of piglets born. A majority of the herds had issues with ectoparasites such as lice and fleas, and some, more commercial, farms had problems with piglet and post-weaning diarrhea. Endoparasites were common. Suspected African swine fever (acute disease with reddish discoloration of skin, inappetence, weakness and death) were seen in some herds. Biosecurity, meaning all measures to avoid entrance and circulation of pathogens in a herd, was largely unpracticed or inadequate.

The herd health management approach identified constraints, such as poor reproductive performance, previously overlooked by other methodologies. This suggests a need for a holistic approach to tackle constraints in order to improve smallholder pig farm productivity.

## **Description of the production and management system of the Creole cattle from Pasorapa, Bolivia. Farmer perceptions and vulnerability to climate change**

*Gabriela Bottani Claros<sup>1</sup>*

*Elisabeth Jonas<sup>2</sup>, Erling Strandberg<sup>2</sup>*

<sup>1</sup> Universidad Mayor de San Simon – UMSS, Bolivia

<sup>2</sup> Animal Breeding and Genetics Department, Swedish University of Agricultural Sciences, Sweden

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Creole cattle populations constitute an important reservoir of genes related to climate resilience and adaptation to harsh environments. During the last years, an unplanned crossbreeding process is threatening the genetic diversity of local Creole cattle populations in Bolivia, risking the conservation of valuable genes for the global animal genetic resources. Generation of reliable information about the production systems and management practices of local breeds is a key first step for the development of conservation and breeding programs. With this purpose, open-ended and closed-ended questionnaires and interviews were performed with 81 smallholders from 11 communities of Pasorapa, Bolivia. Pasorapa Creole cattle is well-adapted to a xerophytic ecosystem, and a rearing system based on two stages, with cattle being released in the mountains for about 7 months across the year, and for the remaining time herded in the paddocks. Feeding strategies are based on crop residues and consumption of native plant species. High mortality rates are explained mainly by environmental factors, such as predator attacks. Poor infrastructure, insufficient governmental support and deficient health management practices were found. A strong interaction between the environment and the Creole cattle population make this system more vulnerable to the threats of climate change. Farmer perceptions related to cattle diseases, treatments and selection of breeding animals were shown to be relevant elements to be considered in future breeding and conservation programs.



## **Killing Them Softly: Moral Practices in Modern Livestock Farming**

Hanna Wernersson<sup>1</sup>

<sup>1</sup> Stockholm Resilience Centre, Sweden

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The livestock sector is progressively seen as problematic on environmental, health, and ethical grounds. With regards to environmental and health concerns, eating ‘less but better’ is a commonly voiced solution. In industrialised economies, there is currently a development of ‘new’ livestock systems. These practices seek to combine traditional methods and modern material equipment and, as such, de-normalise intensification. Seen this way, they are post-industrial. Swedish examples include regenerative grazing and mobile slaughterhouses.

‘Less’ and ‘better’ killing is, however, still killing. This is a proposed case study of Swedish post-industrial livestock farms aiming to understand how these farmers deal with the (deepening) ethical concerns regarding killing animals for food.

The question is,

*How is killing animals for food made morally acceptable in post-industrial livestock farming?*

Two interrelated sub-questions will aid the investigation,

- 1) *How is the quality of life of animals understood in these farming systems?;* and
- 2) *What farming methods are employed to realize this understanding?*

The sub-questions will capture (1) values and (2) behaviour, respectively. The logic between each constitutes the moral practice, the “*how*” in the research question.

The focus on farmers’ viewpoints will make important scientific contributions as they are often neglected or, at best, included as interests rather than morally worthwhile in themselves. This gap is potentially skewing our understanding of, and debates on, animal husbandry.

The actual study will take place this fall and combine participant observations and interviews with four farmers. A tentative analysis of online material has, however, already been conducted. These farmers tend to actively socialize online and the material revealed a particular set of moral practices that seem to represent a particular animal-human relationship. Farming animals is arguably the most significant social formation of nature-society relations and a (re)examination of these (changing) relations is informative for the sustainability transformation quest.

## Infectious diseases in Indian ruminants as potential causes of reduced productivity

Johanna Lindahl<sup>1, 2, 3</sup>

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Health is very important for livestock productivity. Many infectious diseases reduce the capacity of an animal to grow, to produce milk or eggs, and to reproduce. Some of the infectious bacterial diseases that are common in Indian ruminants, such as coxiellosis and brucellosis, may cause abortion, repeat breeding and reduced milk yield. In order to assess the importance of these two infectious diseases, we conducted a seroprevalence survey in two states of India. Large ruminants, cattle and buffaloes, were surveyed in the poor states of Assam and Bihar, while small ruminants were surveyed in Assam and Odisha.

In each state, three districts were purposefully selected. In each district one urban and one rural community development block were selected randomly, and from each block, 2 villages were randomly selected. In each village, 10 farms were selected, and the farmers interviewed. At each farm, serum from up to 3 female ruminants were screened for antibodies against *Coxiella burnetii* and *Brucella* spp using enzyme-linked immunosorbent assay.

Out of 244 farms with small ruminants, 53 farms had at least one animal seropositive for at least one disease. Farm seroprevalence for brucellosis in Odisha was 22% (95% CI 16%–30%) and 9.8% (95% CI 5.7%–16%) in Assam. *Coxiella* seroprevalence in Odisha was 12% and 1.6% in Assam. Among the 534 farms with large ruminants, 93 (17.4%) had at least one cow that were serologically positive for *C. burnetii*. Significantly ( $p < 0.001$ ) more farms were positive in Bihar (79 farms, 27.1%,) than Assam (14 farms, 5.8%). Only 2 out of 292 farms (0.7%) in Bihar were seropositive for brucellosis, while 45 out of 242 (19%) of the farms in Assam had at least one positive cow.

These results indicate that these diseases are likely to contribute to the low productivity.

## Perceptions and practices of Zambian sheep and goat traders on small ruminant health and disease

Sara Lysholm<sup>1</sup>

Klara Fischer<sup>1</sup>, Musso Munyeme<sup>2</sup>, Jonas Johansson Wensman<sup>1</sup>

<sup>1</sup> Swedish University of Agricultural Sciences, Sweden

<sup>2</sup> University of Zambia, Zambia

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Infectious diseases of small ruminants pose serious threats to food security for millions of people around the world, especially to resource-constrained smallholders in countries such as Zambia. Trade of animals and animal products is often regarded as a key factor in the spread of infectious pathogens over large distances, and there are numerous instances where trade is the suspected reason behind pathogens crossing borders and finding their ways into naïve populations. In these processes, the animal trader plays an important role, but in spite of this, very few studies have been performed to understand the reasoning and actions of this group.

In our research, we attempted to understand the perceptions and practices of Zambian small ruminant traders regarding health and disease in sheep and goats, and the implications that this can have on disease transmission. We visited the two largest small ruminant markets in Zambia, Chibolya in Lusaka and Kasumbalesa close to the border to Democratic Republic of Congo, and performed semi-structured interviews with key informants in the small ruminant value chain.

We found that many traders had experience with trading sheep and goats with signs of disease, but either were unaware of the associated risks or felt compelled to sell clinically ill individuals due to economic constraints. Some traders were willing to sell diseased animals for human consumption but not to farmers, since they did not believe that sheep and goat infections can be transferred to humans. The majority of the small ruminants in both markets are sold for human consumption, but some are kept alive and brought to farms, mainly for breeding purposes. Many are also exported to neighbouring countries, most notably to the DRC and Angola. This poses clear risks for zoonotic disease transmission as well as for spreading infections over large distances, both nationally and internationally.

## **Entrepreneurship as empowerment? Gendered opportunities and challenges in entrepreneurial urban and peri-urban agriculture in Tanzania**

Karolin Andersson<sup>1</sup>

Katarina Pettersson<sup>1</sup>, Johanna Bergman Lodin<sup>1</sup>

<sup>1</sup>Swedish University of Agricultural Sciences, Sweden

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This project will develop our understanding of entrepreneurial urban and peri-urban agriculture (UPA) in Dar-es-Salaam, Tanzania and how it is gendered. It will explore how and why women, men and youth engage as entrepreneurs in UPA, which gendered and generational opportunities and challenges they face and how this influences their empowerment. The research will reflect on the policy and practice interventions needed to develop UPA in Dar-es-Salaam and similar contexts, and to integrate it into inclusive urban planning activities. Data will be collected through qualitative interviews, focus group discussions and participatory observations with urban farmers and stakeholders involved in entrepreneurial UPA in Dar-es-Salaam. The project is a timely response to calls within agricultural research, gender studies, urban planning and organizational research to broaden empirical and theoretical rigor on gender in African UPA. The project will address the more specifically identified needs to research UPA in its entrepreneurial forms and from a feminist perspective. By considering it as a deliberate accumulation strategy pursued by UPA entrepreneurs, it will also complement, broaden, and challenge dominant understandings of UPA as solely a subsistence strategy pursued by the poor.

## **How and when does agriculture in South American and African countries depend on rainforests for their rainfall?**

Lan Wang-Erlandsson<sup>1</sup>

Maganizo Kruger Nyasulu<sup>1</sup>, Ruud van der Ent<sup>2,3</sup>, Patrick Keys<sup>4</sup>, Ingo Fetzer<sup>1</sup>, Line Gordon<sup>1</sup>

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<sup>4</sup>Colorado State University, USA

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With over 90% of agriculture being rainfed, rainfall is essential for food security and livelihoods in sub-Saharan Africa and South America. In some regions, up to about 50 % of rainfall comes from the Congo and Amazon rainforests. Through transpiration, the forests supply considerable amount of evaporation to the atmosphere, which travels as atmospheric moisture with winds to provide downwind land areas with rainfall, through i.e. moisture recycling. However, ongoing deforestation dampens the water cycle and prolongs the dry season, while climate change increases drought and fire risks. What do the dual threats to forests mean for agriculture? Here, we examine the moisture recycling of the Amazon and Congo rainforests using 34 years of data. We find that the importance of both forests as regional rainfall suppliers increases during dry seasons, a role that further increases in dry years. However, while this dry year amplification raises relative moisture contribution from both the rainforest itself and other land areas in the Amazon, it only raises the rainforest relative moisture contribution in the Congo. Country-level analyses show that rainfall dependence on evaporation from forests can vary substantially between seasons and years. While the rainforests primarily occupy Brazil and the Democratic Republic of Congo, many of their neighbouring countries have a stake in the rainforest as they heavily rely on forest moisture for their rainfall, a dependence which often increases during dry seasons. Seasonality in moisture recycling also has implications for different agricultural crops with different growing seasons. In view of ongoing deforestation and climate change, and the implications for forest resilience and agricultural production, we conclude that the temporal variation in moisture recycling constitutes an important feature to consider in forest and moisture recycling governance.

## **Modelling of potential biochar production capacity and bioenergy generation in Kenya and its impact on climate change from a life cycle perspective**

*Md Aquif Rahman*<sup>1</sup>

*Cecilia Sundberg*<sup>1, 2</sup>

<sup>1</sup> KTH Royal Institute of Technology, Sweden

<sup>2</sup> Swedish University of Agricultural Sciences, Sweden

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Energy generation and food production are two of the major causes of climate change. Biochar can simultaneously address both the sectors to mitigate the harmful impacts on climate. It is a multifunctional product derived from biomass. The process of converting biomass to biochar releases a considerable amount of energy in the form of primarily heat and electricity. This paper studies the potential biochar availability and bioenergy generation capacity in Kenya. It further analyses the life cycle of the system in terms of greenhouse gas emissions and land use. A model has been developed for calculating the biochar and bioenergy potential based on the availability of biomass; agricultural residues of the major crops grown across Kenya and residues from forestry. The pyrolysis process is used for the conversion of biomass to biochar, electricity, and heat. The produced biochar is used for increasing crop yield and carbon sequestration in soil. The results are discussed in two parts. In the first part, it exhibits different biochar potentials basing on different biomass and technologies. The different biochar potentials have different positive impacts on the yield of crops, as well as agricultural residues, which further increases biochar potentials. The result also presents the variation of heat and electricity generated, which are compared to the equivalent amount of replaceable fossil fuel. The second part shows carbon dioxide emission and impacts on land use during the system's lifetime. This report highlights the possible use of biomass as biochar in enhancing food security and supplying energy at local levels. After its initial successful application to Kenya, the model can be used for analysis in other developing countries.

## **Future scenarios of land use change in southwest Russia**

*Nataliia Pustilnik*<sup>1, 2</sup>

*Robert Pazur*<sup>3</sup>

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At the global level land is becoming a scarce resource and given that demand is unlikely to decrease it is expected that different land use management strategies, such as intensification, land use zoning or extensification will compete (Lambin and Meyfroidt 2011). Creating scenarios of future land use thus becomes an important tool in assessing the impact of different land management strategies. Southwest Russia, characterized by fertile black humus soils, has large potential for agricultural expansion or intensification with comparatively low environmental trade-offs (Patrick Meyfroidt et al. 2016). However, there is a lack of comprehensive assessments of how processes such as re-cultivation and intensification may impact land use patterns in the future, ecosystem services and society. In this research we attempt to develop future land use scenarios for different conditions using forward looking land use change model, which allows to simulate changes in land systems in response to demand, land system characteristics and local environmental conditions and can better reflect the effect of different management strategies on the environment and society (Letourneau, Verburg, and Stehfest 2012; Verburg et al. 2009). The scenarios will be informed by interviews with key stakeholders, such as farmers, agriscientists and public officials, as well as land use trends from research. The results will include a spatially explicit future land use maps for different socio-economic conditions. The findings can be used by policy and decision makers for assessing the consequences of different agricultural policies in combination with social and environmental factors, as well as by researchers for assessing the impacts of land use change on carbon storage, biodiversity or rural development.

## **Food consumption and nutrient deficiencies trends in the Democratic Republic of Congo**

*Patrice Mirindi<sup>1,2</sup>*

*John Mburu<sup>1</sup>, John Ulimwengu<sup>3</sup>, Wim Marivoet<sup>3</sup>*

<sup>1</sup> University of Nairobi, Kenya

<sup>2</sup> African Economic Research Consortium, Kenya

<sup>3</sup> International Food Policy Research Consortium, Senegal

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All the countries members of the United Nation are committed to achieving SDG 2. Africa has seen the least progress in terms of improvement towards malnutrition prevalence. Particularly in DRC, around 4.5 million people are chronic food insecurity, the country has been ranked 176th out of 189 Human Development Index. Due to lack of data, it is hard to have indicators that give a current state of the food security and nutrition yet the situation is extremely alarming. Different studies have been conducted to give an overview of the nutritional status and economic changes in the country.

Moreover, studies have shown that DRC faces a higher variability in time and space in its economy that should lead to nutrition transition. Unfortunately, there is no information on the hidden hunger and resilience in the context of food. Therefore, the purpose of this study was to assess households food budget share, the budget allocated to each food groups and to map the nutrient deficiencies as well as analysing their trends between 2005 and 2012 for urban and rural areas for the 26 provinces of DRC. The study used secondary data from the National Household Surveys collected between 2005 and 2012. Our results suggested that households spend ¾ of their budget on food, implying vulnerability towards food security in all the provinces. We classified DRC in five different clusters having almost similar food intake. Moreover, about 60 per cent of the budget allocated to the food is spent on cereals, root and tubers as well as meat and fish. The overall nutrient intake suggests hidden hunger all over the country, with negative nutrients intake trends. Consequently, social protection, mitigation intervention, pro-poor policies, multi-stakeholder partnerships as well as resilient food system are needed to alleviate food insecurity and malnutrition in DRC.

## Factors limiting maize yield in two Ghanaian villages vary with field age

Sigrun Dahlin<sup>1</sup>

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<sup>6</sup> ICRAF, Kenya

Identifying factors limiting crop yields are important to sustainably intensify crop production. A survey was carried out to assess the dominating soil and crop-management factors that most strongly limited yields in two villages in Eastern Region, Ghana, in 2016. Eighty-seven maize fields on 60 farms were identified and soil samples collected before crop establishment and analysed for soil chemistry and texture, and information on drainage and slope collected. Crop measurements taken at approx. ear initiation, tasseling and silking stages included SPAD readings (N sufficiency), height, vigour, number of leaves, precise development stage and density of the crop, and maize yield at maturity. Weed cover and height were also scored. Through a combination of principal component analysis and multiple regression, seven components relating to timing & success of planting, weed pressure, pests & diseases, soil chemical and physical conditions, and N sufficiency and P supply (through fertilization and mineralization from the soil) were established. Subsequent step-wise regressions showed that late planting (relative to onset of rains) and poor weed control were overall most strongly limiting yields. However, low soil fertility and low P supply were the most limiting factors for fields that had been under cropping for 5 years or more (49 observations). The area has been characterized by shifting cultivation but land is now becoming increasingly scarce which forces farmers to keep permanent fields. Results suggest that soil fertility management need to be introduced to retain soil fertility under permanent farming. Farmers in the villages use herbicides but alternative or complementary technologies may be needed to sufficiently control weeds. Farmers also need more reliable and accessible weather forecasts to enable timely planting. Enhanced access to extension services on soil, crop and weed management is a crucial factor.

## Nutrient imbalances in two Ghanaian regions: from nutrient mining to excess

Sigrun Dahlin<sup>1</sup>

Håkan Marstorp<sup>1</sup>, Ingrid Öborn<sup>2</sup>, Fred Dzanku<sup>3</sup>

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Low fertilizer use in sub-Saharan Africa and subsequent nutrient mining in crop production systems have been acknowledged as contributing to declining soil fertility. However, this is not universally true and blanket recommendations may lead to nutrient surpluses locally and poor nutrient use efficiency. Here, we revisited a database of data derived from structured interviews held in eight villages in Eastern region (Eastern) and Upper East region (Upper East), Ghana. We calculated nutrient balances for 297 maize fields based on fertilizer inputs, maize yields, and fate of crop residues as determined by the dominating farming systems in the regions. Yields were considerably higher in Eastern (median 1.3 t ha<sup>-1</sup>) than in Upper East (median 0.5 t ha<sup>-1</sup>), but variation was large. Most plots in Eastern and two villages Upper East had negative nitrogen (N) balances while the remaining villages showed a small positive balance or a neutral result. Seven villages showed positive average phosphorous (P) balances. However, a majority of fields in Upper East were unfertilised and showed negative balances, and the overall surplus was due to strongly positive balances on the fewer fertilised fields. The average potassium (K) balances were close to neutral for most villages, with negative balances for the majority unfertilised plots and positive balances for fertilised plots. Results suggest that yields in Eastern were to a large extent limited by nutrients and would benefit from higher inputs. The large nutrient surpluses in Upper East suggest yields were limited by other factors, e.g. rainfall. In the latter, blanket recommendations not taking production levels into account may lead to inefficient fertilizer use, and calls for higher precision in farming.

## **The endurance of olive Biocultural Heritage in Sicily: long-term patterns of intercropping systems for sustainable futures**

*Vincenza Ferrara*<sup>1</sup>

*Anneli Ekblom*<sup>1</sup>, *Anders Wästfelt*<sup>2</sup>

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<sup>2</sup> Department of Human Geography, Stockholm University, Sweden

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Accelerating climate change calls for new deeper knowledge on agro- ecosystems. Low-intense systems may be key for mitigation of vulnerability and to build ecological and social resilience (Kongsager 2018; Schermer et al. 2018). Among low-intensity agroecosystems, our poster will focus on Mediterranean agroforestry intercropping, with special attention to olive land use dynamics occurring at different temporal and spatial scales in the island of Sicily.

Mediterranean islands are characterised by the high biodiversity; their complex historical biogeography makes them important ecological reservoirs, able to tell us about how the long-term entanglements between human and environment have played a role in the preservation of such biocultural heritage (Medail 2017). Olive intercropping systems have resulted in the formation of cultural landscape and heritage that supports placed based and practice-based know-how, drawing on transmitted and new knowledge – what we call Biocultural Heritage (Lindholm and Ekblom 2019).

The domestication and continuous careful management of olive trees by locals have been crucial for their longevity and the development of sustainable food systems (Chan et al. 2016), and such agrosystems can thus be seen as stabilities in a changing landscape along time and space: living biocultural refugia (Barthel et al. 2013), which preserve both biodiversity and the extraordinary “melting pot” of different traditional agroecological knowledges crossing the island for millennia.

Since the 7th century BC (Langgut et al. 2019), the Sicilian landscape has been shaped through the relationship between humans and olive trees, displayed in a variety of spatial patterns according to different historical periods and relative land use strategies (Ferrara 2016). These enduring landscapes, as the food systems they support, are under threat due to climate change and intense land abandonment; a huge threat for their ecological complexity, agricultural practices, cultural heritage and local communities’ livelihood (Biasi et al. 2017).



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## Food security and migration governance

Session leader: Jesper Bjarnesen, Nordic Africa Institute (NAI)

Lecture room: L

### Session Schedule

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|--------------------|--|
| <b>14.15-14.20</b> | <b>Welcome</b><br><i>Jesper Bjarnesen</i>  |
| <b>14.20-14.35</b> | <b>Migration, agriculture and food security</b><br><i>Ahmed Ekzayez</i>  |
| <b>14.35-14.50</b> | <b>When the strong arms leave the farm</b><br><i>Elisabeth Simelton</i>  |
| <b>14.50-15.05</b> | <b>Food security impacts of climate change among pastoral households in Northern Tanzania</b><br><i>Ronald Ndesanjo</i>  |
| <b>15.05-15.20</b> | <b>Determinants and welfare impacts of internal migration in Egypt: Implications for sustainable development</b><br><i>Assem Abu Hatab</i>                             |
| <b>15.20-15.30</b> | <b>Discussion</b>  |
| <b>15.30-15.45</b> | <b>Coffee break</b>  |
| <b>15.45-16.00</b> | <b>Impact of youth rural-urban migration on the agricultural sector in Uganda and policy reforms</b><br><i>Robert Kibaya</i>   |
| <b>16.00-16.15</b> | <b>Empowering household income former IDPs through traditional food: A case study of two twin Mozambican cities</b><br><i>Inês Raimundo</i>                            |
| <b>16.15-16.30</b> | <b>Contracts between smallholders and private firms in Mozambique and their implications on food security</b><br><i>Cecilia Navarra</i>                                |
| <b>16.30-16.45</b> | <b>Constraints and Enabling factors for engaging youth and women into agri-food in Africa: The role of innovations in youth entrepreneurship</b><br><i>Anne Roulin</i> |
| <b>16.45-17.00</b> | <b>Discussion</b>  |

## **Migration, Agriculture, and Food security.**

*Ahmed Ekzayez<sup>1</sup>*

<sup>1</sup> UN FAO, Turkey

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Understanding contemporary migration, both international and internal, remains a challenge. The decision by people to migrate either within their own countries or across borders is influenced by an intricate set of factors. This report examines the complex interlinkages between migration, agriculture, food security and rural development and the factors that determine the decision of rural people to migrate; including economic factors, employment opportunities, conflict, poverty, hunger, environmental degradation and climate shocks.

The relationship between food security and migration can be direct, when people do not see viable options other than migrating to escape hunger. The linkages between agriculture, food security and migration can also be indirect as a strategy by households to cope with income uncertainties and food insecurity risks. Sending one or more family member to work in economic sectors other than agriculture can increase their capacities to cope in the event of adverse shocks.

Moreover, migration gives rise to both opportunities and challenges. The report assesses the impact of migration on the countries of origin and destination, with a focus on rural areas and the agricultural sector. It also discusses how agricultural and social policies can address these challenges and capitalize on the opportunities created by migration trends.

Adopting a development approach means increasing the options available to individuals to allow them to pursue better agricultural, rural or urban livelihood opportunities, with safe and regular migration as one of those options. Complex migration dynamics should be mainstreamed into food and nutrition security strategies and initiatives. Donors, starting with the G7, should support transformative actions around the FNS-migration nexus in Africa, with a particular focus on women, nutrition, climate change and environmental sustainability.

## **When the strong arms leave the farms**

*Elisabeth Simelton<sup>1</sup>, Nozomi Kawarazuka<sup>2</sup>*

<sup>1</sup> World Agroforestry (ICRAF), Vietnam

<sup>2</sup> International Potato Centre (CIP), Peru

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Vietnam is experiencing fast economic development, especially around urban growth poles with increasing gaps between rich and poor. Non-farm incomes and 'export labour packages' are becoming increasingly important strategies to leapfrog out of poverty for both rural youth as well as among the heads of households. We present an ongoing study in two provinces in Vietnam, with different types of socioeconomic settings and poverty:

Ha Tinh in northcentral Vietnam, a disaster struck province with high unemployment levels, where farmers and leaders are looking to transform away from rice cultivation and monoculture forest plantations, alternatively seeking off-farm jobs, when abroad resulting at high economic risks and loss of farm labour for several years.

Dien Bien in the northwest, is a province with ethnic minority groups, complex topography and high real poverty levels. Here, farmers, often young males or couples take seasonal non-farm jobs to complement their livelihoods.

Drawing on 200 household surveys, focus group discussions and participatory videos in both provinces, the study looks at the implications from several angles:

- What happens on-farm when 'the strong arms' leave the farms? Does it alter on-farm decision-making? We discuss three myths about feminization of agriculture.
- What does this mean for agriculture research and advice? We discuss how standard questionnaires often fail to capture the 'new farmer' typologies and highlight examples where we need to think new.
- Finally, we exemplify the roles of agriculture in relation to job-migration. We identify three clusters, where (1) migration becomes a stepping stone out of agriculture, (2) non-farm incomes and remittances are used to maintain farm status quo, (3) the farm becomes the point of last resort and economic resilience when things didn't turn out as planned. We discuss the need to recognize the diverse role of farms in rural development policies.

## **Food security impacts of climate change among pastoral households in Northern Tanzania**

*Ronald Ndesanjo<sup>1</sup>*

*Ida Theilade<sup>2</sup>, Martin Nielsen<sup>2</sup>*

<sup>1</sup>Institute of Development Studies, University of Dar es Salaam, Tanzania

<sup>2</sup>Department of Food and Resource Economics, University of Copenhagen, Denmark

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The overall aim of the study was to investigate impacts of climate change on food security among pastoral households in Northern Tanzania. Specific research questions included the following: What are the local climatic patterns and trends? What is the status of household food security? How does local climate influence household food security? Do households have in place food security strategies? What are the determinants of household food security sustenance? The study employed household survey to gather primary data. Climatic data were obtained from Tanzania Meteorological Agency (TMA). The survey was undertaken among 300 households in Simanjiro District, Northern Tanzania. Data analysis entailed multinomial regression analyses and Standardized Precipitation Index analysis. The study found that generally, most households did not have sufficient food supply during normal (supposedly food secure) months thus implying low productivity and food inaccessibility. Households were found to concurrently employ both coping and adaptive strategies to address climatic stresses and shocks particularly drought-driven food insecurity. These include long-term (adaptive) strategies such as household food reserve and seed banking as well as short-term (coping) strategies mainly livestock and asset selling. The study further found that ability to purchase food still remains a key mechanism for households to secure their food needs especially in times of shocks. This happens particularly during crop failure and when common coping and adaptive strategies are no longer viable. Along the same line, the study found that livelihoods diversification in form of agro-pastoralism and migration are key determinants for household food security. These strategies are commonly supplemented by selling livestock especially when households are in a dire food scarcity situation. It is concluded that drought is the main driver of household food insecurity. Also, a combination of livelihoods diversification and migration are key strategies for household food security and overall resilience enhancement.

## **Determinants and welfare impacts of internal migration in Egypt: Implications for sustainable development**

*Assem Abu Hatab<sup>1</sup>*

*Franklin Amuakwa Mensah<sup>1</sup>, Carl Johan Lagerkvist<sup>1</sup>*

<sup>1</sup>Department of Economics, Swedish University of Agricultural Sciences, Sweden

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Fueled by urbanization together with associated environmental and socioeconomic changes, Egypt has witnessed rapid and uncontrolled internal migratory movements during the past few decades. As it is the case in other developing countries, the study of internal migration in Egypt has received little attention, despite its increasingly recognized long-term impacts and inextricably links to sustainable development. Using data from the latest round a nationally-representative Labor Market Panel Survey conducted in 2012, this paper examines the determinants and welfare effects of internal migration in Egypt. The empirical results confirm that drivers and welfare effects of internal migration vary considerably in relation to different internal spatial movements and gender and age groups. Generally, the probability to migrate within the national borders of the country is higher for younger, more educated and individuals with non-permanent employment. Unsurprisingly, the results reveal that there is a higher probability for individuals to move to urban areas than to rural areas. In relation to welfare impacts, the study finds a significant positive effect of internal migration on migrant's welfare. Especially, rural-rural and urban-urban types of migration were observed to be welfare enhancing. However, we found insignificant welfare effect of rural-urban migration. Conceding age and gender, the results suggest that females and older migrants are expected to achieve higher welfare gains from internal migration. These findings underscore important implications that may inform future research and policies for effective management of internal migration to make the most of its sustainable development impacts in Egypt and potentially other developing countries experiencing increasing internal migration trends.

## **Impact of youths rural-urban migration on the agricultural sector in Uganda and policy reforms**

*Robert Kibaya<sup>1,2</sup>*

<sup>1</sup> Kikandwa Rural Communities Development Organization (KIRUCODO), Uganda

<sup>2</sup> Youths In Technology and Development Uganda (YTEDEV), Uganda

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Evidence has shown that majority of the population in most rural areas are small scale farmers providing food for human consumption and raw materials for export and manufacturing industries. According to Uganda National Population and Housing Census of 2014, nearly two thirds (64%) of the working population was engaged in subsistence agriculture and close to 80% of the all households in the country were involved in agriculture compared to 74% in 2002. The results also indicate that more rural households participated in agriculture at 90% compared to their urban counterparts at 46%. The number of young migrants increased from 23.2 million in 1990 to 28.2 million in 2013 (UNICEF, 2014). According to FAO's 2016 conceptual framework on addressing rural youth migration at its root causes at household level, young members may move to work elsewhere as part of the household's risk diversification strategy but also in response to the household's expectation of higher returns in the future or to personal aspirations. In particular, rural youths are those more likely to migrate in response to the lack of gainful employment and entrepreneurial opportunities in agriculture and related rural economic activities.

The paper will discuss youth rural-urban migration in Uganda and its impact on agriculture as well as looking at new policy reforms and best practices.

## **Empowering household income former IDPs through traditional food: A case study of two twin Mozambican cities**

*Inês Raimundo<sup>1</sup>*

<sup>1</sup> Eduardo Mondlane University, Mozambique

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Studies on urbanisation of Mozambique do not look into how people have relinquished traditional food, especially the poor urban. In 2014, the African Food Security Urban Network released the first report on the state of food security in Maputo, subsequently Hungry Cities Partnership released the following: Food insecurity, poverty and informality (2016a); the State of Food Security in Maputo, Mozambique (2016b); the Urban Food System of Maputo, Mozambique (2016); Food insecurity in the context of climate change in Maputo city, Mozambique: Challenges and coping strategies (2017). Meanwhile, within the HCP project in the year of 2014 I interviewed people in two twin cities (Maputo and Matola) trying to understand the new diet among these people. The interviews that I undertook unveiled a situation that many of researchers deliberately or not, did not pay attention on the fact of households shift diet. The data indicates that even poor were eating food like beef, biscuits, cold meat packed in cans, boxes and, bottles rich of sugar, fat and sodium versus traditional food such as *cacana* (*Momordica balsamica* L.), *pumpkin leaves*, *cassava*, *xima*, fish and country chicken. After this work I formulated three hypothesis that justify the reasons for the change: 1) most of interviewed city dwellers are former IDPs who came to Maputo and Matola during the 16 years of "civil" war (1976-1992), then they were forced to adapt into city diet; 2) people assume that eating processed food reveal to be well-off while eating traditional indicates their status of poverty; and 3) new diet has been influenced by food brought to Mozambique by cross border traders. Linking with the conference topic my paper will focus on former IDPs to discuss how this shift has affected their diet and how investing in traditional food can empower them taking into account the prices

## Contracts between smallholders and private firms in Mozambique and their implications on food security

Cecilia Navarra<sup>1</sup>

<sup>1</sup> European Parliamentary Research Service, Belgium

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The focus of this paper is the role played in rural contexts by contract farming agreements between smallholders and private investors. These contracts can take different forms, but in general are agreements under which producers commit to supply produce to a buyer firm. They are—at least on paper—at the centre of agrarian policies in Mozambique, through the Strategic Plan for the Development of the Agricultural Sector 2011–2020. Studies on the effect of these contracts on producers usually find out an increase in income, but the effect is still unclear with respect to other variables. The focus of this paper is on contracts' effects—in the Mozambican case—on food security. We may expect contrasting effects to be at work: on the one hand, the effects of increased income, while, on the other, the effects of giving up food production and of monopsonistic market relations. This paper exploits a panel dataset (2002–2005) collected by the Mozambican Ministry of Agriculture among a nationally representative sample of rural households. Overall, the main findings of the paper indicate that selection in contracts is the main driver of the observed differences, while there is no evidence of a causal effect of contracts on increased food security.

## Constraints and Enabling factors for engaging youth and women into agri-food in Africa: The role of innovations in youth entrepreneurship

Kostas Karantininis<sup>1</sup>, Vera Sadovska<sup>1</sup>

<sup>1</sup> Swedish University of Agricultural Sciences, Sweden

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Presenter: Anne Roulin. Agripreneurship Alliance

Both youth and agriculture are themes that have been at the centre of the development discourse during the last decade. This agenda was set especially by two consecutive World Development Reports on “The Next Generation” (WB 2006) and “Agriculture for Development” (WB 2007) (see also other related literature (Adelman, 1978; Timmer, 2009; DeJanvry, 2010)). Similarly, the various issues around the challenges of Africa's demographic dividend and the engagement of youth in agriculture and food for sustainable development, have been central at various forums both regionally and internationally (Ahmed, et al, 2016; Ayele et al, 2016; Bloom et al, 2003; Girard, 2017; Sumberg, et al, 2014). Yet, two themes that transcend the discussions and remain largely unanswered until today, are the questions addressed in this paper: What is the role of agriculture in regional development and what is the role of youth in recharging agriculture and reducing migration.

There exist many initiatives to engage youth into agriculture, such as agri-business incubators, youth workshops, start-up competitions, hackathons, to name just a few. Yet, there is very little knowledge and follow-up on the impact of such initiatives. The objective of this paper is to assess the impact of youth engagement innovations and investigate the constraints and enabling factors that lead to their success and failures.

The methodology is based on both literature review and primary data analysis. The data are originating from two consecutive surveys (2018 and 2019) of the AGCELERATE workshops at Makerere, Uganda. These workshops engage students, researchers and other agri-food entrepreneurs in training, study trips and a hackathon. The participants involved are from Uganda and Sweden. Some preliminary results and analysis undertaken during 2018 workshops will be compared and analysed further when the new survey is available in August 2019.

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## **Aqua-agro farming system: A sustainable solution to food security and nutrition?**

*Session leaders: Kartik Baruah; Anders Kiessling, Swedish University of Agricultural Sciences*

Lecture room: J

### Session Schedule

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|--------------------|---|
| <b>14.15-14.30</b> | <b>Utilization of biofloc meal as a feed raw material as an integrated approach for sustainable aquaculture</b><br><i>Julie Ekasari</i>   |
| <b>14.30-14.45</b> | <b>The Artemia Genome Provides Insight in Crustacean Biology</b><br><i>Stephanie De Vos</i>   |
| <b>14.45-15.00</b> | <b>Epigenetic Management of Stress and Disease Resistance in Farmed Shrimps</b><br><i>Parisa Norouzitallab</i>  |
| <b>15.00-15.15</b> | <b>Novel farming methods, reduced waste or increased local production? An integrated perspective on what matters most for emerging aquaculture systems</b><br><i>Kristina Bergman</i> |
| <b>15.15-15.45</b> | <b>Coffee break</b>   |
| <b>15.45-16.00</b> | <b>Waste heat driven membrane distillation for concentrated nutrients and fresh water recycle for sustainable farming: Swedish greenhouse production</b><br><i>Ershad Ullah Khan</i>  |
| <b>16.00-16.15</b> | <b>Towards controlling acute hepatopancreatic necrosis disease in farmed shrimp, using bioactive compound phloroglucinol</b><br><i>Bipul Dey</i>                                      |
| <b>16.15-16.30</b> | <b>Effect of variant ovarian fluid on sperm performance and egg fertilization rates of Arctic charr (<i>Salvelinus alpinus</i> L.)</b><br><i>Lwabanya Mabo</i>                        |
| <b>16.30-16.45</b> | <b>Seizing Blue Bioeconomy Opportunities: Review of Developments in Sustainable Food Solutions</b><br><i>Ashkan Pakseresht</i>  |
| <b>16.45-17:00</b> | <b>Fish farming in Tanzania and the availability and nutritive value of local feed ingredients</b><br><i>Prof. Torbjorn Lundh</i>   |
| <b>17.00</b>       | <b>Group Discussion for 10 min</b>  |

## Utilization of biofloc meal as a feed raw material as an integrated approach for sustainable aquaculture

Julie Ekasari<sup>1</sup>

Muhammad Agus Suprayudi<sup>1</sup>, Mia Setiawati<sup>1</sup>, Dedi Jusadi<sup>1</sup>

<sup>1</sup>Department of Aquaculture, Faculty of Fisheries and Marine Science, Bogor Agricultural University, Indonesia

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With the increase of global demand of aquatic products, world aquaculture production has been steadily increasing. This increase needs to be supported by the supply of high quality feed and thereby high quality feed raw materials. Unfortunately, for some countries most of the feed raw materials are imported products, which could significantly affect the feed price and ultimately the profitability. In this regards, some efforts has been made on finding local alternative materials for aquaculture feed. Biofloc-based aquaculture system has been widely studied and applied in the production of various aquaculture species. The basic principle of this system is the stimulation of heterotrophic microbial conversion of nutrient waste in aquaculture system into microbial biomass. The microbial biomass forms aggregate, which later known as “biofloc”. The biofloc generated in this system are available to be consumed in situ by the cultured organism. Biofloc biomass can also be collected and be used as a feed ingredient. The biomass can be obtained from an aquaculture unit that apply biofloc systems or from a bioreactor using aquaculture effluent as the source of nutrients for the microbes. Thereby, overall nutrient utilization in biofloc-based aquaculture system could be more efficient and the level of nutrient wastes that maybe harmful for the cultured organism could be minimized. The present study elaborates the results of some experiments regarding the use of biofloc meal and its modification in some aquaculture species that have been done in the Department of Aquaculture, Bogor Agricultural University, Indonesia. Our studies demonstrated that biofloc meal is potential to be included in aquaculture feed as it contained some essential nutrients, which are beneficial for the cultured organisms. We also identify some challenges in the utilization of biofloc biomass, including the productivity and the stability of nutrient content in biofloc, and efficient harvesting procedures.

## The Artemia Genome Provides Insight in Crustacean Biology

Stephanie De Vos<sup>1</sup>

Gilbert Vanstappen<sup>1</sup>, Z. Nambu<sup>2</sup>, Marnik Vuylsteke<sup>3</sup>, Anita De Haese<sup>1</sup>, Y. Van de Peer<sup>3</sup>, Patrick Sorgeloos<sup>1</sup>, Stephan Rombauts<sup>3</sup>, Peter Bossier<sup>1</sup>

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<sup>3</sup> Department of Plant Systems Biology, VIB, Belgium; Department of Biotechnology and Bioinformatics, Ghent University, Belgium

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*Artemia*, is a genus of small planktonic crustaceans found in hyper saline environments worldwide. They are used as live food in aquaculture, specifically for larval growth of more than 85% of the marine species reared in aquaculture and have also been marketed as pets named “sea monkeys”. Many of its biologically interesting features are related to its unusual life cycle and extremophily. Under optimal conditions, adult females produce free-swimming larvae, whereas under stress, females produce resting eggs (cysts) that can remain viable for years, similar to plant seeds. These cysts are in diapause, during which cell division and embryonic development are arrested and respiration rate drops 100%. Currently, a genomic toolkit is available for *Artemia* including the mtgenome sequence, a sex-specific genetic linkage map ( $2n = 42$ ), a known WZ-ZZ sex-determining system, 8 sex-linked markers, a known haploid genome size of 0.93 Gb, and molecular markers, such as RFLP and microsatellites. To understand *Artemia* biology in-depth however, the *Artemia* genome is required. The Artemia Reference Center aims to present *Artemia franciscana*, a quickly, cheaply and easily breedable species (life cycle 4 weeks, common garden experiments), as a new crustacean research model. Female *Artemia franciscana* were sequenced (NGS, PacBio), assembled de novo and annotated, resulting in a 820 Mbp reference genome sequence ( $N50 = 116\,673$  bp; GC% = 35 %) with 21,828 predicted genes (average length 934 bp) containing long introns (average. length 3458 bp), made available for partners via the online annotation platform ORCAE. We present an annotated high-quality draft genome assembly containing virtually all known *Artemia* genes (published as proteins or as ESTs). This genome will be of great aid in elucidating mechanisms underlying the typical *Artemia* life cycle and its extremophilic features.

## **Epigenetic Management of Stress and Disease Resistance in Farmed Shrimps**

*Parisa Norouzitallab<sup>1, 2, 3</sup>*

*Kartik Baruah<sup>4</sup>, Priyanka Biswas<sup>2</sup>, Daisy Vanrompay<sup>1</sup>, Peter Bossier<sup>2</sup>*

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Finding novel strategies for conditioning economically important (brood) shrimp resulting in robust offspring (disease resistance and fast growing) is highly necessary to address the current challenges faced by the shrimp farming sector. Very recently, epigenetics has been considered as an approach for producing healthy and stress-resistant animals. Epigenetic modifications are responsible for non-genetic and heritable regulation of activation and suppression of (certain) genes.

The molecular mechanisms behind epigenetic modifications and across generation inheritance of phenotypes is not yet fully unraveled. In this study, by using brine shrimp *Artemia* as model organism, phenotypic and epigenomic responses of the animals and their 3 subsequent generations was studied in response to non-lethal heat shocks (tested by using clonal population) or pathogenic *V. campbellii* (tested by using bisexual animals). After hatching the *Artemia* eggs, the F0 progeny were divided into two groups: 1) exposed to a nonlethal heat stress (a classical stress inducer) or 2) exposed to pathogenic bacterium *Vibrio campbellii*. The other group was grown unexposed, under normal culture conditions (C-F0). Adult parental (F0) females from the treatment (T-F0) and control (C-F0) groups produced their next-generation cysts (i.e., T-F1 and C-F1, respectively). The disinfected cysts were hatched to produce their corresponding larvae (i.e., T-F1 and C-F1). The F1 larvae from both groups were further cultured isothermally at 28°C, without stress exposure, to maturity, after which the F2 larvae were collected. The experiment was continued until, and including, the F3 generation.

The T-F1 to T-F3 progenies from both groups were tested for their resistance phenotypes by conducting stress resistance tests. Training induced by exposure of the parental generation to an abiotic/biotic stressor markedly increased the resistance of the T-F1 to T-F3 progenies towards secondary infection. Also, this acquired trait was associated with altered levels of histone tail modifications i.e. H3/H4 acetylation and H3K4Me3.

## **Novel farming methods, reduced waste or increased local production? An integrated perspective on what matters most for emerging aquaculture systems**

*Kristina Bergman<sup>1</sup>*

*Patrik Henriksson<sup>2, 3</sup>, Sara Hornborg<sup>1</sup>, Max Troell<sup>2, 4</sup>, Malin Jonell<sup>2, 4</sup>, Friederike Ziegler<sup>1</sup>*

<sup>1</sup>RISE Research Institutes of Sweden, Sweden

<sup>2</sup>Stockholm Resilience Centre, Sweden

<sup>3</sup>WorldFish, Malaysia

<sup>4</sup>The Beijer Institute of Ecological Economics, Sweden

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Land-based recirculating aquaculture systems (RAS) constitute an emerging food sector in Sweden. The sustainability debate in society related to conventionally produced seafood (wild-caught and farmed) and meat has likely been a major driver. Small companies producing species such as tilapia *Oreochromis niloticus* and clarias *Clarias gariepinus* profile themselves as more sustainable choices than e.g. salmon farmed in net pens. But what do we actually know about their broad sustainability performance? Are we comparing apples and pears? We evaluated one of these new and relatively small-scale systems using Life Cycle Assessment, an integrated tool for environmental assessments widely used to product supply chains and identify improvement options. It was found that feed use is of paramount importance, also for this type of comparatively high-tech aquaculture system, where inclusion of feed ingredients based on by-products from relatively inefficient animal production systems increase the carbon footprint. Results are compared to existing seafood systems, quantitatively as well as qualitatively, and trade-offs are discussed in relation to Agenda 2030 goals. Results can be used to identify important aspects to consider in the future development of this sector.

## **Waste heat driven membrane distillation for concentrated nutrients and fresh water recycle for sustainable farming: Swedish greenhouse production**

*Ershad Ullah Khan<sup>1</sup>*

<sup>1</sup> Department of Energy and Technology, Swedish University of Agricultural Sciences, Sweden

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The purpose of a greenhouse is to allow the cultivation of horticultural crops outside of their traditional climatic zones and requirements. The primary objective of a greenhouse is to produce higher yield outside the cultivation season, which is possible by maintaining the optimum temperature at every stage of the crop. In case of greenhouse cultivation, thermal energy associated expenditures can be significant. Heating is one of the main costs for greenhouse especially in the cold regions like Sweden. High water quality is particularly important in organic greenhouse production in order to prevent soil salinization and ensure optimal soil biological activity. Additionally, drained greenhouse wastewater nutrient recovery holds promise for more sustainable water and agricultural industries. Moreover, greenhouse drained/wastewater nutrient and/water recovery is anticipated to become a promising strategy to sustain fertilizer and food production. In these above circumstances, industrial waste heat integrated with membrane distillation (MD) and greenhouse production could be an interesting combination in order to reduce costs of energy, recycle the fresh water and organic fertilizer as well as save the environment. MD is a thermally-driven wastewater purification and/concentration process involving a hydrophobic, microporous membrane. The objective of this work was to quantify the performance of membrane distillation in terms of separation and purification efficiency and water production rate and analyze the use of thermal energy consumption in MD and commercial Swedish greenhouses. Furthermore the aim of study is to investigate how MD is perform under different operating conditions. The integrated system consists of industrial low grade waste heat source, greenhouse production facility and membrane distillation unit. The waste heat can be delivered to feedwater (greenhouse drain water) in order to drive MD and the cooling side of the MD is heat exchanged with hot water return line. The integrated MD system performance dependent on waste resources availability.

## **Towards controlling acute hepatopancreatic necrosis disease in farmed shrimp, using bioactive compound phloroglucinol**

*Bipul Dey<sup>1</sup>*

*Peter Bossier<sup>1</sup>, Kartik Baruah<sup>2</sup>, Vikash Kumar<sup>1</sup>*

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Aquaculture, the fastest growing food producing sub-sector of agriculture, significantly contributes to the nutrition of the growing population. Shrimp is an important aquaculture product, however, diseases limit the commercial production of shrimp. An infectious bacterial disease called acute hepatopancreatic necrosis disease (AHPND) occurring huge mortality and thus economic losses in global shrimp industry since 2009. *Vibrio parahaemolyticus*, the causative agent of AHPND possess non-inherent plasmid-encoded PirA and PirB genes producing PirA and PirB toxins, respectively. The inherent virulence factors of the pathogen, in combination with toxins, were considered to occur AHPND in shrimps. Traditional use of antibiotics in controlling bacterial diseases is no longer recommended due to human health and environmental concerns. In recent years, there is a growing interest in using plant-derived phenolic compounds as alternative to antibiotics because of their multidimensional benefits. In this study, we examined the efficacy of phloroglucinol, a phenolic compound, in controlling AHPND in an axenic *Artemia franciscana* and AHPND causing *V. parahaemolyticus* MO904 host-pathogen model system. The results showed dose-dependent significant protection to the host, with highest protection at 2  $\mu$ M dose of phloroglucinol. This dose did not affect the growth of the pathogen, but significantly inhibited several tested virulence factor production namely swimming motility, caseinase activity, biofilm formation and exopolysaccharide production of *V. parahaemolyticus* MO904; and markedly reduced the production of extracellular proteins in the bacteria culture environment both after 12 and 24 hours of exposure. Although the effects of phloroglucinol on PirA and PirB still needed to be unraveled, but presumably the compound might have inhibitory effect on the production of PirA and PirB along with other extracellular proteins. In conclusion, a 2  $\mu$ M dose of phloroglucinol at least partially protected the host against AHPND infection due to its anti-virulence property.

## **Effect of variant ovarian fluid on sperm performance and egg fertilization rates of Arctic charr (*Salvelinus alpinus* L.)**

*Lwabanya Mabo*<sup>1</sup>

*Henrik Jeuthe*<sup>2,3</sup>, *Anders Alanärä*<sup>3</sup>

<sup>1</sup>Swedish University of Agricultural Sciences, Sweden & Lake Tanganyika Research Unit, Zambia

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<sup>3</sup>Department of Wildlife, Fish, and Environmental Studies, Swedish University of Agricultural Sciences, Sweden

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Successful in vitro fertilization in aquaculture is highly dependent on the method used to handle or treat the eggs and milt. As such it is of paramount importance that timely evaluation of the methods is conducted to enhance hatchery productivity and reduce the cost of production.

In this study, three methods of handling eggs of Arctic charr in Sweden were evaluated with the objective of ascertaining the importance of retaining the ovarian fluid in the egg batch.

Further, activation of fish sperms with a commercial activator, ActiFish™, was tested to compare the fertilization rates, in a bid to overcome the current low egg fertilization and hatching rates among farmed Arctic charr. Variation of the volumetric amount of the ovarian fluid did not yield dissimilar fertilization rates.

As such, tempering with the volume of the ovarian fluid under the current study did not affect the performance of the sperms and consequent fertilization rates. Further, no differential fertilization rates were recorded for the sperm extender and freshwater. However, positive relationships were recorded for fertilization rate and sperm velocity (VCL). The study contends that high and successful fertilization rates are likely to be obtained with or without the ovarian fluids under in-vitro fertilization of Arctic charr eggs.

## **Seizing Blue Bioeconomy Opportunities: Review of Developments in Sustainable Food Solutions**

*Ashkan Paksereshi*<sup>1</sup>

*Masoomeh Rashidghalam*<sup>2</sup>

<sup>1</sup>Department of Economics, Swedish University of Agricultural Sciences, Sweden

<sup>2</sup>Department of Agricultural Economics, University of Tabriz, Iran

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Bioeconomy is a privileged area of research with unprecedented multi-faceted insights to drive circular economy and commercialization of sustainable solutions to our today challenges. Blue bioeconomy industries have taken advantage of the growing opportunities provided by sustainable use of marine resources in the development and commercialization of sustainable food innovations. The business and developments of the blue bioeconomy and clean-tech are growing. Key sectors in this respect include business activities based on making use of aquatic biomass, water-based tourism, the value chain of fisheries and growing algae for food and fuel. Seizing opportunities and competence building of food innovation provided by blue bioeconomy requires a thorough understanding of challenges as well as the competitive landscape of potential substitute alternatives. In addition, successful commercialization of novel foods entails a favorable overall consumers' response. As most of the firms are still experiencing and trailblazing in this matter, the current challenge is, therefore, to learn how to benefit from blue bioeconomy's potential for sustainable food solutions and its success on the markets. In the last decade, research interest has increased towards research and development of bio-based innovation. Yet, a clear roadmap for the future of blue bioeconomy food innovation and a meta-review of how far the field has come remains providential. Therefore, through a systematic literature review, we aim to identify research trends and gaps in the field, understanding of obstacles and opportunities, and therein provide clear propositions to guide future research. Based on a systematic review, over articles published in peer-reviewed journals retrieved from Web of Science® and Scopus® databases are descriptively analyzed, with results synthesized across current research trends. Implications for the advancement of knowledge are embedded in the purposefully outlined theoretical, contextual and methodological perspectives, providing future research directions for scrutinizing blue bioeconomy capability in sustainable food development.

## **Fish farming in Tanzania and the availability and nutritive value of local feed ingredients**

*Francis Pius Mmanda<sup>1,2</sup>*

*Deogratias Pius Mulokozi<sup>1,3</sup>, Jan Erik Lindberg<sup>2</sup>, Anna Norman Halden<sup>2</sup>, Matern S.P Mtolera<sup>1</sup>, Rukia Kikula<sup>1</sup>, Torbjorn Lundh<sup>2</sup>*

<sup>1</sup> Institute of Marine Sciences, Tanzania

<sup>2</sup> Swedish University of Agricultural Sciences, Sweden

<sup>3</sup> Stockholm University, Sweden

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Aquaculture industry is one of the fast food-growing activities in Tanzania which outpacing the high demand of fish and fishery products, but its expansion has been constrained for decades by limited availability of good quality feeds at affordable prices. Majority of tilapia fish farmers were relied on local feed ingredients as supplement diets for their farmed fish. However, their nutrient content vary widely within and between regions. Therefore, an investigative surveyed study were performed from January 2017 to February 2018 to gather baseline data on their availability and nutritive values content. In total, 202 fish farmers were interviewed and 30 different ingredients were collected from the study sites for chemical analysis. The findings showed that, majority of respondents involved in aquaculture operations were males (82.7%), with a high proportion (55.0%) in the age group 40-60 years. Most commonly cultured fish species (82.2%) was tilapia, mostly (87.6%) raised semi-intensively at a stocking density of 2-3 fish/m<sup>2</sup>. Over 80% of respondents relied on local feed ingredients as supplement diets for cultured fish. The most common feed ingredients were maize bran (28%), Lake Victoria sardines (11%) and sunflower seed cake (11%). Crude protein content in most analysed local ingredients was medium-high, while Crude fat content was high in some animal and agricultural by-products, but was medium-low in other ingredients. In general, agricultural by-products, aquatic plants and industrial by-products had a medium-high content of nitrogen-free extract, while there were major differences in ash content between the feed ingredients analysed. According to mineral content, the results showed a wide range of mineral concentrations in the local feed ingredients used by tilapia fish farmers in Tanzania. These data provide a good platform for development of feeding strategies for cultured tilapia based on current culture systems, availability of local feed ingredients in Tanzania and their nutritional content.

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## **Diversified agroecological cropping systems for sustainable food systems**

*Session leader: Erik Steen Jensen, Swedish University of Agricultural Sciences*

Lecture room: K

### Session Schedule

<b>14.15-14.20</b>	<b>Introduction</b> <i>Erik Steen Jensen</i>
<b>14.20-14.40</b>	<b>Intercropping grain legumes and cereals for sustainable food systems</b> <i>Georg Carlsson</i>
<b>14.40-15.00</b>	<b>Importance of intercropping of plants in South Africa used in the natural products industry</b> <i>Karen Swanepoel</i>
<b>15.00-15.20</b>	<b>Intercropping as an Ecological Precision Farming tool to deal with extreme weather and field heterogeneity</b> <i>Iman Raj Chongtham</i>
<b>15.20-15.35</b>	<b>Coffee break</b>
<b>15.35-15.55</b>	<b>Effect of management practices on legumes productivity in smallholder farming systems in sub-Saharan Africa: A meta-analysis</b> <i>Tarirai Muoni</i>
<b>15.55-16.15</b>	<b>Multispecies perennial forage legume and grass mixtures for improved nitrogen supply of organic arable cropping systems</b> <i>Nawa Raj Dhamala</i>
<b>16.15-16.35</b>	<b>Company-community partnership and climate change adaptation practices: the case of smallholders' coffee farmers in Indonesia</b> <i>Ayu Pratiwi</i>
<b>16.35-16.55</b>	<b>Effect of fertilizer subsidies on crop diversification: insights from cropland allocation behaviors of households in Northern Ghana</b> <i>Solomon Amoabeng Nimako</i>
<b>16.55</b>	<b>Closure</b>

## **Intercropping grain legumes and cereals for sustainable food systems**

*Georg Carlsson<sup>1</sup>*

*Nicolas Carton<sup>1</sup>, Iman Raj Chongtham<sup>1</sup>, Nawa Raj Dhamala<sup>1</sup>, Erik Steen Jensen<sup>1</sup>, Carolina Rodriguez Gonzalez<sup>1</sup>*

<sup>1</sup> Department of Biosystems and Technology, Swedish University of Agricultural Sciences, Sweden

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Grain legumes such as beans, lentils and peas are climate-smart and nutritious food sources and provide nitrogen inputs to cropping systems via symbiosis with nitrogen-fixing bacteria. Thanks to their high contents of protein, fibers and essential vitamins and low content of fat, an increased consumption of grain legumes and a reduced meat consumption would improve human health in many western diets. Furthermore, such dietary shifts would reduce land use, climate impact and the need for nitrogen fertilizer inputs compared to the cereal- and meat-dominated food systems that are typical for many developed countries. However, grain legumes are known to have larger yield variability and lower competitiveness against weeds than cereal crops, and these challenges represent obstacles for increases in global grain legume production. Intercropping, the practice of growing two or more species at the same time and in the same field, has been shown to increase resource use efficiency and yield stability compared to sole crops, at least under low-input management. We present results from research on several grain legume crops, cultivated in field experiments as sole crops and intercrops with cereals, showing that intercropping increases the efficiency in the use of land and nitrogen compared to sole crops. Intercropping also reduces weed abundance and yield variability compared to grain legume sole crops. Thanks to the complementary use of resources, notably increased reliance on nitrogen fixation by the legume and increased per-plant-acquisition of soil-derived nitrogen by the cereal, intercropping will free up land and nitrogen for other crops. Diversifying food production and consumption by including more grain legume-cereal intercrops in farmers' fields and increasing the proportion of legume-based food in diets can thereby increase global food security in synergy with reducing agriculture's negative environmental impact.

## **Importance of intercropping of plants in South Africa used in the natural products industry**

*Karen Swanepoel<sup>1</sup>*

<sup>1</sup> Coordinator of the Southern African Essential Oil Producers Association SAEOPA, South Africa

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The Natural product industry is a fast growing and changing industry and African plants are now fashionable to be included in new products. Essential oils and cold pressed oils, plant extracts, and powders of indigenous plants amongst others are the focus areas. These plants as crops can be intercropped with existing crops and at the same time act as insect repellents and as biological control of pests. Rose geranium of *Pelargonium* var Rose, *Adansonia digitata* (Baobab), *Citrullus lanatus* (Kalahari melon) and *Schlerocarya birrea* (Marula) oil, pulp and powder of both are under supplied in a growing market of currently developed products that have already been accepted by most international companies. These are naturally growing in areas of macadamia, avocado, mango and banana production and can easily be incorporated as intercropping options. There is now also extra demand for oils and plant fats to replace traditional crops. Advantages and challenges have been identified with potential of sustainable crop development amidst existing food crops as not to influence the supply for food security. Climate change and pressure on natural resources can be managed if careful sustainable measures are taken in time. This study could assist role players of community projects, agricultural and rural development schemes in decisions of choosing alternative crops and for skills and entrepreneurship development and poverty alleviation. The information from the study can also be applied by government departments, small scale and emerging farmers in the feasibility studies of utilization of natural products as new enterprises. This presentation will focus on the potential of sustainable supply of the natural products as identified to the advantage of the producers of South Africa.

## **Intercropping as an Ecological Precision Farming tool to deal with extreme weather and field heterogeneity**

*Iman Raj Chongtham*<sup>1</sup>

*Adam Flöhr*<sup>1</sup>, *Johannes Albertsson*<sup>1</sup>, *Julian Zachmann*<sup>2</sup>, *Sebastian Munz*<sup>2</sup>, *Erik Steen Jensen*<sup>1</sup>

<sup>1</sup> Department of Biosystems and Technology, Swedish University of Agricultural Sciences, Sweden.

<sup>2</sup> Institute of Crop Science, University of Hohenheim, Germany

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Agriculture is facing several tough challenges; to improve yield and quality, farmers' earnings, resource-use efficiency, soil fertility, biological pest control, farmland biodiversity, resilience to changing climatic and market conditions, and at the same time to reduce the use of agrochemical inputs. Furthermore, intrinsic factors such as high heterogeneity within a field (e.g. soil moisture, texture, nutrient availability, and exposure to sunlight) can result in large spatial differences in growth and yield potential of crops.

Intercropping, i.e. growing two or more crop species simultaneously on the same field, has the potential to address several of these socio-economic and bio-physical challenges by exploiting the ecological principles of competition, complementarity and facilitation.

To test this, long strips of crops: oat sole crop, pea sole crop, and oat-pea intercropped, were grown in a field with heterogeneous soil conditions, and crop performances based on e.g. grain yield, straw and weed biomass were measured. In the first year of experiment (2018), due to severe drought in southern Sweden, all pea plants (in sole and intercropped strips) died at flowering stage. The predicted means of weed biomass at harvest indicated that sole oat strips have the least, sole pea strips have the most, and the intercrop strips were intermediate. However, oat grain yield in the intercropped strips was  $3487 \pm 1370$  kg/ha (mean  $\pm$  SD), despite, having only 50% of the sole crop density, compared to  $4065 \pm 1698$  kg/ha in oat sole crop strips. This preliminary finding shows the potential of intercropping to reduce the vulnerability of cropping systems to unpredictable extremes, such as drought and price fluctuation, through diversified crops in space. This presentation also discusses the concept of Ecological Precision Farming (Jensen et al. 2015) and the possible use of intercropping cereals with legumes as a tool to increase yield stability on fields with heterogeneous conditions.

## **Effect of management practices on legumes productivity in smallholder farming systems in sub-Saharan Africa: A meta-analysis**

*Tarirai Muoni<sup>1, 2</sup>*

*Mattias Johnson<sup>3</sup>, Ingrid Öborn<sup>1, 4</sup>, Christine Watson<sup>1, 5</sup>, Göran1 Bergkvist<sup>1</sup>, Andrew Barnes<sup>6</sup>, Alan Duncan<sup>2, 7</sup>*

<sup>1</sup> Department Crop Production Ecology, Swedish University of Agricultural Sciences, Sweden

<sup>2</sup> International Livestock Research Institute, Kenya

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<sup>4</sup> World Agroforestry, (ICRAF), Kenya

<sup>5</sup> SRUC, United Kingdom

<sup>6</sup> SRUC, United Kingdom

<sup>7</sup> Global Academy of Agriculture and Food Security, University of Edinburgh, United Kingdom

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Legumes play a key role in food and nutrition security, as livestock feed as well as for soil fertility in mixed smallholder farms in sub-Saharan Africa (SSA). The environmental conditions under which smallholder farming is practiced in SSA are highly heterogeneous and there are also large differences in management practices, thus legume productivity is variable. In order to quantify the effects of intercropping, inoculation, minimum tillage and phosphorus application on legume grain (food) and biomass (fodder) yield and biological nitrogen fixation (BNF) in a range of SSA contexts, a meta-analysis, involving 120 publications, was carried out. The results show that intercropping reduced legume biomass and grain yields to varying extent, although the land equivalent ratio (LER) for the sum of the intercrops in all/most cases were higher than 1. Pigeon pea (*Cajanus cajan*) yields a relative land equivalent ratio (rLER) of 90%, while for groundnut (*Arachis hypogaea*) and soybean (*Glycine max*) rLER were around 60%. Inoculation and phosphorus application increased legume grain and biomass yield. Inoculation also increased BNF. The effects of inoculation and phosphorus application on legumes varied with soil type. Minimum tillage had no effect on legume productivity, although data was less abundant for that variable. Among the legumes included in this meta-analysis, pigeon pea competes less with companion in intercrops and other crops including groundnut and soybean are good alternatives for intercropping in SSA. There are insufficient studies to draw firm conclusions on the effect of minimum tillage on legume productivity, thus there is need for more studies which investigate how tillage influences legume production in SSA smallholder farming. We conclude that although intercropping results in lower grain and biomass yield, other benefits including soil fertility improvement and high overall yield improve crop productivity in smallholder farms make it an attractive option.

## **Multispecies perennial forage legume and grass mixtures for improved nitrogen supply of organic arable cropping systems**

*Nawa Raj Dhamala<sup>1</sup>*

*Georg Carlsson<sup>1</sup>, Erik Steen Jensen<sup>1</sup>*

<sup>1</sup> Department of Biosystems and Technology, Swedish University of Agricultural Sciences, Sweden

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Nitrogen (N) management is central for sustainable food production: N limitation may lead to food insecurity while N surplus may cause environmental degradation. Integration of perennial forage legumes in arable cropping systems provides inputs of biologically fixed N, reducing the need for energy-demanding N fertilizers. We conducted a three-year field experiment in an organic arable cropping system at the Swedish University of Agricultural Sciences (SLU), Alnarp, Sweden. The experiment included four forage legumes (*Medicago sativa*, *Melilotus officinalis*, *Lotus corniculatus* and *Trifolium repens*), and four grass species (*Phleum pratense*, *Dactylis glomerata*, *Festuca pratensis* and *Lolium perenne*) in pure stands and mixtures of different composition. Variation in plant productivity, legume biological N<sub>2</sub> fixation and N acquisition as affected by species choice and composition of perennial forage legumes and grasses were assessed under low and high cutting frequency. The majority of the legume-grass mixtures were as productive as the highest performing legume or grass pure stands, and the mixtures generally competed more strongly against weeds than pure stands. Legumes derived up to 90% of their N from N<sub>2</sub> fixation, and this was often higher in legumes grown in mixtures with grasses. Total N accumulation in harvested biomass was highest in pure stand of *M. sativa*, followed by legume-grass mixtures which in turn accumulated more N than grass in pure stand. Root N concentration varied between species composition in the same pattern as total aboveground N accumulation, whereas total root biomass and amount of N did not vary significantly between species mixtures and cutting frequencies. The study provides insights about the resource efficiency of N acquisition in perennial forage legume-grass mixtures. Including multispecies forage legume-grass mixtures in rotation with arable crops systems may improve productivity, multifunctionality and the overall sustainability of organic arable cropping systems.

## **Company-community partnership and climate change adaptation practices: the case of smallholders' coffee farmers in Indonesia**

*Ayu Pratiwi<sup>1</sup>, Guenwoo Lee<sup>2</sup>, Aya Suzuki<sup>3</sup>*

<sup>1</sup> Turku School of Economics, University of Turku, Finland

<sup>2</sup> Institute of Economic Research, Hitotsubashi University, Japan

<sup>3</sup> Graduate School of Frontier Sciences, Department of International Studies, The University of Tokyo, Japan

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Climate change affects agricultural production system. The effective diffusion of sustainable and resource-conserving agricultural practices is paramount in the developing world where agricultural productivity remains low; vulnerability and food insecurity high; while the direct effects of climate change are harsh. At the same time, demand for high quality and responsibly sourced agricultural produce continues to grow globally. Intersectoral company-community partnerships are especially pronounced in many global commodity chains, which main purposes are to directly procure commodities from the farmers, resulting in more effective supply chains and consequently improving farmers' welfare. Despite their important roles, little is known about their contribution in helping their smallholders' clientele harness the climate change adaptation strategy. This paper aims to examine the effects of such partnership upon the resource-conserving and sustainable practices of the smallholders' farmers, taking the case of coffee growers in Lampung, Indonesia.

To do that, we firstly outline the impact of climate change on the smallholders' farmers agricultural practices and highlight the role of the partnership in mitigating such effects. Secondly, we estimate the effects of participation in company-community partnership on climate change adaptation strategies of 240 randomly-selected coffee farmers within 3-years period, particularly on the adoption of water and soil conservation practices, grafting methods, and farm diversification. Based on propensity score matching and inverse probability weighting regression, we find that participation in the partnership depends on the motorcycle possession, the cultivated farmland size, and the size of advice networks. Apart from improving farmers' farm income, participation in the partnership also drives the adoption of conservation practices and grafting methods to improve the plants' tolerance to environmental stress; and the diversification of spices crops and hardwood. We conclude that in the smaller scale, company-community partnership manages to improve the smallholders' farmers welfare while simultaneously helps spur sustainable practices for climate change adaption.

## **Effect of fertilizer subsidies on crop diversification: insights from cropland allocation behaviors of households in Northern Ghana**

*Solomon Amoabeng Nimako<sup>1</sup>*

*Rose Nyikal<sup>1</sup>, Chris Ackello-Ogutu<sup>1</sup>*

<sup>1</sup> Department of Agricultural Economics, University of Nairobi, Kenya.

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Agricultural input subsidies have been identified as viable entry points to tackling food insecurity by ensuring food sufficiency through crop intensification, which comes with productivity and income gains. Indeed, Ghana's Fertilizer Subsidy Program (GFSP) has been fairly successful in contributing towards achieving these targets. However evidence from literature suggests that specific-crop biased subsidy programs have implications not only for output and incomes, but also a potential distorting effect on crop diversification in general and the choice and mix of crops cultivated in particular. This could have implications for households' resilience to price, weather and disease-related risks; and dietary diversity from local production. Despite the existence of these synergies and tradeoffs, focus of past studies on Ghana's FSP has been on its impact on yields, income and fertilizer adoption; with almost no attention to its crop diversification effects.

Against this backdrop, this study uses data from 247 randomly selected households in Ghana's Upper West region to assess the effect of the country's maize-biased FSP on households' cropland allocation decisions. A tobit model adapted within an endogenous treatment regression framework was used to examine the relationship between the GFSP and the share of total farmland allocated to respective crop groups.

The results show that the GFSP appears to discourage diversification. Notably, a strong positive relationship was found between households' participation in the GFSP and the share of land allocated to the subsidy-biased crop, maize; while a significantly negative effect on land allocations to legumes and other cereals was observed. Furthermore, factors like distance to market, gender relations and access to extension services had varying effects on land allocation decisions.

The study recommends an effective expansion of the GFSP to support a wider range of crops. Also, increasing farmers' access to extension services and improving rural infrastructure could increase their diversification abilities.

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## **Yield Gaps – causes of yield gaps and how can they be smaller/closed?**

*Session leaders: Ingrid Öborn; Sigrun Dahlin; Håkan Marstorp, Swedish University of Agricultural Sciences; Magnus Jirström, Lund University*

Lecture room: N

Session Schedule

**14.15 Introduction to session**

*Moderator: Sigrun Dahlin*

**Sustainability assessment of smallholder farms: unveiling the short-term impact of sustainable intensification interventions**

*Defne Ulukan*

**Smallholders' perceptions and attitudes to within- and between-plot crop yield variability in resource-poor communities**

*Ibrahim Wahab*

**The non-responsiveness of crops to fertilizers under some soils in sub-Saharan Africa**

*Jeremiah Okeyo*

**Healthy sheep and goats for resilient livelihoods and improved food security – the need for a transdisciplinary approach**

*Jonas Johansson Wensman*

**15.15 Coffee break**

**15.45 Session continues**

*Moderator: Ingrid Öborn*

**Mapping the global potential of water harvesting to increase crop production from successful case studies**

*Luigi Piemontese*

**Small farmers, Large Fields – an initiative to improve yield gap of small farms through synchronized participatory farming**

*Sampriti Baruah*

**Gender differences in smallholder maize plot management and production: Empirical Evidence from two villages in Western Kenya**

*Stephen Wambugu*

**Biochar production and application in small-scale farming in Kenya: Yield increases and local perceptions.**

*Yahia Mahmoud*

**Comments and discussion**

**17.00 Closing of session**



## **Sustainability assessment of smallholder farms: unveiling the short-term impact of sustainable intensification interventions**

*Defne Ulukan<sup>1</sup>*

*Pierre Chopin<sup>1</sup>, Anja Faße<sup>2</sup>, Gregor Mager<sup>2</sup>, Ingrid Öborn<sup>1,3</sup>, Göran Bergkvist<sup>1</sup>*

<sup>1</sup> Crop Production Ecology, Swedish University of Agricultural Sciences, Sweden

<sup>2</sup> TU Munich Campus Straubing for Biotechnology and Sustainability, Germany

<sup>3</sup> World Agroforestry (ICRAF), Kenya

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Smallholder farmers are stricken by food insecurity and poverty in Eastern Africa. In order to enhance rural livelihoods and food security, sustainable intensification projects aim at improving the performance of farming systems. Innovations introduced by projects target to increase productivity and income while preserving the environment and improving human wellbeing. Impact assessments of such interventions typically include indicators measuring economic and agronomic dimensions. However, there is a need to integrate a broader range of indicators to evaluate the impact of interventions on the multidimensional sustainability of farm households. We built a tool to assess farm household sustainability in Tanzania before and after the implementation of sustainable intensification innovations – such as fertilizer micro-dosing and rainwater harvesting – in two regions, namely Morogoro and Dodoma. We follow three major steps: 1) we identify and calculate relevant sustainability indicators before and after the first year of innovation implementation, 2) we develop a farm household typology to observe the short-term effect of innovations on different types of farm households, 3) we perform a functional analysis to observe the chain of change after innovation implementation in order to explain the change in sustainability levels. Overall, thirty basic indicators of sustainability (equally distributed between social, economic and environmental dimensions) were calculated for over 800 farm households. A strong variability in the range of indicator scores was observed; for instance, average gross margin per hectare ranged from -600 US\$ to over +2000 US\$ for the year preceding innovation implementation. We will explain these variations and analyze the short-term impact of innovation implementation through farm household typology. Lastly, we will discuss recommendations on sustainable intensification strategies based on the determinants of sustainability revealed by the comparison between farm households.

## **Smallholders' perceptions and attitudes to within- and between-plot crop yield variability in resource-poor communities**

*Ibrahim Wahab<sup>1,2</sup>*

*Ola Hall<sup>1</sup>, Magnus Jirström<sup>1</sup>*

<sup>1</sup> Department of Human Geography, Lund University, Sweden

<sup>2</sup> Department of Geography and Resource Development, University of Ghana, Ghana

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It is now mainstream view that agricultural production and productivity must increase by at least 60% in the next three decades to be able to feed a 9-billion global population. There is also increasing consensus that much of this needed increase should: 1) emanate from mostly developing countries; and 2) be attained through intensification rather than extensification. In spite of modest gains, doubts still linger about the ability of developing regions to achieve the needed increases in agricultural production and productivity. Yield variability – both within and between plots – has been found to be an important source of the low productivity among rainfed, smallholder farmers in resource-poor communities. The present study therefore seeks to explain farmers' perceptions and attitudes to observed variability on such plots.

Using aerial images in photo-elicitation interviews, the study finds that the general attitude of smallholders to the presence of poor patches is that of indifference. They assign apparently management-related sources of low crop vigour to nature and assert that not much can be done to remedy the phenomenon. The study also finds that smallholder farmers, by and large, aim for optimization, rather than maximization, of yields. That is, while farmers are generally satisfied with their current outputs, they concede they could produce much more with adequate, appropriate, and timely use of farm inputs. Though fertilizer application is well worth the investments in terms of final outputs, smallholder households which are cash-strapped at crucial periods of crops production would do without fertilization rather than rely on loans with unreasonable terms. Thus, smallholder farmers in resource-poor communities view investments on their farms in the form of fertilizers, pesticides, and herbicides as too risky. As alternatives, they would rather invest their already limited resources in non-farm ventures. These findings have important implications for the future of small farms.

## **The non-responsiveness of crops to fertilizers under some soils in sub-Saharan Africa**

*Jeremiah Okeyo*<sup>1</sup>

*Michael Kinyua*<sup>2</sup>, *Job Kihara*<sup>2</sup>

<sup>1</sup> University of Embu, Kenya

<sup>2</sup> International Centre for Tropical Agriculture (CIAT), Kenya

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In sub-Saharan Africa (SSA), the problem of crop non-responsiveness to fertilizer application has been identified at different spatial scales and is a major concern among farmers, researchers and other stakeholders. Several factors associated with crop non-responsiveness to fertilizers include degraded highly weathered soils with very low organic matter and poor structure that result in low nutrient holding capacity, silent deprivation of micronutrients consistent with historical nutrient management, and soil acidity/alkalinity. In this review, we aimed at: i) identification of the extent of crop non-responsiveness to fertilizer amendments and the main contributing factors, and ii) quantification of yield gaps associated with such soils under smallholder systems in SSA. A literature search combination of published literature and project datasets carried out under smallholder farming systems in SSA, yielded over 16,200 paired data points with comparable control/experimental plots. The fertilizer response ratio (RR) was on average 2.32 with 17.3 % of the studies having a RR  $\leq$  1.0 indicative of non-responsiveness. Assessment of soil, climate and environmental factors only accounted for 43 % of the observed variation in the fertilizer RR. Multiple constraints which often have high spatial variability are linked to crop response to fertilizers and associated yield gaps under smallholder farming systems in many countries. Interventions geared towards enhancing efficiency of fertilizer use in SSA, need to address the most limiting conditions including secondary and macronutrients. Long-term sustainability of smallholder systems requires a buildup and maintenance of soil organic matter to levels that enhance nutrient use efficiency.

## **Healthy sheep and goats for resilient livelihoods and improved food security – the need for a transdisciplinary approach**

*Jonas Johansson Wensman*<sup>1</sup>

*Karin Alvåsen*<sup>1</sup>, *Mikael Berg*<sup>1</sup>, *Johanna Bergman Lodin*<sup>1</sup>, *George Dautu*<sup>2</sup>, *Klara Fischer*<sup>1</sup>, *Cecilia Fåhræus*<sup>3</sup>, *Tebogo Kgotlele*<sup>4,5</sup>, *Johanna Lindahl*<sup>1,3,6</sup>, *Sara Lysholm*<sup>1</sup>, *Gerald Misinzo*<sup>4</sup>, *Musso Munyeme*<sup>7</sup>, *Edwin Ngowi*<sup>8</sup>, *Emeli Torsson*<sup>1</sup>, *Ewa Wredle*<sup>1</sup>

<sup>1</sup> Swedish University of Agricultural Sciences, Sweden

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<sup>3</sup> Uppsala University, Sweden

<sup>4</sup> Sokoine University of Agriculture, Tanzania

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<sup>6</sup> International Livestock Research Institute, Vietnam

<sup>7</sup> University of Zambia, School of Veterinary Medicine, Zambia

<sup>8</sup> University of Dodoma, Tanzania

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Sheep and goats are important species for food and nutrition security, especially for resource-constrained smallholder farmers in developing countries such as Tanzania and Zambia.

They are cheap and thus more affordable by the more resource-constrained and vulnerable groups.

Women and youth are usually the owners or care-takers. Thus, these animals play an important role for poverty alleviation and especially goats will likely become even more important over time in light of climate and environmental changes. For any livestock production to be economically, socially and ecologically sustainable, healthy animals are key. Healthier livestock would increase the productivity and livestock's contribution to food security and livelihoods, at the same time reducing the impact on natural resources. Disease and death of even single goats can have devastating effects on a family's livelihood. Mortality rates of animals in low-income countries are 3–10 times higher than in high-income countries. As a result of this high mortality, farmers lose one animal for every second goat sold, severely hampering development. Presence of zoonotic diseases, such as brucellosis or coxiellosis, could also infect people and further have a negative impact on human health and livelihoods. Thus, improved animal health would have a tremendous effect on the income and livelihoods of smallholders, particularly women and youth.

Here, we present a multi-disciplinary initiative including animal, veterinary and social sciences.

We believe that this multi-disciplinary approach, aiming to provide a holistic view on sheep and goat production and its effects on livelihoods, is important for bringing sheep and goat health forward for more resilient livelihoods and improved food security.

## **Mapping the global potential of water harvesting to increase crop production from successful case studies**

*Luigi Piemontese<sup>1</sup>*

*Giulio Castelli<sup>2</sup>, Ingo Fetzer<sup>1</sup>, Jennie Barron<sup>3</sup>, Hanspeter Liniger<sup>4</sup>, Nicole Harare<sup>4</sup>, Elena Bresci<sup>2</sup>, Fernando Jaramillo<sup>1,5</sup>*

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<sup>3</sup> Department of Soil and Environment, Swedish University of Agricultural Sciences, Sweden

<sup>4</sup> Centre for Development and Environment, University of Bern, Switzerland

<sup>5</sup> Department of Physical Geography, Stockholm University, Sweden

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Agriculture has a dominant role in achieving the SDG of hunger eradication, with the double challenge of increasing food security while preserving natural ecosystems. Water harvesting is a well-known practice that can provide supplemental irrigation, increasing water productivity thus contributing to sustainable intensification of agriculture. Water harvesting has been widely applied in different social-ecological contexts and demonstrated to be a valuable approach to increase food production sustainably. However, current global estimates are based on purely biophysical models, which provide valuable information on the ecological suitability of water harvesting but neglecting the relevance of the socio-economic dimension of agriculture, which can be a critical factor in the feasibility and success of sustainable transformations. The lack of comprehensive social-ecological estimates can thus hinder the development and effectiveness of policies and funding to out-scale this technology globally. This work provides an evidence-based global estimate on the potential of water harvesting to increase crop production with a social-ecological lens. We analyse the social-ecological similarities in 171 successful water harvesting case studies to estimate global areas for potential successful out-scale of water harvesting. The hotspot for successful implementation can complement conventional hydrological analysis and guide policy development at global scale. The methodological approach can be replicated at finer scales to guide regional agricultural intensification with sustainable land and water management practices.

## **Small farmers, Large Fields – an initiative to improve yield gap of small farms through synchronized participatory farming**

*Sampriti Baruah<sup>1,2</sup>*

*Samarendu Mohanty<sup>1</sup>*

<sup>1</sup> International Potato Center (CIP), India

<sup>2</sup> International Rice Research Institute, Philippines

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Most of the small and marginal farmers of Odisha are ill-equipped or low tech, with marginal land (frequently affected by flood and drought) and in the Indian context limited by ascribed statuses like caste and gender. With an objective to address the various obstacles faced by small and marginal farmers, Mohanty et al. (2017) piloted a model of synchronized farming called the ‘Small Farmers–Large Fields’ (SFLF) model, which allows the small farmers to benefit from economies of scale by organizing themselves into groups and synchronizing their operations. The model is piloted in two villages with 112 farmers (35 females and 77 male) who have organized themselves into groups and synchronized their operations by selecting one rice variety, establishing group nursery, and transplanting and harvesting around the same time through single contract, thus essentially converting their small landholdings into a large field. Based on the data collected from the participating farmer at the end of the first pilot season, the average per acre yield was estimated to be 28kgs per acre compared to 22kgs per acre in the previous season and the average per hectare profit was estimated to be at USD 390 vis-à-vis USD 191 in the previous season. Apart from the monetary benefits, farmers saved time and energy in each of the farming activities done together.

The study has utilized an embedded mixed method research (MMR) design, where one data set provides a supportive, secondary role in a study based primarily on the other data type (Creswell, Plano Clark, et al., 2003). Researchers use this design when they need to include qualitative or quantitative data to answer a research question within a largely quantitative or qualitative study. Also this study has been a participatory action research (PAR) initiative.

## **Gender differences in smallholder maize plot management and production: Empirical Evidence from two villages in Western Kenya**

*Stephen Wambugu<sup>1</sup>*

*Magnus Jirstrom<sup>1</sup>*

<sup>1</sup> Chuka University, Kenya

<sup>2</sup> Department of Human Geography, Lund University, Sweden

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Gender differences in farm management and agricultural productivity among smallholders in sub-Saharan Africa is a topic that is receiving increasing attention from researchers and policy makers. This paper examines certain aspects on gender differences in maize plot management and production that hitherto have either been given inadequate research attention or been addressed in studies often yielding conflicting results. The paper investigates gender differences in five maize plot management practices and in social and economic factors that can be assumed to influence these practices. These are plot sizes and their location relative to the farm homestead; sources of inputs and their use; sources of labor and its use; weeding frequency and extent of green maize harvesting. A diagnostic and descriptive survey was conducted in two villages in western Kenya to get a wide coverage of maize management and production practices among male- and female- managed maize plots. A hand held GPS device was used to get the coordinates and exact location of the maize plots and homesteads. A total of 55 male- and 115 female-managed maize plots operated by 95 farm households were examined. Chi squared tests were used to examine the significance of gender differences.

Findings analyzed and discussed in the study reveal, for instance, that female plot managers used less inorganic fertilizer than male plot managers. While no significant gender difference in the use of improved seeds was detected, the sourcing of seeds differed with female plot managers manager relying relatively more on local shops and male managers on agro-dealers. Gender of the plot manager did not significantly influence the use of hired, family or voluntary labor and, relatedly, the study found no significant difference in the frequency of weeding.

## **Biochar production and application in small-scale farming in Kenya: Yield increases and local perceptions**

*Yahia Mahmoud<sup>1</sup>*

*James Gitau<sup>2</sup>, Erik Karlun<sup>3</sup>, Thomas Kätterer<sup>4</sup>, Geoffrey Kimutai<sup>5</sup>, Mary Njenga<sup>2, 6</sup>, Gert Nyberg<sup>7</sup>, Kristina Roing de Nowina<sup>3, 8</sup>, Dries Roobroeck<sup>5</sup>, Cecilia Sundberg<sup>9</sup>*

<sup>1</sup> Department of Human Geography, Lund University, Sweden

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<sup>4</sup> Department of Ecology, Swedish University of Agricultural Sciences, Sweden

<sup>5</sup> IITA, Kenya

<sup>6</sup> World Agroforestry (ICRAF), Kenya

<sup>7</sup> Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, Sweden

<sup>8</sup> CGIAR, Kenya

<sup>9</sup> Department of Sustainable Development, Environmental Science and Engineering (SEED), KTH Royal Institute of Technology, Sweden

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Degradation of agricultural soils and forest resources are two pervasive challenges in rural landscapes of sub-Saharan Africa. Biochar-producing biomass gasification technologies attract evermore interest because these can empower small-scale farmers to produce energy and food more sustainably by improving energy use efficiencies, lowering emissions and strengthening climate resilience. In order to assess the potential impacts and the feasibility of soil biochar amendments we are carrying out on-farm trials with 150 households in three agroecosystems in Kenya. A participatory approach was followed for testing uptake of gasifier cook stoves and effects of biochar use on crop production. The outcomes that will be presented include: (a) the degree of feasibility, (b) the effects on crop yields, (c) the general attitudes towards the idea of using the cookstoves to produce biochar, and (d) patterns of biomass fuel use. Effects of domestically produced biochar, at rates of 1–10 t DW ha<sup>-1</sup>, on the production of maize (*Zea mays*) and kale (*Brassica oleracea*) were compared with normal farming practices. At the site located in Kwale the yield increases of maize showed a strong positive correlation with biochar dose. In the first season, yields increased from 0.9 Mg ha<sup>-1</sup> in the control plot to 4.4 Mg ha<sup>-1</sup> in average in the biochar-amended plots. At another site (Siaya), an average biochar dose of 2.8 Mg ha<sup>-1</sup> lead to an increase in maize yields from 2.9 to 3.8 Mg ha<sup>-1</sup> in average in the first season and from 1.7 to 2.5 Mg ha<sup>-1</sup> in the second season after biochar addition. Findings from this action research indicate that producing and using biochar on small-scale farms offers suitable opportunities to close yield gaps across Kenya and in similar agro-ecological environments.

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## **Soil degradation and the SDG's**

*Moderator: Matthew Fielding, SIANI and Stockholm Environment Institute (SEI)*

Lecture room: 02

Session schedule: 14.15-17.00

In this webinar, we will look at the socio-economic drivers of soil degradation and explore solutions that can help achieve the SDGs related to soil health, sustainable land use and climate change.

Soils are key to sustainable development and underpin many of the SDGs, playing an important role in agriculture, land use management, poverty alleviation and ecosystem resilience. However, across the globe soil health is often overlooked, resulting in increasing rates of land degradation.

In this webinar, we will look at the socio-economic drivers of soil degradation and explore how these drivers are linked to land degradation as a whole. We will learn about the scale and geographical scope of the various (4) types of soil degradation and their consequences.

Furthermore, we will look at soil as a dynamic material that can be both the cause and the solution to many climate issues. This webinar will present tools, concepts and models related to soil carbon, soil quality and soil degradation that can help meet the Sustainable Development Goals for climate change and sustainable land use.

Featuring:

- Ruth Sitienei – soil scientist at the Africa Program of the Nature Conservancy, Kenya
- Nicholas Jarvis – Professor at the Department of Soil and Environment, SLU
- Dagmar Henner- Ph.D. Research Student on modeling the impacts of second-generation bioenergy crops on ecosystem services, University of Aberdeen
- Moderator – Matthew Fielding, SIANI and Stockholm Environment Institute

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## Translating science into policy and practice for food security

Session leaders: Magnus Jirström, Lund University, Madelene Ostwald, GMV and Linköping University

Lecture room: L

Session Schedule

**08.30-12.00** with coffee break as planned in the program

Commentators: Elisabeth Simelton & Moses Osiru

### Presentations before coffee break

**1. Designing for development in human-centred food production systems: weather index insurance in eastern Uganda**

*Fiona Lambe*

**2. Factors contributing to behavioral change among farmers of rainfed systems in Côte d'Ivoire in a context of increased climate variability**

*Mar Moure Peña*

**3. Lean farming technologies for sustainable crop production system**

*Swaminathan Veeramuthu Murugan*

**4. Participatory tools to support prioritization of sustainable intensification practices in tropical smallholder farming systems**

*Alan Duncan*

**5. The drivers of change and challenges in the evolution of tsetse and trypanosomiasis management practices in coastal Kenya**

*Arnold Musungu*

**6. The Sub-Saharan Africa Soil Data Manager (SSA-SDM)**

*Kristin Piikki*

### Coffee break

### Presentations after coffee break

**8. Translating agronomic insights for improved farm management: Experiences from co-learning with African farmers**

*Katrien Descheemaeker*

**9. Urban agriculture policy workshops in Kenya's medium-sized cities: linking research to policy and practice**

*Samuel Onyango Omondi*

**10. Food security and polluted soil – risks and opportunities for food production on polluted soils**

*Henrik Haller*

**11. From marginal to mainstream: Experiences from a short course for African irrigation professional on farmer-led irrigation (development)**

*Chris De Bont*

## **Designing for development in human-centred food production systems: weather index insurance in eastern Uganda**

*Fiona Lambe<sup>1</sup>*

*Matthew Osborne<sup>1</sup>, Arjan Verschoor<sup>2</sup>, Naira Dehmel<sup>3</sup>, Ylva Ran<sup>1</sup>*

<sup>1</sup> Stockholm Environment Institute, Sweden

<sup>2</sup> University of East Anglia, United Kingdom

<sup>3</sup> London School of Economics, United Kingdom

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Climate variability causes small holder farmers to adopt risk-avoidance strategies like choosing not to invest in technologies or services that could boost their agricultural productivity and incomes. Thus, climate shocks can both cause and perpetuate poverty traps and food insecurity for small holder farmers. Although insurance would seem like an obvious approach to reduce risk for smallholders, insuring small scale farmers has been challenging: it is hard to verify the legitimacy of claims by the insurer and there is a risk that farmers can willfully destroy or damage the insured good to receive payment (moral hazard). Weather index insurance (based on satellite data) is a promising innovation that could address many of the shortcomings of traditional indemnity insurance. However, the question of how such a product should be packaged and delivered to meet the needs of smallholder farmers remains open. We applied the Behaviour and Choice Initiative (BCI) toolkit, a methodology combining service-design and field experiments to support the development of a weather index insurance for small holder farmers in Mbale, Uganda. We investigated existing risks and their degree of severity and frequency as well as formal and informal risk coping mechanisms, including agricultural and economic diversity as well as breadth of social networks and institutions. The study demonstrated that Mbale smallholders are not a homogeneous group of “poor famers”, but instead have different income levels and diverse ways of dealing with climate shocks. The research approach allowed us to rigorously develop and test a range of appropriately designed insurance packages that were responsive to the heterogeneity of the communities with which we worked. We argue that such human-centred, transdisciplinary approaches are urgently needed to address the food insecurity and agricultural productivity challenges facing smallholder farmers in the global south.

## **Factors contributing to behavioral change among farmers of rain-fed systems in Côte d'Ivoire in a context of increased climate variability**

*Mar Moure Peña<sup>1</sup>*

*Matthias Garschagen<sup>2</sup>*

<sup>1</sup> Institute of Environment and Human Security, United Nations University, Germany

<sup>2</sup> Ludwig-Maximilians-University Munich, Germany

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In recent decades, intra- and inter-seasonal rainfall variability have increased in West African agro-ecological transition zones. In a context of structural dependency on agriculture combined with deep-rooted vulnerabilities, climate variability exerts high pressure on the livelihoods of farmers in the region, a majority of whom rely on rain-fed systems. Unable to confidently continue using the cues from the traditional rainfall calendar, farmers need to make critical decisions about planting times under increasing uncertainty. The choices farmers have to make in agriculture are complex and climate is but one variable to consider. Despite abundant research on smallholder farmers' coping and adaptive practices, knowledge gaps remain concerning the specific weight of climate-induced uncertainty in the interplay of environmental and cognitive factors which influence decision-making and the formation of habitual behavior. Using empirical evidence from two case study villages near Gagnoa, Côte d'Ivoire, this research aims to contribute to the advancement of perception studies for climate change adaptation and risk. A mixed-methods approach using focus groups, interviews and survey data was used to recreate underlying mental models of perception, beliefs and attitudes and link this to different planting behaviors. Results show that 1) higher degrees of climate-induced uncertainty are moderately associated with the continuation of planting habits rather than to the flexibility to change. 2) Other subjective and background factors such as beliefs and identity roles play a bigger role. 3) Perception of environmental changes and associated risks differs in focus and emphasis between sexes and with respect to official accounts. Despite the fact that farmers generally perceive a strong positive relationship between rainfall variability and yield loss, the salience of climate-related concerns is overshadowed by that of more immediate psychological, social and physical concerns, particularly among women. A number of policy and scientific implications are drawn, particularly relevant for planned adaptation initiatives.

## **Lean farming technologies for sustainable crop production system:**

*Swaminathan Veeramuthu Murugan<sup>1</sup>*

*Melmangalam Ramanathan Ramasubramaniyan<sup>1</sup>*

<sup>1</sup> National Agro Foundation, India

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Farming is becoming increasingly unviable due to low productivity and poor profitability. We are working especially for small and marginal holders for the sustainable crop production through lean farming technologies. This technology includes judicious combination of organic, bio and inorganic inputs without compromising on the yield potentialities as well as environmental/ecological sustainability. Conventionally farmers practice either chemical farming with high use of agrochemicals which challenges environmental safety and sustainability of ecosystem or organic farming with no chemicals which compromises on yields and economics of the farmers as well as non availability of organic inputs in sufficient quantities. We experimented and scaled these technologies with 150 Small farm holders. Lean farming technologies are operating based on three principles

1. Comprehensive soil health and fertility management including site specific nutrient for major, secondary and micronutrients as against conventional farming where focus is only on major nutrients.
2. Modified land management practices which facilitates in situ moisture conservation and improve water and land use by minimum soil disturbance and residue management to improve soil organic matter.
3. Natural and Integrated Pest Management strategies include preventive and curative methodologies.

These three principles are taught to the small holder farmer's through intensive capacity building followed by front line demonstration (FLD) using control and treatment method. In control plots, farmers follow their conventional methods to grow crops but in demo plot they are instructed to follow the principles of lean farming. The yields and cost of cultivation for both plots are compared. The results are promising with 50% reduction in cost of cultivation apart from increasing productivity up to 150% of various crops. This process innovation can be applied to any crop in all the Agro climatic zones of the world to ensure food security.

## **Participatory tools to support prioritization of sustainable intensification practices in tropical smallholder farming systems**

*Alan Duncan<sup>1,2</sup>*

*Ben Lukuyu<sup>1</sup>, Ingrid Öborn<sup>3</sup>*

<sup>1</sup> International Livestock Research Institute, Kenya

<sup>2</sup> Global Academy of Agriculture and Food Security, The Royal (Dick) School of Veterinary Studies and The Roslin Institute, University of Edinburgh, United Kingdom

<sup>3</sup> Department Crop Production Ecology, Swedish University of Agricultural Sciences, Sweden

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Smallholder mixed crop-livestock farms dominate land use in Sub-Saharan Africa and supply much of the food for the human population. Such farms are under pressure to intensify sustainably to meet growing demands for food related to rapid population growth. A range of promising sustainable intensification technologies have been identified and catalogued in the literature. Farmer adoption of technologies has been slow and much research on adoption has focused on farm/farmer characteristics. Furthermore, development actors have tended to operate in "promotion mode", persuading farmers of the merits of their preferred technologies rather than seeking to understand system constraints to technology adoption and then working with farmers to select appropriate interventions based on the suitability to the local system. Participatory tools which match technologies to local contexts are a promising means of supporting farmers in technology selection thereby increasing likelihood of adoption. We have developed two such tools. The Feed Assessment Tool (FEAST) is designed to support prioritization of livestock feed technologies. It does this through a structured set of questions which help development actors and farmers build a systematic understanding of the livestock feeding system including simple quantification of important system characteristics such as land availability, labour availability, access to inputs/credit and so on. The tool then matches a series of pre-defined intervention technologies to the local system to yield a prioritized list of promising interventions. LegumeCHOICE is a similar tool which focuses on prioritization of multi-purpose legumes (grain, fodder, tree) in smallholder systems. This tool matches a series of legume technologies to the local context in a similar fashion to FEAST. It also takes account of expressed farmer needs and matches legume species to the local biophysical conditions. Both tools have promise to enhance adoption of sustainable intensification practices in Sub-Saharan Africa.

## **The drivers of change and challenges in the evolution of tsetse and trypanosomiasis management practices in coastal Kenya**

*Arnold Musungu<sup>1</sup>*

*David Jakinda Otieno<sup>1</sup>, Beatrice Muriithi<sup>2</sup>*

<sup>1</sup> University of Nairobi, Kenya

<sup>2</sup> International Centre for Insect Physiology and Ecology, Kenya

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Animal trypanosomiasis is a major constraint to livestock production and a threat to food security in most parts of sub-Saharan Africa (SSA). Smallholder cattle producers are particularly affected because access to veterinary services is limited in most cases. While control operations for the disease and its vectors have been ongoing for over decades in the region, the disease is still endemic and continues to cause havoc to farmers. The continued threats by trypanosomiasis and its vectors imply that future policies in the management of the disease and its vectors require a detailed re-examination of the past and ongoing control practices and methods so as to identify the gaps and challenges. This paper assessed the drivers of change and challenges in the evolution of tsetse and trypanosomiasis control practices and methods in coastal Kenya using recent data from focus group discussions (FGDs). Analysis reveals that population growth, indigenous knowledge, climate change, infrastructural development, technology, private veterinary services, entry of international research organizations and devolution were the main drivers of change in the tsetse and trypanosomiasis management practices by the community. Further, farmers' indiscriminate use of drugs, proximity to national park, lack of cooperation from households who don't own any stock and failure to involve farmers in the rolling out of new control technologies were the main challenges in the current control efforts. The results from this study call for an integrated approach that accommodates various tsetse and trypanosomiasis control methods including farmers' indigenous knowledge as sustainable solution to the problems brought about by the disease.

Keywords: tsetse, animal trypanosomiasis, coastal Kenya, drivers, challenges.

## **The Sub-Saharan Africa Soil Data Manager (SSA-SDM)**

*Kristin Piikki<sup>1,2</sup>*

*Mats Söderström<sup>1,2</sup>, John Mutua<sup>1</sup>*

<sup>1</sup> International Center for Tropical Agriculture (CIAT), Kenya

<sup>2</sup> Swedish University of Agricultural Sciences, Sweden

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Site-specific crop management is recognized as a fundamental basis for sustainable intensification of crop production. To make efficient use of available agronomic inputs such as fertilizers, manure, lime, irrigation water and pesticides, decisions related to types and rates of these inputs, needs to be based on local conditions; else products may be applied –and wasted– where they are not needed, while nutrient deficiencies, water stress, suboptimal pH, weed competition and crop diseases may occur where too little is applied. The Sub-Saharan Africa Soil Data Manager (SSA-SDM) is a tool for translating food security policies into practice, by implementing methods developed in research projects and providing open data as decision support for site-specific management decisions. The system can be used at a range of scales (e.g. countries, counties, villages and fields) and is available for the SSA region. Open datasets are provided that can be used to guide additional soil testing and they can be locally adapted to become more accurate at the intended scale of use. Potential stakeholders are e.g.: i) fertilizer companies wishing to supply the right fertilizer blend to local needs (which depends on soil types/properties); ii) authorities for designing programmes for sustainable intensification, such as subsidies of lime in areas with low pH; iii) extension officers who want to generate risk maps of nutrient deficiencies in districts or regions; and iv) individual farmers or groups of farmers who want to make well founded decisions on input investments. This web-based soil information system is intended to be a platform onto which further web-based services for decision makers, and practitioners in SSA crop production can be built. It will thus work as a channel to put agronomic knowledge, research and useful datasets into practical use.

## **Translating agronomic insights for improved farm management: Experiences from co-learning with African farmers**

*Katrien Descheemaeker<sup>1</sup>*

*Wytze Marinus<sup>1</sup>, Esther Ronner<sup>1</sup>, Gatien Falconnier<sup>2</sup>, Eva Huet<sup>1</sup>, Arouna Dissa<sup>1</sup>, Myriam Adam<sup>3</sup>, Gerrie van de Ven<sup>1</sup>, Ken Giller<sup>1</sup>*

<sup>1</sup> Plant Production Systems Group, Wageningen University, The Netherlands

<sup>2</sup> CIRAD, France

<sup>3</sup> CIRAD-INERA-ICRISAT, Burkina Faso

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Agricultural research for development projects often aspire to enhance food security and livelihoods through the sustainable increase of farm production. As the intended end-users and beneficiaries, farmers are increasingly being solicited to participate and share their perspectives so that technologies and farming practices can be tailored to the farming context with better adoption as a result.

As a powerful alternative to “top-down” technology transfer, participatory approaches have both normative (e.g. farmer empowerment, capacity building) and pragmatic (e.g. adaptation to farmers’ constraints and opportunities) benefits, but may suffer from site-specificity and being time-consuming. An additional challenge lies in translating scientific findings into actionable information for farmers and, vice-versa, in incorporating farmers’ perspectives into research (re-)design and technology development. Drawing from research across East and West Africa, we describe key elements of a co-learning approach that engages with these challenges. Firstly, iterative research cycles allow reorienting and adapting research topics, experiments and models, thus evolving to a research agenda that aligns with farmers’ interests. Secondly, where research informs and is informed by multi-actor discussions, the process benefits from the complementary knowledge of stakeholders and researchers. Thirdly, common grounds (e.g. symbols or metaphors) result in shared mental models and more effective communication. We describe the emergence of co-learning from the iterative implementation of on-farm experiments and evaluation of tested technologies using shared criteria and indicators. Additionally, recurring ex-ante assessments using (simple) models allow farmers to explore potential effects of changes in farm management and farm design, before making changes in real life. Detailed monitoring of implemented on-farm changes allows the iterative evaluation and adaptation of the practices, as well as assessing the effectiveness of the approach. We reflect on the scalability of the co-learning approach on the one hand and of the developed technologies and farming practices on the other hand.

## **Urban agriculture policy workshops in Kenya's medium-sized cities: linking research to policy and practice**

*Samuel Onyango Omondi<sup>1</sup>*

*Magnus Jirström<sup>2</sup>, Diana Lee-Smith<sup>3</sup>, Willis Oluoch-Kosura<sup>1</sup>, Davinder Lamba<sup>3</sup>, Samuel Ikua Thiong'o<sup>3</sup>*

<sup>1</sup> University of Nairobi, Kenya

<sup>2</sup> Department of Human Geography, Lund University, Sweden

<sup>3</sup> Mazingira Institute, Kenya

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Agriculture is a feature of contemporary African cities that is expected to persist. In Kenya, the practice provides income/food to farming households. However, urban agriculture (UA) is often marred with risks like irrigation using untreated sewage water, unsafe handling of agricultural produce, zoonoses, and environmental pollution. Despite this, Kenya does not yet have a policy that guides and regulates the practice. However, the Nairobi City County has an Act that promotes and regulates UA.

The project aims at organising UA policy workshops in three medium-sized cities/towns in Kenya (Kisumu, Thika, Nakuru) through a collaboration between the AgriFoSe2030 programme, University of Nairobi, Mazingira Institute, and the cities/towns. The main aim is to initiate a process that would move forward development/implementation of effective UA policies in small and medium-sized towns/cities in Kenya by disseminating research findings to stakeholders. The paper will present preliminary observations from the project, which runs from February to September 2019.

Specific objectives:

1. To conduct workshops in selected counties that involve UA stakeholders, focusing on small and medium-sized towns/cities
2. To facilitate discussions on pertinent issues in UA including its benefits and risks
3. To disseminate research findings on UA to stakeholders, thereby contributing to UA policy and good practices
4. To discuss UA policy directions in the towns/cities
5. To build on the expertise of Nairobi City County in developing and trying to implement UA policy and activities

Using a food systems approach, several stakeholders will be invited to the workshops, including urban farmers, county agricultural/livestock officers, urban planners, public health officers, traders, producer/trader organisations, NGOs, service providers, and researchers. The counties concerned will participate in organising and inviting workshop participants, while other stakeholders will be consulted to assess their interest/issues they would want to be discussed. Preparatory meetings will be held with group of farmers to assess their priority issues/needs.

## **Food security and polluted soil – risks and opportunities for food production on polluted soils**

*Henrik Haller<sup>1</sup>*

<sup>1</sup> Department of Ecotechnology and Sustainable Building Engineering, Mid Sweden University, Sweden

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Global food production needs to increase by 50 % in order to ensure food security for the expected world population by 2050. Soil pollution is a serious threat to food security. Currently, at least 22 million hectares are affected by soil pollution globally and a considerable amount of the world's food supply, especially in the Global South, is grown on polluted soils. This often happens unsuspectingly and without measures to avoid that the pollutants enter the food chain. Policy and practice in terms of soil governance (e.g. legal prescriptions, regulation, market incentives, rules, norms, habits, attitudes that concern soil) typically lag behind the scientific state-of-the art for soil pollution. Although, numerous health risks are involved with growing food on polluted soil, with thorough knowledge about the planted crop's bioaccumulation and translocation patterns, efficient phytoremediation programs can be designed that give economic incentives to landowners and avoid that consumers are exposed to toxic levels of contaminants. However, food safety policies are typically not integrated with soil and water pollution management policies and many regulatory and other obstacles exist to implementing such programs. This study raises some issues that need to be considered in order to translate the scientific knowledge on pathways of human exposure and bioaccumulation patterns into policies and practices that can effectively address the soil pollution problem and avoid that it affects food security in the short and long term.

## **From marginal to mainstream: Experiences from a short course for African irrigation professional on farmer-led irrigation (development)**

*Chris De Bont<sup>1</sup>*

<sup>1</sup> Department of Human Geography, Stockholm University, Sweden

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The Studying African Farmer-led Irrigation Development (SAFI) project and its partners conducted research on farmers' irrigation initiatives in Tanzania and Mozambique from 2015–2018. At the start of the project, Farmer-Led Irrigation Development (FLI(D)) was a rather unknown academic concept referring to farmers taking the lead in establishing, expanding or improving irrigation. By the time the project ended, the World Bank had adopted FLI as a key strategy towards irrigation expansion, including an animation video, a website and a hashtag. While there was a shared interest in farmers' irrigation initiatives, the interpretation of the concept of FLI(D) was quite different. Within this context, the SAFI team organised two short courses for African irrigation engineers, policy makers and academics to introduce our vision of FLID through a message that was acceptable for an audience consisting of primarily engineers. In this presentation, I highlight the communication strategy, the training experience and the results, based on two consecutive training sessions, course evaluations and follow up questionnaires. I show how, especially in a context in which researchers from the Global North do research in the Global South, reciprocity in research and outreach is key, and how a shared interest can bridge diverging views. At the same time, I outline the challenges in doing this, and how we (partially) overcame these thanks to a research team with a variety of academic and personal backgrounds. I conclude with the impact the course had on the participants' views and professional activities – as reported by themselves – and reflect on the benefits and limitations of doing these outreach activities, both in terms of influencing policy and researchers' experiences.

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## Tenure reforms for inclusive rural development and food-security

Session leaders: Jenny Friman; Lasse Krantz; Maria Ölund, Focali and LARRI

Lecture room: K

### Session Schedule

<b>09.00-09.05</b>	<b>Introduction by the moderators</b> <i>Jenny Friman and Maria Ölund</i>
<b>09.05-10.15</b>	<b>Abstract presentations (10 min each):</b>  <b>Women as victims of land grabbing: Implications for food security and livelihoods in Cameroon</b> <i>Samuel Chenwi Chengwa</i>  <b>Land grabbing, conflict and the struggle by communities to sustain rural livelihoods in Cameroon</b> <i>Valentine Ndi</i>  <b>Questions and discussion</b>  <b>Understanding the Links between Tenure and Food Security</b> <i>Yayoi Lagerqvist</i>  <b>Sources of within and between plot variability in crop vigour and yields on rainfed, smallholder family farms in Ghana</b> <i>Ibrahim Wahab, Magnus Jirström, Ola Hall</i>  <b>Community-based land tenure reform for local development – experiences from Nampula province, Mozambique</b> <i>Margareta Espling</i>  <b>Questions and discussion</b>
<b>10.15-10.45</b>	<b>Coffee break</b>
<b>10.45-11.10</b>	<b>Forest Tenure Reforms: Perspectives on tenure security outcomes in Peru and Colombia</b> <i>Iliana Monterroso and Anne Larson</i>  <b>Questions and discussion</b>
<b>11.10-12.00</b>	<b>Introducing the open discussion: Tenure reform for inclusive rural development: what have we learnt?</b> <i>Moderated by Jenny Friman and Maria Ölund</i>
<b>11.15-11.30</b>	<b>Reflections on the held presentations and to the theme</b> <i>Anne Larson and Lasse Krantz</i>
<b>11.30-12.00</b>	<b>Open discussion on the overall theme for the session: Tenure reform for inclusive rural development - what have we learnt and where do we go from here?</b>

## **Women as victims of land grabbing: Implications for food security and livelihoods in Cameroon**

*Samuel Chenwi Chengwa<sup>1</sup>*

<sup>1</sup> University of Yaounde, Cameroon

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This paper will examine the multiple implications of land grabbing for local food production and rural livelihoods in Cameroon. It will demonstrate how land accessed by communities to grow crops and to harvest forest resources is being acquired for the development of monoculture oil palm plantations by Sithe Global Sustainable Oils Cameroon (SG-SOC). I will show how traditional cultural prescriptions have combined with contemporary statutory land laws to masculinize power over land to the detriment of woman. Using a feminist political ecology lens, I will argue that this change in land use particularly erodes women's rights to access land and forest resources, and in turn negatively affects food production and rural livelihood in the country. In addition, the paper will show how women serve as gate-keepers in ensuring local food production through subsistence and semi-subsistence agriculture but are unfortunately the main losers of territory that the state considers as 'empty' or underutilized. The paper will conclude that, rural women's active participation in the decision-making processes concerning the use of and/or allotment of land to foreign investors is indispensable in order to ensure that provisions are made for alternative farming spaces or livelihood options, particularly for those rural women facing dispossession of land and natural resources.

## **Land grabbing, conflict and the struggle by communities to sustain rural livelihoods in Cameroon**

*Valentine Ndi<sup>1</sup>*

<sup>1</sup> University of Yaounde, Cameroon

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Rural communities in the South West Region of Cameroon continue to suffer a range of political conflicts resulting from large-scale land acquisition (LSLA). The study will make use of empirical evidence to show that the quest for livelihoods that are threatened by large land acquisition projects generate an unfriendly atmosphere of inward competition for, and outward contestation of, claims to land. Land accessed by villages in the region has been acquired successfully by an agribusiness company for the production of palm oil. The study will argue that the conventional top-down approach used in acquiring land in the region ignores the voices and interests of land users, leading to conflicts. This method of acquisition implies only local power holders benefit or are likely to benefit from large land deals. I will use theories and concepts of peasant resistance [Scott, 2005, 2008; Adnan, 2007; Malseed, 2008 and others] to explain how conflicts unfold in the region. The study will submit that in order for an agro project to succeed, and to guarantee peace and stability among local communities in the South West Region of Cameroon, there is a need to invert the conventional approach to foreign land acquisition – shifting from dominance by elite interests to one that is more participatory and people-centered.

## Understanding the Links between Tenure and Food Security

Yayoi Lagerqvist<sup>1</sup>

<sup>1</sup> The University of Sydney, Australia

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Recognising one's power to access, use and manage natural resources are fundamental to improving livelihood. Scholars and development practitioners have long argued for the importance of securing tenure over natural resources. By formally recognising long-term tenure over land and forest, communities and individuals have the incentive to invest and maintain such resources. It is also considered that having a long-term tenure encourages productive use and management of natural resources. However, tenure reform alone is insufficient in guaranteeing food security. Not only is it dynamic but weak tenure security may lead to land degradation and mismanagement, thereby compromising food production and access to food. The paper reviews resource tenure reform in Laos, positioned at the heart of mountainous mainland Southeast Asia. Laos has achieved steady economic growth since the mid-1980s as the country transitioned from planned to market based economy. Tenure reform has become one of the critical political challenges in Laos, as increasing influx of private sector investment in natural resources seek to redefine and transform the country's forest and land into potential investment capital. The paper unpacks the changing society-nature relationship in Laos since the early tenure reform in the 1990s, and further explores how the government policy to "turn nature into capital" is transforming people's relationship with land and forest, especially in the upland communities where people traditionally engaged in shifting cultivation. The paper further examines how the change in tenure affects food production system and community members' access to food. The paper argues that while recognition of local tenure over land and forest is essential, it does not ensure sustainable food production and equitable access to food. The paper highlights the importance of improving our understanding on the links between tenure and food security.

## Sources of within and between plot variability in crop vigour and yields on rainfed, smallholder family farms in Ghana

Ibrahim Wahab<sup>1, 2</sup>

Magnus Jirström<sup>1</sup>, Ola Hall<sup>1</sup>

<sup>1</sup> Department of Human Geography, Lund University, Sweden

<sup>2</sup> Department of Geography and Resource Development, University of Ghana, Ghana

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Yield levels and their variability is an important strand of the literature on rainfed family farms. The present study seeks to explain the sources of yield variabilities using aerial photos of farm plots and photo-elicitation interviews in two farming communities in the Eastern Region of Ghana. The study finds significant plot yield variability in both study communities. In the more urban Asitey, yield variability is relatively higher – with coefficient of variation (CV) of 61% compared to the more rural Akatawia (CV = 46%). The main source of this observed variability is land tenure systems. Farmers' willingness to invest to maintain the fertility of their plots is not only related to rental costs and the need to exact good returns but also the extent of tenure security. Less-secured tenure implies the possibility of being ejected at a moment's notice and thus little motivation to invest. The study also finds significant within plot variability in crop vigour in both study communities, though the nature of these variability differs in important respects. While poor patches are predominantly located on the borders of plots in Akatawia, they are more random in Asitey plots. Even within Asitey, the nature of poor patches vary depending on plot location relative to the community centre as well as plot ownership structure. For instance, rented plots closer to the community centre are more intensively cultivated and so their poor patches relate to erosion and plough lines. However, on plots located further away, farmers' unwillingness to invest is due to the informal and, thus, insecure tenure. The significant within and between plot variability implies significant scope for general increases in yields both at the plot and village levels. The challenges relating to land tenure security will however need addressing to encourage farm investments.

## **Community-based land tenure reform for local development - experiences from Nampula province, Mozambique**

*Margareta Espling<sup>1</sup>*

<sup>1</sup> Unit of Human Geography, Department of Economy and Society, University of Gothenburg, Sweden

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During the 2000s, the ‘community lands’ approach has become widely supported as an approach for improving tenure security in sub-Saharan Africa, as it combines the recognition of customary tenure systems with the facility to grant state authorised land titles. Customary tenure systems are valued because they are adapted to local livelihoods and the multiple land-uses these imply. In this approach the rights to access and manage land and other natural resources are formalised at the level of the community as a collective landholding unit.

The Mozambican 1997 Land Law has been praised as one of the most progressive land legislations in Africa based on community-based land rights. As an example, the legislation provides for communities to negotiate directly with external investors.

This paper aims at discussing the Mozambican land tenure reform in practice based on the case of Nampula province, where population pressure on land is high and several national and international investors have shown great interest in accessing land for investments in large scale agriculture and mining. This paper is based on interviews with key informants and various representatives of eight communities that had had their land delimited since at least two years. Findings indicate that there are a number of aspects that seem to support, and aspects that seem to challenge, inclusive development in the studied communities. Further field work will be carried out in early August, which is expected to add further detail to the role of the community-based land tenure model in local development processes in the Mozambican context.

Keywords: Land tenure reform, community-based land tenure, Nampula Province, Mozambique

## **Forest Tenure Reforms: Perspectives on tenure security outcomes in Peru and Colombia**

*Iliana Monterroso<sup>1</sup>, Anne Larson<sup>1</sup>*

<sup>1</sup> Center for International Forestry Research, CIFOR, Peru

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Globally, communities and indigenous peoples are estimated to hold as much as 65% of the available land under customary tenure but only 18% of this land has been formally recognized either as owned or designated for the use for indigenous peoples (RRI, 2015). In sub-Saharan Africa, as much as 70% of the land can be categorized as customary common property; nonetheless, only 3% of this land is formally recognized in law (Alden-Wily 2018). In contrast, Latin America has witnessed widespread policy reform, which has changed regulations that redefined tenure rights around forest lands (Roldan, 2004). As of 2015 nearly 33% of Latin American forests were under some type of collective tenure regime owned by communities, most of which are of indigenous peoples, and another 6% was designed for their use. This portion of land represents above 60% of the global increase of forest under community ownership or control in the period of 2002–2015. This devolution process has taken place, drawing from a variety of institutional types: from collective land and territorial titling to co-management schemes and concession contracts that recognize lesser or temporary rights (RRI, 2014 and 2012; Larson et al., 2010; RRI and ITTO 2009; Sunderlin et al., 2008). Peru and Colombia have been at the forefront of countries formalizing rights to indigenous communities in forest areas under collective tenure arrangements. In Peru, since 1974 more than 2,000 communities have been titled in the Amazon over 11 million hectares, representing about 20% of the national forest area (MINAM 2016). In the case of Colombia, more than 38 million hectares has been recognized both as indigenous resguardos or Afrodescendant communities. Using results from participatory scenario exercise in both countries this presentation will discuss factors that influence differing visions on tenure security outcomes and challenges to reform implementation processes.

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## Resilient landscapes

Session leaders: Anna Tengberg, Malin Gustafsson, SIWI/SWH, Nighisty Ghezae, IFS

Lecture room: N

Session Schedule

<b>09.00-09.05</b>	<b>Welcome</b> <i>Nighisty Ghezae</i>
<b>09.05-09.15</b>	<b>Background - Water for Resilient Landscapes</b> <i>Anna Tengberg, Malin Gustafsson</i>
<b>09.15-09.30</b>	<b>Market driven afforestation – trajectories in social resilience and environmental sustainability under land-use intensification</b> <i>Erik Karlton</i>
<b>9.30-9.45</b>	<b>Do transaction costs influence farmers to sell at the farm gate or alternative markets? Evidence from smallholder rubber in Liberia</b> <i>Patrice Mirindi</i>
<b>09.45-10.00</b>	<b>Selection of native tree species for multifunctional landscapes supporting food security in agro-ecological regions of Rwanda</b> <i>Bonaventure Ntirugulirwa</i>
<b>10.00-10.15</b>	<b>Questions and discussion</b>
<b>10.15-10.30</b>	<b>Coffee break</b>
<b>10.30-10.45</b>	<b>Effects of grazing pressure on soil infiltrability and preferential flow in the dry miombo woodlands</b> <i>Lufunyo Lulandala</i>
<b>10.45-11.00</b>	<b>Effects of carbon forestry on vegetation, local livelihoods and wildfire risk in Ethiopia</b> <i>Maria Johansson</i>
<b>11.00-11.15</b>	<b>Using Agroecology &amp; Farmer Training to Build Resilient Landscapes</b> <i>Muneezay Jaffery</i>
<b>11.15-11.30</b>	<b>Locally controlled forest restoration – a governance and market-oriented approach to resilient landscapes</b> <i>Anders Malmer</i>

## **Market driven afforestation – trajectories in social resilience and environmental sustainability under land-use intensification**

*Erik Karlton<sup>1</sup>*

*Jennie Barron<sup>1</sup>, Fantaw Yimer<sup>2</sup>, Linley Chiwona-Karlton<sup>3</sup>, Asmamaw Alemu<sup>4</sup>*

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<sup>4</sup> University of Gondar, Ethiopia

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In this project, we will analyze how a rapid, market driven land-use change from agriculture to forestry currently occurring in the Amhara region in Ethiopia affects social resilience and environmental sustainability. Our aim is to identify and describe positive and negative trajectories in (i) rural household income and gender equity, (ii) agricultural production and food security, (iii) waterbalance at landscape level and downstream, (iv) carbon sequestration in biomass and soil at landscape level and (v) soil fertility and long-term sustainability of agricultural and forest production. The project combines expertise in house hold economy, gender, water and soil management from Ethiopia and Sweden. We will use qualitative and quantitative participatory methods, spatial biophysical measurements and modelling to establish current trajectories and test our hypotheses. Thereafter, we will utilize a participatory landscape scale scenario development model for an evidence based participatory process where we together with stakeholders model potential future trajectories of social resilience and production sustainability in the production landscape. Project output will be used to initiate a policy development dialogue with relevant actors. Emerging markets are becoming an important driver for future land-use change in SSA. This project will provide knowledge and method output important for evidence based policy development on resilience and sustainability.

## **Do transaction costs influence farmers to sell at the farm gate or alternative markets? Evidence from smallholder rubber in Liberia**

*Francis Mulbah<sup>1</sup>*

*Cecilia Ritho<sup>1</sup>, John Mburu<sup>1</sup>*

<sup>1</sup> Department of Agricultural Economics, University of Nairobi, Kenya

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Transaction costs and other factors have proven to be major constraints to food crops farmers' access to improve market. However, there is limited empirical evidence that the same is true for non-food crops specifically natural rubber. This study determined the effect of transaction costs and socioeconomic factors on smallholder natural rubber farmers' decisions to sell their produce at the farm-gate to itinerant traders or the alternative markets in Liberia. Cross-sectional data was collected from 200 smallholder natural rubber farmers in Gibi and Kakata districts through a multistage random sampling. A binary logistic regression model was employed to determine the choice of selling outlets used by farmers. The results indicate that the choice of selling outlets is significantly influenced by transaction costs specified as distance to the nearest market, ownership of transport means, access to market information and time taken to find potential buyers and socioeconomic variables, access to extension services and household size. The results support the hypothesis that transaction costs are the main determinants of smallholder rubber farmers' choice of selling outlets. The study recommends that policy could aim at establishing market support services in the form of market information systems and affordable means of transportation to enhance access to up to date market information on trading partners and prices.

Keywords: Liberia, natural rubber, transaction costs, farm-gate, selling outlet

## **Selection of native tree species for multifunctional landscapes supporting food security in agro-ecological regions of Rwanda**

*Bonaventure Ntirugulirwa*<sup>1</sup>

*Etienne Zibera*<sup>2</sup>, *E Bahati Ntawuhiganayo*<sup>3</sup>, *Donat Nsabimana*<sup>4</sup>, *Johan Uddling*<sup>5</sup>, and *Göran Wallin*<sup>5</sup>

<sup>1</sup> Rwanda Agriculture and Animal Resources Development Board, Rwanda

<sup>2</sup> Department of Biology, University of Rwanda, Rwanda

<sup>3</sup> World Agroforestry, Rwanda

<sup>4</sup> Department of Biology, University of Rwanda, University Avenue, Rwanda

<sup>5</sup> Department of Biological and Environmental Sciences, University of Gothenburg, Sweden

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Soil erosion, land degradation and deforestation are major environmental concerns being exacerbated by increasing population pressure. Forestry and agroforestry as a part of a multifunctional landscape can reduce these effects combined with increased provision of crop yield, fodder and other useful products for farmers as well as supporting climate change mitigation and adaptation and regional hydrology. Native tree species can potentially provide many of these ecosystem services in combination with sustained biodiversity. However, the use is hampered by the limited knowledge on management practices and suitability in different ecological regions as well as their climate sensitivity. The aim of this study was to assess native tree species suitability for plantation in different regions of Rwanda, considering also projected climate change and the multi-functionality in the agricultural landscapes. Based on studies of potential natural vegetation at different elevations and potential use, 84 plant species native to Rwanda, mainly trees, were selected. A number of traits and other characteristics of these species were analysed to identify knowledge and gaps with regard to the suitability for plantation in multi-functional landscapes and their potential climate sensitivity. Both literature and experimental data will be reported. The results from this assessment will be valuable also for native tree species selection in similar ecological zones of east and central Africa.

Keywords: food security, agroforestry, environment, native tree species

## **Effects of grazing pressure on soil infiltrability and preferential flow in the dry miombo woodlands**

*Lufunyo Lulandala*<sup>1</sup>

*Raphael Mwalyosi*<sup>2</sup>, *Gert Nyberg*<sup>1</sup>, *Catherine Masao*<sup>2</sup>, *Ulrik Ilstedt*<sup>1</sup>

<sup>1</sup> Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, Sweden

<sup>2</sup> Institute of Resource Assessment (IRA), University of Dar Es Salaam, Tanzania

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Grazing pressure is among very important factors when considering soil infiltrability and preferential flow as main pathways for underground water recharge in tropical drylands. The fact that most of the dry ecosystem communities practice livestock keeping as the main economic activity stress the importance to study its implications in relation to soil hydrological properties for the sustainability of both ecosystems and communities inhabiting them. This study was conducted in Kitulungalo Forest Reserve and its surrounding villages in Morogoro Rural District, Tanzania. The area is a Miombo vegetation zone, the surrounding communities mainly practice agriculture and some charcoal production. We adopted the hierarchical Land Degradation Surveillance Framework (LDSF) sampling and data collection protocol by establishing a sentinel site of 10 by 10 kilometres. The area was stratified such that four main land uses were identified. These are i. Forest reserve, ii. Active agricultural land, iii. Farms under fallow, iv. Forest outside the reserve. Infiltrability was estimated by using a single ring method while preferential flow parameters by blue dye tracer, followed by image analysis of the photographs. We also tested the exclusion of grazing on infiltrability both inside and outside of two 10 years old fences enclosed plots of 30 by 90 meters. Preliminary results indicate that the higher the grazing pressure, the higher the bulk density and active agricultural land was observed to have a significantly lowest bulk density ( $p$ -value = 0.0052 and 0.001 respectively). Infiltrability and carbon (tonnes per hectare) didn't show any significant difference due grazing effect. Agricultural land had higher total stained area of 817.93cm<sup>2</sup> and uniform infiltration depth of 21.9cm than any other land use while forest reserve had highest preferential flow (%) although not significant. Results from fenced plots showed a significantly higher infiltrability inside than outside of both plots ( $t = 2.50$ ,  $p = 0.012$ ).



## Effects of carbon forestry on vegetation, local livelihoods and wildfire risk in Ethiopia

Maria Ulrika Johansson<sup>1, 2</sup>

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<sup>5</sup> College of Natural Sciences, Addis Ababa University, Ethiopia

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Carbon forestry an important climate mitigation strategy and African countries have committed to restore large areas of degraded forests. Africa is “the fire continent” with large areas burnt, mostly in early-season, low-intensity anthropogenic fires in systems with long history of traditional fire management. Forest restoration maps based on climatic potential for forests neglect the ancient role of fire, and many carbon projects are allocated to land used for grazing. Forest restoration requires exclusion of fire and grazing, which may increase surface fuel loads and wildfire risk. In Ethiopia, all landscape burning is banned, but savannas and sub-alpine heathlands have been managed by fire for centuries. We did experimental exclusion of fire and grazing in wooded savanna, subalpine forests and heathlands. We quantified effects on surface fuels, biodiversity and fuel-break structure. We interviewed local landusers to discern local fire knowledge and fire history. Two-year fire exclusion in wooded savanna gave fire intensities killing shrubs but not large trees. Interviews revealed that tree-killing fires occurred in the 1970’s after a tse-tse outbreak killed livestock. In subalpine forests, grazing exclusion led to surface fuel build-up, but in 10 years fuels never cured enough to burn, but they did burn following the Rinderpest epizootic in the 1890’s. In the heathlands traditional patch burning favours biodiversity and pastoral livelihoods. A stronger enforcement of the burn-ban in a national park has over 50 years lead to loss of young stands acting as fuel breaks in the landscape, resulting in larger heathland fires. Conflicting goals and lack of compensation may lead to increased arson ignition. This in a changed climate with increased frequency of extreme fire-weather. Due to misconceptions of local fire ecology and historical landuse, climate-mitigation schemes aimed to increase carbon storage ironically instead can result in net carbon loss by increasing wildfire risk.

## Using Agroecology & Farmer Training to Build Resilient Landscapes

Muneezay Jaffery<sup>1</sup>

<sup>1</sup> Green Shoots Foundation, United Kingdom

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Presentation or Poster, Muneezay Jaffery, Operations Manager Green Shoots Foundation  
Introduce techniques Green Shoots Foundation is using in Cambodia for building resilience and also methodology for how to measure improvement in the resilience of the landscape (this includes soil/ water/ households).

These techniques include: conservation agriculture, USD 100 home garden, integrated pest management, establishing a permaculture food forest, which has trees/ shrubs (especially for composting) and other “forgotten foods” from the Khmer cuisine. The main issues farmers are facing is: lack of water/ sporadic rain/ poor quality of seeds and increased pests/ Through our work we are making a case for building resilience via sustainable diets and improved skills of farmers. On our demo-site/ training plot there is greater focus on natural farming and low-cost/ low-input technology. Our past track record has included improving the quality of a 4 Ha rice paddy via: cover crops/ bat manure and improved water management techniques. We monitored land improvement by comparing rice tonnage and also the land value appreciation. Our plan now is to include agroforestry within the rice paddy and showcase the benefits of this technique to local farmers.

In the same locale we introduced school vegetable gardens for better nutrition and environmental stewardship from a young age. A video link shows our “Garden to Plate” approach:

<https://www.youtube.com/watch?v=PokrkgSSGac>

We have now established our own Agri-Tech centre where we bring the various strands from the last six years together and focus on: horticulture training/ rainwater harvesting/ chicken raising and frog raising. The idea is to diversify activities on the land in order to achieve the highest yield without exhausting natural resources.

## **Locally controlled forest restoration – a governance and market-oriented approach to resilient landscapes**

*Thorsten Celandér<sup>1</sup>*

*Klas Bengtsson<sup>2</sup>, Lotta Samuelson<sup>3</sup>, Anna Tengberg<sup>3</sup>, Anders Malmer<sup>1</sup>*

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Forest landscapes will in the future become increasingly important in the transition from a fossil fuel-based world into a circular bio-economy. Well managed natural forests, together with small- and large-scale forest plantations, agroforestry and trees in the landscape, play an important role in climate change adaptation and mitigation, while meeting the growing global demand for wood-based products. A training program under planning focuses on the critical question: How to scale up restoration of forest landscapes while at the same time securing prosperity of local communities and sustaining ecosystem services?

We aim at promoting forest and landscape restoration (FLR) for natural forests, plantations and agroforestry depending on needs, sometimes in combination. The training is intended to improve abilities of responsible authorities and involved organizations to support value creation for local land users. Socially, economically and ecologically sustainable use, even of natural forests, can combat poverty, promote resilience, secure water supply and ensure local engagement for bringing back trees and forests in the landscape by creating tangible livelihood benefits for local people.

Scalable forest restoration and sustainable forest management requires local participation and economic viability. The unique characteristics of this program is the strong focus on good governance, water and other natural resource management, entrepreneurship, local business scenarios, product development and markets. Equally important for sustainability and scalability are multi-stakeholder participation, gender equity and fair sharing of created wealth along sustainable and competitive value chains. The program is built on the conviction that large-scale forest restoration will only happen if smallholders, communities and local entrepreneurs become active agents of change in the forest restoration process.

The program targets a wide group of participants with an interest in locally controlled forest restoration including government agencies, smallholders and local communities, forest and water managers, entrepreneurs, NGOs and forest companies (private and state controlled).

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