

International Conference on Integrated Systems Research



Integrated Systems Research for Sustainable Intensification in Smallholder Agriculture

Conference Program & Book of Abstracts

March 3-6, 2015, IITA Headquarters in Ibadan, Nigeria.

<http://humidtropics.cgiar.org/international-conference-integrated-systems/>

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PROGRAM ON
Integrated Systems
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About the Conference

Organized by the CGIAR Research Program on Integrated Systems for the Humid Tropics (Humidtropics), in collaboration with the CGIAR Research Programs on Dryland Systems (Drylands) and Aquatic Agricultural Systems (AAS), the international conference on **Integrated Systems Research for Sustainable Intensification in Smallholder Agriculture** deals with major components within systems research in agriculture. The conference provides a platform for exploring the issue of how integrated systems research contributes to development outcomes, associated both with livelihoods of smallholder farmers and maintenance of natural resources underpinning system productivity. It will enable the sharing of experiences from research undertakings on integrated systems, with an emphasis on results: data, methods and lessons learned. The conference takes place at the Conference Center of the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria, from March 3 to 6, 2015.

Theme: The Role of Systems Research in Sustainable Intensification

Conference outcomes

- Demonstrate and share experiences and evidence to the effect that Systems Approaches in agriculture research are effective and contribute to livelihoods and natural resource management
- Share methods, tools and research approaches used in Systems Research
- Explore opportunities for new partnerships in Systems Research for development
- Identify opportunities for cross-system learning, and methods to do this effectively
- Special peer-reviewed publication

Core questions

- How to move systems concepts into practice?
- How do we move to scale and impact with systems research and development?
- What is the value added of that approach? Why is Systems Research needed to achieve this?

Opening remarks

- Dr. Nteranya Sanginga, Director General, International Institute of Tropical Agriculture (IITA)
- Dr. Kwesi Atta-Krah, Director, CGIAR Research Program on Integrated Systems for the Humid Tropics (Humidtropics)
- Dr. Yemi Akinbamijo, Executive Director, Forum for Agricultural Research in Africa (FARA)
- Dr. Frank Rijsberman, Chief Executive Officer, CGIAR Consortium
- Dr. Ann Tutwiler, Director General, Bioversity International

Keynote speakers

- Prof. David W. Norman, Professor Emeritus, Kansas State University: *Historical Trajectory of Farming Systems Research: Past, Present and Future*

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- Dr. Bernard Hubert, President, Agropolis International: *Systems Thinking toward Institutional Innovation and Change*
- Cynthia McDougall, Senior Scientist, Gender & Equity Theme Leader, WorldFish and Aquatic Agricultural Systems (AAS): *Gender in Integrated Systems Research*
- Dr. Marie de Lattre-Gasquet, Senior Foresight Scientist, CGIAR Consortium: *Facilitating Changes in Complex Humid Systems: the Role of Foresight*
- Dr. Andy Hall, Agriculture Flagship, CSIRO: *Are We There Yet? The Challenge of Continuous Learning in Systems Research Practice*
- Dr. Dennis Garrity, UN Drylands Ambassador & Senior Fellow, World Agroforestry Centre (ICRAF): *Understanding African Farming Systems as a Basis for Sustainable Intensification*
- Dr. Linley Chiwona Karltun, Swedish University of Agricultural Sciences (SLU): *Systemic Nutrition Security Solutions for Transformative Change*
- Dr. Fergus Sinclair, Systems Science Leader, World Agroforestry Centre (ICRAF): *Systems Science at the Scale of Impact: Reconciling Bottom up Participation with the Production of Widely Applicable Research Outputs*

Key session topics

- Conceptual underpinnings of systems research
- Integrated systems improvement and sustainable intensification in practice:
 1. Market based intensification;
 2. Integration of crosscutting issues (nutrition, gender & equity);
 3. Integrating productivity and natural resource management;
 4. Conceptual underpinning: sustainable intensification/systems research.
- Partnerships and institutional arrangements for innovation, scaling up and impact:
 1. Performance and impact of multi-stakeholder innovation platforms;
 2. Approaches to scaling;
 3. Institutional and methodological issues in working in multi-stakeholder setting;
 4. From farm to landscape and further: integration of scales.
- Foresight in systems research for development impact
- Future directions: how to take systems research forward?

Conference Facilitator: Jurgen Hagmann

Technical Committee: Ingrid Oborn, ICRAF (Chair); Bernard Vanlauwe, IITA; Cees Leeuwis, WUR; Roberto Quiroz and Victor Mares, CIP; Richard Thomas, Drylands/ICARDA; Michael Phillips, AAS/WorldFish; Kwesi Atta-Krah and Eric Koper, Humidtropics/IITA

Collaborating CGIAR Research Programs: Drylands and AAS

Organizing Partners: IITA, ICRAF, ILRI, CIAT, Bioversity International, IWMI, CIP, AVRDC, Wageningen University, *icipe*, FARA

Organizing Secretariat: Humidtropics, IITA, Ibadan, Nigeria

Conference Program: Day 1 – March 3

8:00 CONFERENCE REGISTRATION

9:00 OPENING SESSION – Interactive opening session with presentation of the Conference Program, introduction of participants and their expectations

10:00 BREAK

10:30 OFFICIAL OPENING – Chaired by Dr. Nteranya Sanginga, Director General, IITA
Welcome Adresses:

Dr. Nteranya Sanginga, Director General, International Institute of Tropical Agriculture (IITA)

Dr. Kwesi Atta-Krah, Director, CGIAR Research Program on Integrated Systems for the Humid Tropics (Humidtropics)

Opening Adresses:

Dr. Yemi Akinbamijo, Executive Director, Forum for Agricultural Research in Africa (FARA)

Dr. Frank Rijsberman, Chief Executive Officer, CGIAR Consortium

Dr. Ann Tutwiler, Director General, Bioversity International

12:00 SESSION 2 – CONCEPTUAL UNDERPINNINGS OF SYSTEMS RESEARCH: SETTING THE SCENE

Keynote 1: Prof. David W. Norman, Professor Emeritus, Kansas State University, USA,
dnorman@ksu.edu

Historical Trajectory of Farming Systems Research: Past, Present and Future

The paper starts with a short historical review of the reasons for the initiation of farming systems/participatory approaches in non-green revolution (i.e., in more heterogeneous and less favorable production environments) areas in low-income countries. The evolution of the approach through four phases is then described along, with a brief description of some of the significant methods in which farmer participation has been sought, accessed and evaluated, that enabled/facilitated this evolutionary process. Although, over the last forty years there has been progress in making small-scale farmers much more visible in driving the agricultural research/development agenda through using the four basic stages embodied in the farming systems approach (i.e., descriptive, diagnosis, testing/evaluation and finally dissemination), much still needs to be done. This leads on to a discussion as to some of the barriers still inhibiting true farmer empowerment and why further, such empowerment is imperative, if the agricultural challenges of this century are to be addressed successfully, namely substantially increasing agricultural productivity in an ecological sustainable manner. Given the heterogeneity of the production environments and the fact that many identified improvements are likely to be incremental rather than revolutionary in nature, this will require farmers' intimate involvement in their identification, evaluation and acceptance. Discussion in the paper recognizes that there is increasing globalization/commercialization of agriculture and is predicated on the need to consider the whole farmer-research-development continuum involving multiple stakeholders (i.e., farmers, scientists, extension workers, input/output service providers and policymakers). Such a continuum has been explicitly recognized in the operational plans for the recently reformed CGIAR system. Consequently, the paper concludes with a short discussion on the potentially significant role of innovation platforms and a few words on the potential role of formal modeling.

Keywords: Farming systems research, farmer empowerment, conservation agriculture, farmer participatory approaches/techniques, innovation platforms, formal modeling

12:30 LUNCH

14:00 SESSION 2 – CONCEPTUAL UNDERPINNINGS OF SYSTEMS RESEARCH (cont'd)

Keynote 2: Dr. Bernard Hubert, President, Agropolis International,
bernard.hubert@avignon.inra.fr

Systems Thinking toward Institutional Innovation and Change

Bernard Hubert, Institut National de la recherche Agronomique, Ecole des Hautes Etudes en Sciences Sociales, Président d'Agropolis International, Montpellier, France and Ray Ison, Professor of Systems, The Open University, Milton Keynes, UK and Monash University, Melbourne, Australia

For a second-wave of engagement with Systems thinking in practice within the CGIAR to have meaning and the possibility of being effective, there will be a need to address some of the historically derived, but ever present, constraints to transformation.

Responses, to be effective, require embodied understanding and knowing i.e., the anticipatory (not predicted) possibility of creating effective performances in the face of unfolding surprise. Existing institutional arrangements and praxis continue to present obstacles that constrain systemic learning: globally, there is strong resistance to the appreciation that conservative institutional arrangements and the persistence of framing narratives that are reductionist, deterministic and highly techno-centric in regard to the innovation processes act as a major bottleneck to development effectiveness. Thus a key challenge for future studies and practice is to gain a much clearer understanding of the political economy of this conservatism and identify ways of institutionalizing systemic learning as part and parcel of the research and innovation process.

Without progress in this direction the power of science for the greater good of society will continue to be undermined. Systemic learning is required as a routine element of development investments designed to help multiple actors usefully engage in the process of innovation and change. Requisite institutional change for systemic innovation is not likely from any single initiative. When 'investing' in the establishment of Innovation Platforms incorporate a reframed 'learning project' as a central, organizational Innovation Platform (rather than a project or program) designing, managing and evaluating it at different systemic levels so as to make its facilitative role in enabling institutional innovation explicit, taking into account interdependencies, complexity, uncertainty, controversy, multiple-stake holding/perspectives, etc.

Keywords: Innovation, multi-stakeholder platforms, systems thinking, social learning

Keynote 3: Cynthia McDougall, Senior Scientist, Gender & Equity Theme Leader, WorldFish and Aquatic Agricultural Systems (AAS), C.McDougall@cgiar.org

Gender in Integrated Systems Research

This conference provides a multi-perspective opportunity to explore overarching questions relating to systems research, including that of its value-added. This keynote explores the question of the potential added value of systems research through the avenue of gender and social equity. In particular, the keynote flags the connections between gender & social equity and development research, then 'lifts the lid' on this from a systems research perspective. In doing so, it raises the issue of leverage points in the systems with which we as researchers engage, as well as issues of resilience and transformation. With regards to the latter, the keynote also raises the question of how research might spark and support gender and social equity-related transformation, and flags in particular the role of reflexivity in and through systems research.

Keywords: gender, equity, system, research, leverage points, transformation, reflexivity

Keynote 4: Dr. Marie de Lattre-Gasquet, Senior Foresight Scientist, CGIAR Consortium,
m.delattregasquet@cgiar.org

Facilitating Changes in Complex Humid Systems: the Role of Foresight

A foresight approach can contribute to intensifying sustainably cropping and livestock systems of smallholders for four reasons.

The first reason is linked to time. One the theoretical problem raised by the notion of "sustainable intensification" is the question of time implied by "sustainable". A foresight approach takes time into consideration. It pays as much attention to the past as it does to the futures, and it recognizes that changes take time but that they do not all happen at the same time. By looking at what happened in

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the past 30 or 40 years, we can think about the changes that could take place in the next thirty or forty years.

The second reason is linked to “systems”. A foresight approach is systemic. It can use tools that help understanding a complex system by breaking it up into various components, by identifying on-going processes, and by mapping the relationship between processes. The example of the foresight exercise carried out in Landes Gascogne illustrates the systemic approach and the identification of processes.

The third reason is linked to the interdisciplinary and participatory approach of systems research. Foresight takes into account the men and women that are the actors of a system. When thinking about the futures, it looks at the social system and not only the resources. Possible futures are imagined with stakeholders who discuss their point of view and anticipate together the futures. They come from different disciplines, if they are researchers, and from different institutional backgrounds. The example of Mae Salaep (Thaïlande) illustrates the construction with stakeholders.

Last, in a foresight approach, scenarios can be created using a variety of different building methods. When there is a normative scenario that presents the preferred future (for example: “sustainable intensification for smallholder agriculture”), the strategic foresight approach allows to think about the different ways (or trajectories) that will help the system to get this preferred future. One of the Agrimonde’s scenarios will illustrate this normative approach.

Keywords: foresight approach, long-term, systemic, participatory, methods

15:30 BREAK AND GROUP PHOTO

16:00 SESSION 2 – CONCEPTUAL UNDERPINNINGS OF SYSTEMS RESEARCH (cont’d)

Keynote 5: Dr. Andy Hall, Agriculture Flagship, CSIRO, Andrew.Hall@csiro.au

Are We There Yet? The Challenge of Continuous Learning in Systems Research Practice

16:30 SESSION 3 – DISCUSSION

What fundamental parameters qualify R4D as Systems Research?

What are the critical implementation challenges of Systems Research?

18:00 OPENING COCKTAIL RECEPTION

19:00 DINNER

Conference Program: Day 2 – March 4

8:30 SESSION 4 – INTEGRATED SYSTEMS IMPROVEMENT AND SUSTAINABLE INTENSIFICATION

Recap of Day 1: Implementation Challenges

Keynote 6: Dr. Dennis Garrity, UN Drylands Ambassador & Senior Fellow, ICRAF, d.garrity@cgiar.org

Understanding African Farming Systems as a Basis for Sustainable Intensification

Dennis Garrity, UN/ICRAF; John Dixon, CSE-ACIAR; Jean-Marc Boffa, ICRAF

Africa has witnessed an extraordinary rebound in economic growth over the past decade that has inspired more confidence in the continent's future. But economic growth has not created food security for the third of the population experiencing chronic or crisis-driven hunger. Most of Africa's poor are rural, and most rely largely on agriculture for their livelihoods. Improving smallholder agriculture is fundamental to overcoming the seemingly intractable problem of African poverty. But, how?

There have been some notable achievements in African agriculture during the past decade in some places, but not in many others. We need to identify, understand and build on current successes, and encourage new and innovative thinking about future pathways and opportunities. The African context is unique in its geography, agro-ecology, history, politics and culture. And it is immensely diverse. This requires new ways of organizing and governing the innovation process, from upstream research to downstream implementation. Rebuilding African agricultural research and development capacity to deal with diverse farming systems is an urgent need, in order to enable innovation that faithfully serves the needs of the majority.

The identification and resource allocation process can be enhanced by analyzing farming systems and the driving forces and interactions that shape and constrain them. The farming systems framework is especially helpful to aggregate locations with similar constraints and investment opportunities, identify common issues, and provide options for managing risk and enhancing productivity. Such an approach requires cross-disciplinary or trans-disciplinary thinking – bringing the best of socio-economic and bio-physical analysis together. It also requires a thoroughly grounded approach, allowing for scenarios and options to be elaborated and debated by the multiple stakeholders involved.

We assembled 13 multi-disciplinary teams from across the continent to analyze each major farming system. The work began with a reclassification of Africa's farming systems under the direction of an experienced advisory group. This comprehensive, forward-looking synthesis on African farming systems will be published as a full-length book in 2015, for decision makers in research and development endeavors, both public and private. We hope it can provide a stimulus to the rebuilding of the farming systems perspective as a critical input to both policy and practice in Africa's agricultural development.

Keywords: Farming systems, sustainable intensification, Africa, smallholder agriculture, agricultural development, rural poverty

Keynote 7: Dr. Linley Chiwona Karltun, Swedish University of Agricultural Sciences, Linley.Chiwona.Karltun@slu.se

Systemic Nutrition Security Solutions for Transformative Change

10:30 BREAK

11:00 SESSION 5 – THEMATIC PARALLEL SESSIONS – SUSTAINABLE INTENSIFICATION IN PRACTICE (Abstract presenters are underlined)

Theme 1: Market-Based Intensification - *Dr. Mark Lundy & Dr. Nelson Mango*

11:00 An Assessment of Collective Market Participation for Improved Income among Smallholder Farming Households: A case of Balaka Innovation Platform, Malawi

Mango N., CIAT; Clifton Makate C., Lundy M., Siziba, S., Nyikahadzoi K., Gama M., Mwale S., Oluwole F., n.mango@cgiar.org

This article concerns collective marketing which came up through Innovation platform activities as a critical element for improving income among smallholder farming households in Balaka District. Collective marketing is one of the activities that Balaka Innovation Platform has been addressing since its formation in 2009 under Sub-Saharan Africa Challenge Programme (SSA CP) led by Forum for Agricultural Research in Africa (FARA) and International Centre for Tropical Agriculture (CIAT). In order to mitigate the challenges that African countries are facing in agricultural production and marketing, FARA through Sub Saharan Africa Challenge Programme introduced Integrated Agricultural Research for Development (IAR4D) as an institutional innovation designed to promote agricultural productivity through the adoption of appropriate technologies and marketing modules. The article relies on data from a sample of 115 randomly selected farm households from Balaka Innovation Platform that have been practicing conservation agriculture in a legume-cereal farming system. Using a binary logistic regression and a potential outcomes framework, this paper examines determinants of collective market participation and its impact on smallholder farm households' income. Results indicate that the odds of participating in collective marketing by smallholder farm households in Balaka is significantly influenced by gender, education level, access to social capital through membership in farmer groups that forms the Innovation Platform, farming experience, adoption/practice of conservation agriculture and possession of assets e.g. cellphone and bicycle. Moreover results from the potential outcomes framework indicate that collective market participation impacts positively on income. This paper has thus shown that participation in multi-stakeholder innovation platform activities highly influences collective marketing which in turn impacts positively on smallholder farming households' income. We thus recommend that governments embrace Integrated Agricultural Research for Development (IAR4D) approach whose driver is multi-stakeholder Innovation Platforms as a framework to improving farmers' market participation to increase households' farm productivity and income.

Keywords: Collective Marketing, Improved Income, Innovation Platform, Balaka District, Malawi

11:20 The institutional environment of the cocoa sector in Ghana and Cote d'Ivoire, A call for greater multi-sector collaboration

Divine Foundjemi-Tita, Jason Donovan, ICRAF; Dietmar Stoian, Bioversity International; Ann Degrande, Christophe Kouame, ICRAF, D.Foundjem@cgiar.org

Many consider the institutional environment to underpin value chain performance in the agricultural sector in developing countries. However, assessments of value chains often gloss over the role of the institutional environment in determining performance, leading to a paucity of knowledge about the components of the institutional environment in relation to value chains and empirical evidence to demonstrate how these components contribute to value chain development and poverty-reduction. In this paper, we attempt to fill the gap by analyzing the institutional environment shaping the cocoa value chains in Ghana and Cote d'Ivoire. Our analysis focuses on both common and divergent goals/interests across different group of actors, differentiating between public sector actors (including government policies), private sector actors (including farmers' organizations and multinational companies) and civil society (including NGOs and certification bodies, such as Fair-trade). In this regard, the study will i) map out the critical factors and trends that we assume result from a multitude of organizations and institutions and are beyond the immediate and direct control of farmers ii) the services offered by different actors operating in the institutional environment and that could potentially add value to the development of the cocoa value chain in both countries amongst which: input supplies, market information, financial services, quality assurance and technical services and certification schemes. The relevance of analyzing the interplay between different sectors intervening in the cacao sectors of the two countries is crucial because generating

such knowledge will help to i) address the role of development partners; multinationals, farmer organizations and NGOs in the cocoa sector and ii) determine avenues and opportunities for realistic action, lobbying and policy making.

Keywords: Cocoa, stakeholders, common and divergent goals, avenues and opportunities, Ghana and Cote d'Ivoire

11:40 A Systems Perspective for Achieving Economic Growth and Livelihood Resilience: Towards a Multi-Chain Approach to Value Chain Development

Dietmar Stoian, Bioversity International; Jason Donovan, ICRAF, d.stoian@cgiar.org

Smallholder livelihoods are diversified to meet both subsistence and income needs. While diversification helps to mitigate production and commercial risks, dispersed allocation of household resources may not provide for viable pathways out of poverty. Value chain development (VCD) seeks to address resource inefficiencies and achieve economies of scale by bundling household and other assets for improved production, processing and commercialization of agricultural and forest products. VCD usually focuses on a given value chain where resource allocation and investments appear most promising. Such single-chain approaches; however, tend to ignore complex patterns of gender-specific labor division, income generation, decision making, and access to and control over resources. They also fail to account for smallholders' balancing of subsistence and market-oriented activities aimed at food security and income generation. As a result, conventional approaches to VCD may help meet certain livelihood goals but often remain short of achieving broader livelihood resilience.

This is the principal finding of a comparative analysis of 23 cases of VCD in Asia, Africa, Latin America, and the USA. Cases were chosen to ensure broad coverage across countries, crops, and types of intervention (private sector vs. public sector driven). We assessed livelihood resilience at the level of smallholder households and business viability at the level of small and medium enterprises linking them with downstream value chain actors. While several cases showed building of certain assets at smallholder household and/or enterprise level, we found little evidence for broad-based asset building that would ensure livelihood resilience and business viability as markets contract, natural disasters hit, or regulatory frameworks change.

In response to the limitations of single-chain approaches focusing on the generation of employment and income, we propose an asset-based, multi-chain approach to value chain development for increased livelihood resilience and viability of smallholder businesses. This systemic approach takes into account diverse options across a number of value chains smallholders are linked to in a given territory. It carefully balances food security and commercial risks, and allows for gender-equitable roles and access to assets in line with the different realities and needs of women, men and the youth.

12:00 Effect of Commercialization on Intensification and Productivity in Smallholder Agriculture in Central Africa

Justus Ochieng, Beatrice Knerr, Department of Development Economics, Migration and Agricultural Policy, University of Kassel; George Owuor, AERC, CMAAE program; Emily Ouma, ILRI, Ochieng.Justus1@gmail.com

Commercialization is an important driver of intensification and crop productivity. Therefore, our paper establishes whether commercialization increases intensification through fertilizer and improved seed varieties use and if it eventually increases banana and legume productivity among smallholders in Rwanda and Democratic Republic of Congo (DRC). Cross-sectional data are used in Two Stage Least Squares (2SLS) with commercialization as endogenous variable in both input and productivity models. The results indicate that commercialization has a positive effect on input use and banana and legume productivity although with contribution of human, economic and ecological factors surrounding farmers. Thus influence of commercialization cannot remain strong without complementary effect of market access and resources endowment factors specifically availability of credit, good roads and market information, land and country specific policies. The production system in the region is characterized with low input low output. In addition, the development programs such as Consortium for Improving Agriculture-based Livelihoods in Central Africa (CIALCA) and others targeting to increase crop productivity through promoting commercialization has great potential if smallholders are able to fully participate in the projects.

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This requires strengthening of commercial oriented production considering constraints faced by smallholders in the target countries.

Keywords: Commercialization, Two stage least squares, CIALCA, Rwanda, Democratic Republic of Congo

12:20 General Discussion

12:50 LUNCH

Theme 2a: Integration of Crosscutting Issues - Nutrition Sensitive Landscapes - Dr. Gina Kennedy, Dr. Jeroen Groot & Dr. Roseline Remans

11:00 Overview of Nutrition Sensitive Landscapes: approach and methods

Fabrice Declerck, Bioversity International; Roseline Remans, The Earth Institute at Columbia University; Gina Kennedy, Bioversity International; Jeroen Groot, Wageningen University; Shakuntala Thilsted, WorldFish; Natalia Estrada-Carmona, Bioversity International, corresponding author: Fabrice Declerck f.declerck@cgiar.org

Global challenges—including unsustainable food systems, environmental degradation, and the double burden of malnutrition (under-nutrition and obesity) are interconnected and require a fresh look at how people interact with their environment to fulfill the goals of food and nutrition security. Current agricultural practices are moving toward intensified monocultures, which increase grain yields in the short term, but limit dietary and biological diversity. In addition, population growth, climate change and changing consumer preferences add pressure to these vulnerable systems. A landscape focus on nutrition is called for in order to place greater focus and emphasis on building diversity and ecosystem service based approaches into meeting human dietary and nutritional needs in production landscapes. We provisionally call this the Nutrition Sensitive Landscapes approach (NSL). NSL goes beyond traditional “no harm” approaches toward one that is system and landscape based. The NSL method offers proactive management towards more sustainable diets for vulnerable populations. The approach asks: (1) what are potential synergies and trade-offs between agricultural production, the environment, and food and nutrition security in a given landscape; (2) how do human food choices and food system dynamics have an impact on ecosystem services and human health in a given landscape, and vice versa; (3) how does this relationship change over space and time as landscapes and populations transition, for example, the adoption of agricultural intensification, from subsistence to commercial agriculture, or from rural to urban settings; (4) what are landscape and food system opportunities for enhancing diversity of diets and of the ecosystem and; (5) which system interventions, dietary guidelines, institutions, and incentives can be promoted to create synergies between nutrition, livelihoods, and the environment? In collaboration with the CGIAR Research Programs (CRPs) on Agriculture for Nutrition and Health (A4NH), Aquatic Agricultural Systems (AAS), Forests, Trees and Agroforestry (FTA) and Integrated Systems for the Humid Tropics (Humidtropics), the first phase of NSL research is focusing on pilot projects in three landscapes,: (1) the Barotse floodplain in Western Zambia; (2) Northern Zambia; and (3) Western Kenya. Working in these differing landscapes demonstrates interactions between ecosystems and their populations, and differentiates context-specific factors from those that can be applied in other similar landscapes. In this session we will present the NSL approach and the methods used to assess landscape nutritional capacity and preliminary results from several of the sites where we have initiated work. We anticipate that the presentation will facilitate the use of the methodology in other sites.

Keywords: Ecosystem services, nutrition, dietary diversity, system approach, landscapes

11:20 Systems Analysis in Nutrition Sensitive Landscapes

Jeroen Groot, Stéphanie Alvarez, Carl Timler, Wim Paas, Nester Mashingaidze, Trinidad del Rio, Minke Stadler, Katrien Descheemaeker, Lummina Horlings, Inge Brouwer, Wageningen University; Gina Kennedy, Celine Termote, Jessica Raneri, Fabrice Declerck, Natalia Estrada Carmona, Bioversity International; Roseline Remans, Monica Marie Pasqualino, Columbia University; Alan Debrauw, IFPRI; Ray-Yu Yang, AVRDC; Shakuntala Thilsted, Kate Longley, Andrew Ward, Steve Cole, WorldFish; Mwansa Songe, ILRI; Busie Maziya-Dixon, IITA, jeroen.groot@wur.nl

The Nutrition Sensitive Landscapes (NSL) approach aims to explore tradeoffs and synergies between nutrition security, agricultural production, market interactions and natural resource management. It entails multi-disciplinary analyses of how women's and men's choices in land and farm management and in food acquisition and consumption patterns affect the food system, nutrition adequacy and ecosystem services. Systems analysis is one of the pillars in the NSL approach. It applies experiential learning cycles in case study sites in Zambia, Kenya and Vietnam. In these sites we describe and explain current systems, and we systematically explore windows of opportunity for sustainable redesign and innovation in landscape and farm systems for improved nutrition. Central to the methodology is a gendered participatory approach in all phases of the learning cycle. Results obtained with and for women and men in the study communities include descriptions of use of terrestrial and aquatic resources and of place and time-determined food consumption and farming practices. This has resulted in the mapping and photographing of the inherent heterogeneity and the presence of highly valued places in the landscape, which helped to create awareness and to open discussions on possible improvements in practices to enhance livelihoods. To further inform the exchanges among communities, researchers and other stakeholders, we develop "discussion support tools" that foster identification of a rich diversity in development options and perspectives, rather than single-scenario decision support tools. This participatory and integrated research effort allows formulation of narratives of sustainable food system development for improved nutrition on the basis of more detailed analysis and evaluation of adjustments in the complex reality in the case study areas.

11:40 AAS pilot studies in the Barotse floodplain, Western Zambia

Shakuntala Haraksingh Thilsted, WorldFish; Natalia Estrada, Bioversity International; Monica Marie Pasqualino, Columbia University; Trinidad del Rio, Jeroen Groot, Wageningen University; Gina Kennedy, Fabrice DeClerck, Bioversity International; Roseline Remans, Columbia University, S.Thilsted@cgiar.org

Background: In the Barotse floodplain, food availability and dietary quality are highly seasonal, with a long hunger season. Overall, diets are low in diversity, dominated by the staple, maize. Current agricultural practices are moving towards more intensified monocultures and overfishing that can provide some short-term benefits but further limit dietary diversity and contribute to land and water degradation. Improving year-round dietary diversity sustainably is a major challenge.

Approach: In three focal communities of the AAS (CGIAR Research Program on Aquatic Agricultural Systems) in the Barotse floodplain, pilot studies were carried out, through a research in development approach to identify opportunities for improving year-round consumption of micronutrient-rich foods, within sustainable landscapes. Seasonal food availability calendars, recipes for infant and young child feeding, landscape infographics and spatial mapping of nutritional functional diversity and other ecosystem services were developed, with particular reference to gender. These tools are to inform local and national knowledge exchange platforms and participatory action research on testing of nutritious foods and landscape management practices.

Results: The joint learning process between communities, local government, NGOs and AAS researchers sheds new light on nutritional opportunities and challenges in the Barotse socio-ecological system. Exploring local biological diversity for nutrition over time and space triggered demand for better management and access of local seed systems and participatory testing of multiple varieties for their nutritional and agricultural performance. Participation of both women and men in cooking demonstrations and acceptability trials of dishes made with locally available, common micronutrient-rich foods, with focus on leafy vegetables and fish inform and promote improved quality and diversity of diets. The different uses of the natural resources by women and men, for example, fishing in nearby canals and shallow waters by women and use of this fish for home consumption inform the selection and prioritisation of initiatives to increase the consumption of fish - as an animal-source food supplying multiple, essential nutrients - in women and young children. Next steps include developing and strengthening partnerships for knowledge exchange platforms on options to improve diets and participatory action research to test selected options.

12:00 Feeding habits and nutritional status of young children and their mothers in cocoa producing smallholder households of South-West Côte d'Ivoire

Edith Agbo, University Nangui Abrogoua, Abidjan Côte d'Ivoire; C. Kouame, J. Kahia, L. Diby, L. Coulibaly, ICRAF; A. Mahyao, Centre National de Recherche Agronomique, Cote d'Ivoire; K. Kehlenbeck, ICRAF, corresponding author: C. Kouame ceapadouko@yahoo.fr

In Côte d'Ivoire, cocoa production, which represents 40% of the world production, plays a major role in the country's economy contributing to 10% to the GDP and supporting more than six million farming households. However, at the same time, the major cocoa producing areas of Côte d'Ivoire revealed stunting rates of 27.1% and child mortality levels of 114‰ in 2010. A baseline survey was conducted in 38 villages with 1069 randomly selected cocoa producing smallholder households from February to March 2014 to evaluate fruit and vegetable production and dietary diversity in the South-West (one of the major cocoa production region) by applying semi-structured questionnaires, 24-hours recalls and food insecurity questionnaires. Women (1069) and their children under 59 months (1475) were also subjected to anthropometric measurements. The results revealed that dietary diversity of the surveyed population was low with 80% of women and 94% of children consuming less than 3 different food groups the day before the interview. Food groups consumed most frequently by women according to the 24-h recall were fats and oils (69.5% of respondents), white roots and tubers (53.2%) and cereals (39.1%), while nutrient-dense foods were consumed by few respondents, e.g. fruit and vegetables (16.4%), fish (10.6%) and vitamin A-rich vegetables, fruits and tubers (5.7%). However, mothers reported a more diverse diet for their children as in addition to cereals and tubers, which were consumed respectively by 41.5 and 38.7% of children, they also gave fish (32.5%) and fruit (24.5%) frequently. But, other important food groups were rarely consumed, e.g. vitamin A-rich vegetables, fruits and tubers (14.5%), eggs (11.8%) and meat (10.4%). The low dietary diversity of the surveyed children corresponded with their extremely high stunting rates (related to chronic malnutrition) of 48.7% and high levels of food insecurity (35%) of the surveyed households. The results of the survey indicate that there is need to diversify the food sources among the cocoa producers and to increase the consumption of nutrient-dense food in order to improve nutritional status and health of cocoa producing smallholder households.

Keywords: Consumption, dietary diversity, food security, 24 h-recalls, children, nutritional status

12:20 Discussion

12:30 LUNCH

Theme 3: Integrating Productivity and Natural Resource Management - Dr. Bernard Vanlauwe & Dr. Richard Thomas

11:00 Integrated systems research in the development of drylands

Richard Thomas, ICARDA, r.thomas@cgiar.org

Drylands are crucibles for many of the challenges that developing countries currently face including land degradation, deleterious aspects of climate change, limited job opportunities, increasing migration trends from rural to urban areas, social conflict and civil unrest. This unprecedented convergence of pressures mainly focuses on countries that are ill equipped to cope with them, affecting over 1 billion people. However all is not bleak as dryland populations have successfully adapted through their ingenuity and resilience ever since agriculture began. Scientific research needs to build on this resilience by conducting their studies 'in development'. This means taking a more inclusive trans-disciplinary approach alongside practitioners that include pastoralists, farmers, fishers and foresters.

The drylands systems program of the CGIAR is the largest single concentration of researchers dedicated to building on past efforts in dryland farming systems research and integrated natural resource management. It is undertaking trans-disciplinary approaches that are bottom up but policy relevant providing a credible base for sustainable land management options that include technical, financial, policy and social aspects. Its studies are in line with identified gaps and national, regional and international priorities and are especially congruent with the strategic plans of the UNCCD and its goal of achieving a land degradation neutral world as part of the efforts to develop sustainable development goals. New combinations of options need to be carefully matched with the specific

context of each location and a collation and synthesis of lessons learned from the deployment of sustainable land management options is being done as a foundation of a scaling up and out strategy. Partnerships with local communities, academic researchers, governments and the private sector represent a new way of doing business with an emphasis on reversing the "investment deserts" of drylands. Alongside investments in improving the productivity and resilience of traditional integrated crop-livestock systems the private sector has a key role to play in helping to develop and market new dryland products of high value. New information and communication technologies are being researched that involve the use of geographic information systems, remote sensing, cellular phone link ups to markets and input suppliers. These advances can help create badly needed job opportunities for women and youths.

11:20 Green Rubber: An integrated system approach for agricultural intensification and conservation in the Mekong Region

Jianchu Xu, ICRAF/Kunming Institute of Botany, CAS, J.C.Xu@cgiar.org

Competition for land between agriculture and natural habitats is increasing in the humid tropical regions of the Central Mekong. The expansion of monoculture plantations – particularly rubber – poses a major threat to habitats and species, and risks undermining local livelihoods and the rural economy through threats to ecosystem services and overdependence on commodity markets. If society wishes to reduce these threats and risks we must find ways of system diversification, sustainable intensification of farming systems, and making space for nature without compromising on food production or income generation. Doing this will require integrated system-wide approaches for the development and dissemination of technical innovations, novel institutional arrangements and practical policy support for agriculture and conservation. The most promising mechanisms to achieve these changes include: land use planning and strategic infrastructure development, agroforestry, plantation taxes, ecological buffers and corridor development, incentives such as payments for ecosystem services, and voluntary sustainability standards and certification. I will discuss practical issues and challenges for the implementation of such mechanisms, and the need to understand and anticipate likely unintended consequences.

11:40 Modeling the Impact of Sustainable Intensification on Landscapes and Livelihoods using System Dynamics

Laura Schmitt Olabisi, Robert B. Richardson, Kurt Waldman, Michigan State University, schmi420@anr.msu.edu

Taking a systems view of sustainable intensification requires identifying the dynamic linkages between agriculture, the environment, and climate change that will be affected by introducing new agricultural technologies to smallholder farmers in sub-Saharan Africa. For example, sustainable intensification may improve farmer livelihoods and reduce the need for extensification and deforestation, which could protect wildlife habitat thereby leading to positive consequences for farmers (through income from tourism), or negative consequences for farmers (through human-wildlife conflicts). On the other hand, increased on-farm productivity and farmer income may give farmers more resources to invest in expanding their farms, thereby promoting extensification, which yields more farm income and more extensification (a positive feedback loop). The ongoing Impact of Sustainable Intensification on Landscapes and Livelihoods (ISILL) project, a collaboration between researchers from Africa RISING and Michigan State University, examines these types of tradeoffs in Zambia (Eastern Province and Lusaka Province). The project uses a system dynamics modeling framework to integrate literature review, data collection, and spatial analysis to inform programming and research around agricultural-environment linkages. System dynamics modeling is a technique that has been applied since the 1960's to address complex systems problems in a very broad range of contexts. It is characterized by its incorporation of interdependence, mutual causality, and feedback. Workshops were conducted in Zambia to generate dynamic hypotheses about agriculture-environment linkages and the role of SI in the Zambia context. Using participatory system dynamics modeling we constructed a simulation model to explore systems behavior and feedback loops. Ultimately, we expect this project to identify levers of change in the linked agriculture-environment system in Zambia, and to define an integrated programming and research agenda for the future that can be applied in other economic and agro-ecological contexts.

12:00 Evaluation of Farmer's Knowledge on Vegetable Pests and Diseases and their Management Practices within Cocoa-based Farming Systems in the Humid Tropics of Cameroon

Justin Nambangia Okolle, IRAD; Victor Afari-Sefa, AVRDC; Precilia Tata Ijiang, IRAD; Francis Ajebesone Ngome, IRAD; Jean-Claude Bidogeza, AVRDC, victor.afari-sefa@worldveg.org

A household-level scoping study on crop protection practices and policies was conducted to identify policy-related and institutional constraints and implications for smallholder integration and diversification of vegetables in cocoa-based farming systems in three agro-climatic zones of Cameroon: Western Highlands (Bafoussam area), Humid Forest with mono-modal rainfall (Buea area), and Humid Forest with bimodal rainfall (Ebolowa area). Key informant and focus group interviews complemented with quantitative one-on-one structured interviews and observational assessments were employed. Cropping systems were found to be highly diversified with 87.5% of respondents cultivating vegetables under mixed cropping systems, 85% of whom were women. Climate uncertainty and the seasonality of some crops compel cocoa farmers to diversify crops, food sources and income. Tomato, cabbage, green pepper and watermelon are the preferred vegetables in Baffousam, whereas traditional vegetables such as African nightshade and amaranth dominate in Buea and Ebolowa. Of the 15 vegetables cultivated at all three study sites, more than 60% were traditional African vegetables, with insect infestation and fungal infection known to be the most critical biotic constraints. Average losses on vegetables from pests and diseases ranged from 0 to 25%, except for bitter leaf, where losses ranged from 50 to 75%. Although crop protection practices varied by type of vegetable, the most common employed method was the application of pesticides, especially on huckleberry, tomato, pepper and amaranth. The highest incidence of pesticide application was in Baffousam, with more than 60% of respondents applying it. Despite the awareness of the harmful effects of excessive pesticide application, majority of respondents, particularly in Buea, applied more than the recommended levels. More females than males applied higher than recommended pesticide doses, used banned pesticides, harvested vegetables only 2-3 days after spraying, and applied pesticides not registered for use on vegetables. More than 60% of respondents did not store pesticides in safe places. Hazardous health effects of improper pesticide application include skin irritation (27%) and a combination of skin irritation and watery eyes (21%); diarrhea is common among consumers of excessively sprayed vegetables. Successful intensification and diversification of cocoa-based systems with vegetables will require increasing awareness on safer production methods, long-term harmful effects of pesticide misuse, and strengthening the capacity of regulatory agencies responsible for preventing importation of banned pesticides and to enforce in-country control policies.

Keywords: pest management, pest control, crop protection practices, agricultural knowledge and information systems, farmers' perceptions, hazard, pesticide policy

12:20 Sustainable Intensification of Smallholder Agriculture in Northwest Vietnam: Exploring the Potential of Integrating Vegetables

To Thi Thu Ha, AVRDC/FAVRI; Pepijn Schreinemachers, Jaw-Fen Wang, AVRDC; Nguyen Thi Tan Loc, Le Thi Thuy, Le Nhu Thinh, FAVRI; Andreas Ebert, AVRDC; Narinder Dhillon, AVRDC; Ramasamy Srinivasan, Peter Hanson, Lawrence Kenyon, Ray-Yu Yang, AVRDC; [Victor Afari-Sefa](mailto:ha.to@worldveg.org), AVRDC, corresponding author: To Thi Thu Ha ha.to@worldveg.org

Northwest Vietnam has much potential in terms of natural resources, but it is the poorest region of Vietnam. Current land use is dominated by rice in lowland valleys and maize monoculture on sloping lands. Agricultural intensification, if done sustainably, could help raise the living standards of the people in the region. Vegetable production is one possible pathway of sustainable land use intensification and can be integrated with livestock and agroforestry. Commercial vegetable production only recently developed in the region and is limited to a few communes. We assessed the potential of vegetables to contribute to sustainable system intensification, income and nutrition of poor smallholder households in Northwest Vietnam. Focus group discussions were conducted in 2013 with 60 vegetable producers and consumers in Son La province, and augmented with a survey of consumers in Hanoi, the main market for vegetables. In addition, one-on-one interviews were conducted with 160 upland households not currently growing vegetables on a commercial scale in Son La and Dien Bien provinces. On-farm trials were used to test suitable technologies for

safe vegetable production. Increasing demand for vegetables in urban centers such as Hanoi, as well as the favorable climate and improved infrastructure in Son La creates opportunities for vegetable expansion in Northwest Vietnam. Focus group discussions revealed urban consumers have a perceived favorable view of produce from upland areas; they assume less agro-chemicals are applied to upland crops and consider these vegetables to be safe to eat year-round; however, field observations in communities growing vegetables showed serious problems with pests in tomatoes and the use of unsuitable cultivation methods, suggesting the need to introduce resistant varieties and technologies such as rootstock grafting and integrated pest management to ensure safe vegetable production. In the more remote areas of the region malnutrition is prevalent among ethnic Hmong households that have a lower awareness of the nutritional importance of vegetables. Most households cultivated home gardens without the necessary technical know-how, and thus produced low yields. Commercial vegetable production has low potential in these areas because of the limited market access. Training householders in home garden management, particularly during the dry season, could contribute to improved nutrition. Home garden training should be combined with nutritional education to raise awareness of the benefits of consuming vegetables for a healthy, balanced diet.

Keywords: Agricultural diversification, home-based food production, commercial vegetable production

12:40 LUNCH

Theme 4: Conceptual Underpinnings - Sustainable Intensification and Systems Research - Dr. Simon Attwood & Dr. Michael Phillips

11:00 Sustainable Intensification—Does SI offer a pathway to improved food security and wellbeing for aquatic agricultural system-dependent communities?

Simon Attwood, Bioversity International; Park, S.E., Mills, D., Phillips, M., WorldFish,
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Sustainable Intensification (SI) is garnering increasing attention as a concept and framework for simultaneously bolstering food security and better utilizing (through ecosystem services) and conserving the environment underpinning production. This burgeoning interest is expressed in rapidly increasing quantities of research outputs, numerous institutional reports, and a growing embeddedness of SI in the infrastructure of agricultural research institutions such as the CGIAR. A frequent premise of SI is that of producing more food, for more people, using fewer resources, more judiciously and effectively—little wonder that SI is so popular. However, issues have been raised about what actually constitutes SI and how mechanisms and approaches for its implementation may be put into practice.

There is also concern that SI is primarily being framed around the idea of ‘SI = >yield + <env impacts + ≈land area’, when: a) maximizing yield may not be the most pressing concern for food and nutrition security in many instances, b) sustainable intensification discourse often does not encompass social and governance landscapes, c) oft-mentioned ‘yield gaps’ should also be accompanied by the equally critical (but perhaps more insidious) ‘distribution gaps’ and ‘power balance gaps’.

Another important aspect to SI is its systemic focus; whilst SI research has to date been predominantly focused on terrestrial cropping and livestock systems, much less consideration has been given to exploring SI in systems that combine both terrestrial and aquatic production approaches (e.g. perennial cropping, annual cropping, silviculture, aquaculture, capture fisheries). Sustainably intensifying production in such aquatic agricultural systems will be a critical component of responses to addressing food security issues for the approximate 500 million people presently dependent on these systems in non-OECD countries. We explore how use of the concept of SI in aquatic agricultural systems raises the need to bridge the interface between aquatic and terrestrial production and ecological systems, and ensure the equitable and continued distribution of ecosystem services to communities.

Keywords: Aquatic agricultural systems; sustainable intensification, agro-ecology, ecosystem services

11:20 Systems-oriented approaches to harness the potential of multifunctional farms and landscapes for sustainable intensification in the humid tropics

Jeroen C.J. Groot, Wageningen University (Farming Systems Ecology Group); [Piet van Asten](#), IITA; Katrien Descheemaeker, Wageningen University (Plant Production Systems Group), corresponding author: Jeroen C.J. Groot jeroen.groot@wur.nl

Sustainable intensification aims to increase the productivity of agricultural systems in a sustainable way, by reducing pressure on ecosystems and ecological processes, by safeguarding equitable relations among societal groups (differing in gender and age, etc.), and by supporting the economic viability of farms and associated enterprises. In the social dimension, these efforts aim to contribute to nutritional status, health and overall wellbeing of households and communities in rural areas. Improving the performance of agro-ecosystems to support sustainable intensification requires a multifunctional assessment, embracing productive, ecological, economic, social and cultural facets of farming and household activities and the landscapes and communities in which these are embedded. To support processes of experiential learning and innovation, we use a goal-oriented participatory approach, which contrasts with means-oriented approaches based on direct evaluation of discrete agricultural measures and instruments at plot and farm level that are a priori labeled as sustainable. Conversely, in the goal-oriented approach, assessment is based on comparison of the multifunctional performance of a system to a set of explicit goals, made operational through a set of indicators. Goals are formulated with various stakeholders at different spatial and temporal scales and at different organizational levels. Instead of focusing on individual (optimal) solutions or small sets of scenarios, we propose the use of solution spaces as a central concept. Solution spaces show a larger and broader set of alternative agro-ecosystem configurations that differ in performance of selected indicators, and thereby allow exploring and visualizing the windows of opportunities, and trade-offs and synergies. The combination on-farm trials, household surveys, modeling analyses and participatory evaluations drive the learning cycle from which innovations can emerge.

We illustrate this approach with case studies from Africa, Asia, Latin America and Europe. Currently, the methodology is applied in action sites of Humidtropics, to integrate analyses of productivity, natural resource management, market relations and nutrition adequacy.

11:40 What works where for which farm household: estimated effects of different interventions on food availability across household distributions in East and West Africa

[Randall Ritzema](#), ILRI; Romain Frelat, ILRI/CIMMYT; Sabine Douxchamps, Silvia Silvestri, ILRI; Mariana Rufino, CIFOR; Mario Herrero, CSIRO; Ken Giller, Wageningen University; Santiago Lopez-Ridaura, CIMMYT; Mark van Wijk, ILRI, R.Ritzema@cgiar.org

The CGIAR systems research programs seek to impact the livelihoods of millions of smallholder households across the developing world. Differing economic, societal, political, and biophysical contexts cause significant variability in both food security and poverty levels across these households, and furthermore affect the way that different households would likely respond to potential interventions. In targeting research it is therefore important to not only be able to quantitatively estimate effects of proposed interventions on livelihoods, but to also understand the relative importance of those effects across distributions of households.

This paper presents findings of intervention analysis on 1800 households from research sites in 7 countries across East and West Africa. Analysis focuses on the relative effects from three potential agricultural and economic intervention scenarios against baseline conditions of food availability, as measured by changes to a simple ratio of energy from available food to energy requirements per household. Scenario results highlight the distribution of benefit across households and assist in strategizing for subsequent interventions.

Some key findings from the study are:

* Analysis of food availability ratios across distributions of households provides some indication of the relationship between livelihood strategies and relative poverty and food security in the study sites. These distributions furthermore clarify thresholds in food availability vs. household livelihood strategies, contributing important information to intervention strategy formulation.

* Increases in agricultural productivity are more likely to benefit farm households that range from nearly food-secure to well-off. The very poor and highly food-insecure benefit little.

* Improving the plight of the very poor or highly food-insecure will likely entail non-agricultural interventions, i.e. those focused on wage and labor conditions.

The ramifications of these findings are discussed, and areas for follow-on research are highlighted.

12:00 Farming system opportunities and limitations in East and Central Africa: Exploring scenarios to improve welfare and sustainable land use

John Herbert Ainembabazi, IITA-Uganda; M van Wijk, Wageningen University; L Klapwijk, Wageningen University/IITA; PMN Dontsop, IITA-Kalambo; L Jassogne, IITA-Uganda; B Ekesa, Bioversity – Uganda; B Vanlauwe, P van Asten, IITA, J.Ainembabazi@cgiar.org

Aiming to understand the sustainability of the complex farming systems, this paper examines the diversity of farming systems and their relation with welfare indicators (poverty, food and nutrition security) and sustainable land use in East and Central Africa. Farming systems emerge from dynamic diversification of livelihood strategies in response to changes in welfare target needs, resource productivity, and trade-offs between farm and off-farm opportunities. These changes are characterized by both linear and non-linear relationships. We focus on smallholder farmers in Rwanda to test two hypotheses in connection to farming systems opportunities and limitations: First, the sustainability of farming systems is determined by dynamic agricultural adaptation technologies rather than a system's transformation (subsistence → commercial systems → diversified systems). Second, the diversity in farming systems is driven by welfare targets rather than exogenous differences in agro-ecological systems. Agricultural productivity potential, market access, population density, and agricultural innovation platforms aimed at agricultural transformation are used to describe diversity of smallholder farming systems in Rwanda. We characterize the profiles of major farming systems in Rwanda; quantify the relative number of farms with and without sustainable farming systems; demonstrate the emergence of both desirable and undesirable diverse farming systems; and provide evidence linking sustainable farming systems to indicators of welfare and sustainable land use.

12:20 Hypothesis based typologies for capturing diversity

Stephanie Alvarez, Wim Paas, Wageningen University (Farming Systems Ecology); Katrien Descheemaeker, Wageningen University (Plant Production Systems); Jeroen Groot, Wageningen University (Farming Systems Ecology), corresponding author: Stephanie Alvarez stephanie.alvarez@wur.nl

In agricultural science and research for/in development, typology making has been well developed and provides a flexible methodology for capturing variability in farming systems and households. Capturing this variability is necessary to target and fit farming technologies, and to improve policies and innovations.

The typology approach proposed in this paper is to combine expert knowledge with multivariate statistics. Expert knowledge is obtained through participative approaches; the gained knowledge from participants forms the base for multivariate statistical analysis. We propose a 6-step iterative procedure for typology making that enhances (agricultural) knowledge and understanding:

1. Precisely state the objective of the typology;
2. Formulate a hypothesis on farming system diversity;
3. Identify the key variables characterizing the farming systems;
4. Design a sampling method for data collection;
5. Cluster the farming systems using multivariate statistics;
6. Compare the typology result with the hypothesis and validate the typology with local experts.

The proposed procedure allows combining the objective reproducibility of the statistical methods with the robust and grounded knowledge of experts. We tested, adapted and refined the procedure in various Africa RISING sites, where the constructed typologies now form the basis for developing better targeted technologies.

New ideas and techniques to account for gender and nutrition issues that influence farm performance and household wellbeing in typology making are important to incorporate explicitly. Also, as a spin-off from the procedure described above, appealing and easily applicable tools for

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typology making and visualization can be developed to match and improve the level of understanding of local partners such as county chiefs and extension officers.

Keywords: classification, farming systems, variability, tailoring, innovations

12:40 LUNCH

14:00 SESSION 5 – (cont'd)

Theme 2a (cont'd): Integration of Crosscutting Issues - Nutrition Sensitive Landscapes - *Dr. Gina Kennedy, Dr. Jeroen Groot & Dr. Roseline Remans*

14:00 What has our landscape to offer for community's food and nutrition security; a case of Vihiga County, Kenya

Francis Odhiambo Oduor, Celine Termote, Bioversity International, Nutrition and Marketing Program, Sub-Saharan Africa office, Nairobi Kenya, c.termote@cgiar.org

Background: With the global population expected to exceed 9 billion by 2050, the need for food to feed the growing population is paramount. This situation creates a double challenge to our economies: that of feeding its population while conserving the environment and ecosystems to ensure food production for future generations. Within the nutrition-sensitive landscapes initiative, nutritional, environmental and agricultural targets are set together and options that benefit these multiple objectives simultaneously are identified using a systems approach. The overall objective is to create synergies and minimize trade-offs between reducing malnutrition of vulnerable populations and restoring and employing ecosystem services.

Specific objectives: 1) characterize the diversity of plant and animal species within the landscape that have potential to boost diet diversity and diet quality; 2) to study actual dietary patterns and identify entry points for diversification.

Methods: The study was conducted in ten randomly selected sub-locations in Vihiga County, Western Kenya. Per sub-location, two focus group discussions (one with women, one with men) were organized to document species and varieties available at community level. Subsequently, in each sub-location 40 households with child aged 12-23 months were randomly selected. Interviews were conducted with household heads answering questions with regard to farm species diversity; and care-givers performing two non-consecutive 24h food intake recalls for themselves and the child aged 12-23 months. The food species were identified in the local language (Luhya). Voucher specimens were collected and later identified at the Kenya National Museums. Species and farm data was entered in MS Excel and analyzed using SPSS 22. Food intake recall data were entered and analyzed using Lucille software developed by Ghent University, Belgium.

Preliminary results: 400 households, with mean household size of 6.23 and a dependency ratio of 1.6 participated in the study. A total of 111 plant species were identified by the farmers in their farms, 88.6% of which are edible either as staples, fruits, vegetables or spices and condiments. The top five most popular species on the farms were maize (*Zea mays* L.), beans (*Phaseolus vulgaris* L.), bananas (*Musa* spp.), avocado (*Persea Americana* Mill.) and cowpeas (*Vigna unguiculata* (L.) Walp.). There are 45 wild plant species in the community, 59.2% of which are eaten as vegetable relish. In addition, 13 domesticated animals and 14 wild animal species were inventoried in the farms.

Keywords: Nutrition sensitive landscapes, food biodiversity, dietary diversity, farm diversity

14:20 Multifunctional assessment of nutrition-sensitive landscapes

Nester Mashingaidze, IITA/Wageningen University; Jeroen C.J. Groot, Wageningen University; Celine Termote, Bioversity International; Ray-Yu Yang, AVRDC; Jessica Raneri, Roseline Remans, Gina Kennedy, Bioversity International, N.Mashingaidze@cgiar.org

The Nutrition-Sensitive Landscapes (NSL) approach focuses on building diversity into the landscape and food system to provide multiple sources of nutrients as well as other ecosystem services that are critical for environmental and population resilience. The NSL method offers proactive management towards more sustainable diets for vulnerable populations. Case studies are undertaken in Vihiga County (Kenya) and Son La province (Vietnam) to assess the interactions and interconnectivity in agricultural production, natural resource management (NRM) and nutrition diversity. In each country, two small landscapes were selected for a spatially explicit inventory of

diet diversity and sufficiency in relation to farm productivity, market relations, ecological functions, and the availability of food resources in the landscape. The case study landscapes are contrasting in natural resource availability, farming practices and/or dominant market orientation (subsistence or commercial). The current diet and nutrition, productivity and NRM are characterized and evaluated through the use of AgroBioDiversity and IMPACT Lite survey tools at household level. The potential of new options for land-use and diet composition will be explored using the Landscape IMAGES model. Synergies and trade-offs between the functions in the landscape related to nutrition, productivity and NRM will be quantified. The outputs from this study will contribute to an increased understanding of the system and can be used to inform discussions with stakeholders in the planning process of possible interventions to increase nutrition diversity, agricultural productivity and NRM in Humidtropics action sites.

14:40 **Technical Efficiency Differences between Men and Women Farmers - A Meta-Analytic Assessment**

Justice Djokoto, Central University College, Ghana, dgameli2002@gmail.com

A plethora of empirical studies have sought to determine the effect of farm and farmer characteristics including gender on estimated technical efficiencies. However, the findings of respective studies have tended to differ markedly on conclusions, location, agricultural product, time, measurement of technical efficiency, sample size and other factors. In respect of conclusions some studies noted that men are more technically efficient than women, whilst others reported that women are more technically efficient than men. Yet, others found that there was no difference between both sexes relative to technical efficiency. Therefore, combining evidence, who are more technically efficient, men or women? What factors account for the differences? The study seeks to assess the gender differences in technical efficiency in farming, identify which gender is more technically efficient and investigate the factors that account for gender differences in technical efficiency in farming. Diverse publishers' websites and databases namely, Oxford University Press, Wiley, Taylor & Francis, Sage and Emerald among others were accessed for studies on gender effects on technical efficiency in farming. Databases accessed included EBCOHost, Google Scholar, Cab Abstract, DOAJ and AgEconsearch. Additionally, the reference list of papers dated 2013 and 2014 were searched to identify additional literature. Using the coefficient of gender in the second stage of technical efficiency model as explained variable and study as well as socio-economic characteristics as explanatory variables, regression model will be estimated. The paper is unique for four reasons. First, it will provide opportunity for a straight forward answer to the question of which gender is more technically efficient than the other based on meta-analytic methodology. Second, the identification of the factors that explain the differences will be useful for policy purposes. Third, the study presents meta-analyses of a second stage variable in the technical efficiency estimation procedure. Fourth, publication bias is explicitly accounted for in technical efficiency meta-analysis procedure.

Keywords: farmers, gender, meta-analysis, technical efficiency

15:00 **Integrating nutrition to systems research: Impact pathways and theories of change**

Nancy Johnson, 4NH/IFPRI, corresponding author: Nancy Johnson N.Johnson@cgiar.org
Presented by Roseline Remans, The Earth Institute at Columbia University

Nutrition, like gender and other IDOs, is both an outcome and a driver of other outcomes in an integrated system. This paper identifies some of the ways that nutrition affects and is affected by other elements of the systems, building on work on "agriculture-nutrition" pathways. Using the implications from the conceptual analysis, we assess whether and how nutrition is currently addressed in the impact pathways of systems and NRM CRPs. The paper concludes with some ideas about a cross-CRP research agenda in this area, illustrated with examples from the field.

15:20 General Discussion

16:00 End of session

Theme 2b: Integration of Crosscutting Issues - Gender and Equity - Dr. Anne Rietveld and Dr. Holger Kirscht

14:00 Resolving the Gender Empowerment Equation in Humidtropics

Amare Tegbaru, IITA; Paula Kantor, CIMMYT, Pakistan; Holger Kirscht, IITA; Per Hillbur, Malmö University, a.tegbaru@cgiar.org

The aim of this paper is to outline how Humidtropics can resolve the empowerment equation within this system based CGIAR Research Program (CRP). The intent is to reconcile the dualistic social and technical agenda of a CGIAR CRP with the more transformative social, economic and political objectives at the center of a desired change in social and gender relations. Drawing upon relevant theoretical, conceptual and historical material the paper outlines what it could take to close the social technical divide in order to address the empowerment objective. It emphasizes the role of innovative and socially inclusive processes in form of actor platforms with women as key players. The platforms could take the form of the neoliberal conceptual and structural frameworks of participation; stakeholder partnerships and collective action or other forms of innovative spaces based upon family/kinship and other relationships where innovation and empowerment could sit within existing spaces. The paper concludes that the empowering dimension of the Humidtropics gender project is quite distinct from the traditional gender approach within agriculture, which has been used to separate gender and development from system wide thinking. In seeking transformation of social and gender relations the approach transcends disciplines and sectors, making efforts to establish symbioses and coherence between the social and technical agenda in order to influence innovation and change as collective processes in complex systems.

Keywords: Gender, system-based research, Innovation, Agency, Empowerment

14:20 Gender relations and aquaculture technology adoption in Bangladesh: Merging the social and the technical to enable more secure livelihoods

Miranda Morgan, Afrina Choudhury, WorldFish, A.Choudhury@cgiar.org

In Bangladesh, various research and development projects target women with agricultural technologies that aim to reduce the technology adoption gap between men and women and bring about women's empowerment. In many cases, technologies are designed that accommodate the needs of women and have the potential to enhance productivity, especially of the homestead production system over which women usually have more access and control. However, a recent CCAFS & AAS funded study of two such women targeted aquaculture technologies, disseminated through two WorldFish projects (CSISA-BD and AIN), has found that technology interventions that target women alone may not necessarily enhance women's contributions to aquaculture outcomes and the benefits they derive from them. This discrepancy between expected and actual outcomes arises because women, and men, exist in a multidimensional system of gender relations which influence women's ability to: adopt technologies, gain and apply knowledge and skills to adapt them, achieve anticipated production and consumption outcomes and share equitably in their benefits. Therefore deeper multifaceted research to understand these nuanced social and power relationships is required to design technology interventions that not only provide the tools, knowledge and skills for productivity gains, but also address the underlying causes of gender inequality and unlock the potential of poor and marginalized women and men to participate in and benefit from innovation processes. Results from the study have informed a trial of a new aquaculture technology dissemination approach in two villages of CSISA-BD's Faridpur hub. The technology package has been re-designed to combine technical aquaculture training with gender consciousness raising exercises derived from HKI's Nurturing Connections manual. Families are involved from the beginning of the intervention and the training is modularized to interact with the different stages of the production cycle and address any social and gender issues that may arise as a result of applying new knowledge. Changes in production and in knowledge, attitudes and practices (both technical and social) are being monitored among participating women and their spouses through survey research methods and process documentation.

14:40 Marketing and management decisions in the dryland systems: does women voice count?

Ademonla Djalal Arinloye, Binam J.N., ICRAF-WCA; Sissoko M.M., Traore P.C.S., ICRISAT; Kalinganire A., ICRAF-WCA; Savadogo P., ICRAF-WCA/ICRISAT, a.arinloye@cgiar.org

In sub-Saharan Africa, women are major contributors to the agricultural economy, but face various constraints that limit them from achieving optimal production and agricultural development. There is a lack of scientific evidence on the decision taking and management powers of women when it comes to the issues of household income allocation, livestock and cash crops management and marketing, and water management across countries and ethnic groups in West Africa. The aim of this study was to analysis role played and place reserved for women in Mali, Nigeria, Niger and Ghana with special emphasize on who and how decisions are taking about household's non-farm activities, income allocation, livestock and cash crops management and marketing as well as water management. Data was collected from 6089 individuals from ten sites across Mali (1866), Nigeria (3448), Niger (336) and Ghana (439) through household surveys and focus group discussions. Result shows that Ghana ranks highest in women decision power on managing and marketing household (non-) agricultural products and livestock activities, followed by Niger, Mali and Nigeria respectively. Also women have very few controls in marketing decision on both cash and staple food crops in most of the four countries, except in Niger and Ghana where it was observed women controlling cash (Niger) and staple (Ghana) crops marketing. However, having control in marketing products doesn't necessarily mean that women have equal control on managing income generated from the sales. Discussions revealed that they choose the market where the crops are sold (farm-gate, village, district or urban markets), bargain the prices with the buyers and reporting but they return generated income to the male household head after transactions. The observed low women power in decision making on production factors are found to be cultural and social norms rooted. Most of these norms deny women rights beyond usufruct rights to factors such as land, animals, water usage and trees species to be planted.

Keywords: Gender, decision power, crops management, income allocation, control, West Africa

15:00 Gender Norms and Agricultural Innovation; Insights from Uganda and Nigeria

Anne Rietveld, Bioversity International; Holger Kirscht, IITA; Netsayi Mudege, CIP, a.rietveld@cgiar.org

Both Humidtropics and the CGIAR at large are acknowledging that gender norms, e.g. the roles and accepted behavior of men and women in society, influence to a large extent how innovations in agriculture and NRM are adopted. Up to date our projects generally ignore gender norms or don't understand their interactions with innovations and hereby risk reinforcing gender norms that contribute to unequal division of benefits and harmful outcomes. Although our expected outcomes and impacts usually aim at positive changes in the lives of all people we work with, we seldom try to actively challenge the gender norms which might in some cases be a prerequisite to achieve the set targets.

Current literature on gender relationships and norms are localized case studies, using different methodologies and approaches making a comparison rather difficult and typologies nearly impossible. The lack of standardized and comparable knowledge about gender norms and their relation to innovations is one major reason why we don't address gender norms in the design and conduct of our projects, let alone challenge them. The awareness of this lack of knowledge in the CGIAR system led to the launch of a global qualitative study called "Innovation and Development through Transformation of Gender Norms in Agriculture and Natural Resource Management". In this paper we present the first results from this study analyzing cases conducted in four different Humidtropics and RTB sites in Uganda (Kiboga and Mukono district) and Nigeria (Oshun and Oyo States). Data collection followed the method guide developed by Patti Petesh and a CGIAR executive committee. The guide consists of seven standardized tools including literature review, Focus Group Discussions (FGD), key-informants interviews and individual interviews per case-study. All FGDs and individual interviews were conducted with men and women separately. We focus our analysis on agricultural innovations, related to the experiences of men and women with specific innovations they identified as being used in the community in the last ten years. We

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draw conclusion on which agricultural innovations have the largest impact on gender norms and how women and men in these communities adopt the innovations.

Keywords: gender, social norms, qualitative methods, innovation

15:20 Gender integration in agricultural innovation systems: some considerations to move forward from South-South experiences

Silvia Sarapura, Ranjitha Puskur, WorldFish/AAS, S.Sarapura@cgiar.org

Efforts to integrate gender in agriculture have not been easy and in this paper the authors try to focus on institutional directions to achieve just and equitable agricultural innovation systems. The agricultural innovation framework brings the opportunity to break down traditional social and norms and relations of power that increase poverty, food insecurity and hunger. The most important innovations are those that bring about a positive change in the way smallholders and other rural poor people invest in, produce and market their products; manage their assets; organize themselves; communicate and interact with their partners to influence policies and institutions. Gender is an important component across all these elements. Agricultural innovations can take many forms (institutional, organizational, financial, technological, procedural, methodological, administrative and legal) and occur within many contexts (social, political, cultural). Innovations are also needed in the way that structures (governments, non-governmental organizations, research and finance institutions, and private enterprises) support agricultural development by lifting barriers and creating new platforms for actors' action. In order to demonstrate that agricultural innovation can occur, the authors work on two case studies, the Papa Andina Initiative (CIP) and the Research in Development Approach from the CGIAR Research Program in Aquatic Agricultural Systems (AAS) (WorldFish). Both cases demonstrate that agricultural innovation in systems is possible if measures and processes are well monitored and followed while considering social and gender aspects.

Keywords: agricultural innovation systems, gender, gender transformative change, social transformation, governance, capacity development, stakeholders, research in development, institutions, learning, scaling

15:40 General Discussion

16:10 End of session

Theme 3 (cont'd): Integrating Productivity and Natural Resource Management - Dr. Bernard Vanlauwe & Dr. Richard Thomas

14:00 Exploring options for sustainable intensification in different farming system types of four Africa RISING countries

Carl Timler, Mirja Michalscheck, Wageningen University; Charlotte Klapwijk, Nester Mashingaidze, IITA/Wageningen University; Mary Ollenburger, Wageningen University; Gatien Falconnier, Wageningen University/ICRISAT; Katja Kuivanen, Katrien Descheemaeker, Jeroen Groot, Wageningen University, carl.timler@wur.nl

Sustainable intensification is proposed as a promising way to increase the productivity of agricultural systems while reducing pressure on ecosystems, safeguarding equitable relations among societal groups, and supporting the economic viability of households, enterprises, and communities. In sub-Saharan Africa, the identification and dissemination of options for sustainable intensification is hampered by the large diversity within and between farming systems, and their complexity arising from the interactions among different farm components and external factors. This study therefore uses an integrated farming systems approach to identify and assess context-specific improvements that can then be implemented and tested on-farm to foster experiential learning and facilitate adoption.

We conducted a farming systems analysis for nine Africa RISING intervention sites across four countries, based on rapid and detailed farm characterizations, followed by model-supported diagnosis, and exploration of options for sustainable intensification. Farm diversity was described and analyzed by means of typologies and cross-site comparisons.

Identified constraints varied depending on site and farming system type, but commonly included low input availability, climatic variability, poor soil fertility, sub-optimal livestock feeding, biotic stresses,

and poor access to training and technical advice, all impairing farm productivity, returns to labor and capital inputs, income generation and food security. We investigated entry points that tackle the above constraints by exploring alternative farm configurations, technologies and practices for representative farms. By assessing potential impact of these changes on indicators beyond productivity, trade-offs were identified and assessed, for instance between profitability and household food self-sufficiency, and between nitrogen availability for crop uptake and increased nutrient losses. Taking a systems perspective during the entry point evaluation allowed differentiating potential effects on indicators at the field level versus the farm and household level. The exploration of options for specific farming system types now enables more targeted testing of promising innovations with farmers in the second project phase.

14:20 Co-developing best-best interventions and protocols for their evaluation in the field through Participatory Trials Design Workshops in Rwanda

Edmundo Barrios, Richard Coe, ICRAF (Kenya); Leon Nabahungu, Rwanda Agriculture Board (RAB); Athanase Mukuralinda, ICRAF (Rwanda); Catherine Muthuri, Fergus Sinclair, ICRAF (Kenya), E.Barrios@cgiar.org

Limited adoption of best management principles and practices is a key challenge in Rwanda agriculture. Blending local and technical knowledge is used here as a key principle to foster relevant, credible and legitimate action research. A novel methodological approach, Participatory Trials Design (ParTriDes) workshops, have proven successful to guide the co-development of best bet options by farmers representing seven communities, other relevant stakeholders and agricultural professionals to address constraints to integrated systems improvement. In the same effort, best-bet options are collectively identified and used to explore and learn some of the principles of design while producing detailed protocols that can be readily implemented on the ground. Participatory trials are designed to assess the performance of best bet options and guide the selection of best fit options for up-scaling.

The ParTriDes workshop combines learning by doing capacity building using a participatory approach to systematically identify, classify and prioritize local farmer knowledge on key system components (e.g. soil, crops, livestock and trees) and their interactions, which limit integrated system improvement. New skills and insights facilitated RAB research and extension staff, their partners and farmer communities to jointly design simple design trials, including simple indicators of performance measured by farmers that sample large variations in socio-ecological context. First generation participatory trials involving 84 farmers have been initiated to address issues of soil fertility recovery combining organic (e.g. leaf biomass) and inorganic nutrient sources, diversification of native tree components on-farm as alternative to exotic *Alnus acuminata*, and alternative sources of stakes for climbing beans.

14:40 Impacts of the Integrated Agricultural Research for Development (IAR4D) on the adoption of Natural Resources Management (NRM), Crop and Post-harvest Technologies: Evidence from the Innovation Platforms approach in West Africa

Luke Olarinde, Department of Agricultural Economics, Ladoke Akintola University of Technology; Joachim Binam, ICRAF, Mali; Adewale Adekunle, FARA; Adeolu Ayanwale, Obafemi Awolowo University; Oluwale Fatunbi, FARA, olarinde@yahoo.com

In this paper, we employ data from twelve Innovation Platforms (IPs) of the three Task Forces (TFs) making up the Kano-Katsina-Maradi Pilot Learning Site (KKM PLS) of the sub-Saharan Africa Challenge Program (SSA CP) to assess the impacts of the Integrated Agricultural Research for Development (IAR4D) on the adoption of some key crops, Natural Resources Management and post-harvest technologies.

The results of this assessment are promising across the task forces and KKM PLS. A first cut at the data suggests that there is systematic relationship between the IAR4D intervention and adoption of these key innovations, which were promoted in most cases. About 80-90 percent of the variation in the adoption of NRM observed in the PLS are as a result of the IAR4D. The IAR4D also has positive and significant impact as compared to both the clean and the conventional sites in the adoption of maize (minimum of 10 % and maximum of 90 % variations in adoption). For Soybean adoption, the IAR4D has positive significant impact only on the conventional sites (50% variation in adoption for both models of OLS without and with interaction). Further results indicate that the IAR4D recorded

positive and significant impacts on both the clean and conventional sites in the adoption of cowpea and finally, on the PLS estimates, the IAR4D has positive and significant impact on both the clean and conventional site in the adoption of post-harvest technologies. There are variations of up to 50 percent and 70 percent in the adoption of cowpea and post-harvest technologies respectively. The IAR4D recorded significant and positive impacts as compared to the clean and conventional sites in the three task forces in the adoption of maize, soybean, cowpea and post-harvest technologies. The outcomes of the adoption of the NRM, crop and post-harvest technologies via the IAR4D innovation platforms are quite commendable. In all, the findings on the impacts of the IAR4D are supporting the SSA CPs hypothesis that the IAR4D delivers more benefits to end users compared to conventional approaches (if the conventional ARD approaches have access to the same resources).

Keywords: Integrated Agricultural Research for Development (IAR4D), Kano-Katsina-Maradi Pilot, Learning Scheme, Innovation Platforms, West Africa

15:00 Yield gap assessment is a prerequisite for moving toward ecological intensification: A case study on forage maize in smallholder farmers in Alborz province of Iran

Saeid Soufizadeh, Javad Shirmohammadi, Reza Deihimfard, Jafar Kambouzia, Korous Khoshbakht, Department of Agroecology, Environmental Sciences Research Institute, Shahid Beheshti University, Iran, ssoufizadeh2004@yahoo.com

The concept of ecological intensification of agriculture highly relies on yield potential (Y_p), quantification of yield gap and identification of factors that are responsible in yield gap so that it results in maximization of crop yield, optimization of resource use and minimization of application of external inputs while keeping environment healthy. Achieving such goals needs looking at challenges of agro-ecosystems holistically rather than in isolation which could be well achieved by means of crop simulation models. The goal of the present study was to estimate forage maize yield potential and to assess its yield gap and factors underpinning it in smallholder farmers in Alborz province of Iran. Fifty farms were randomly chosen in the maize belt of the province in 2012 and were studied in terms of soil and plant characteristics through destructive samplings and management practices by means of questionnaire. Agricultural Production Systems IMulator (APSIM) was used to estimate yield potential of forage maize in the region. Yield gap was then calculated at two levels: yield gap 1, between Y_p and yield attained by farmers under best management practice; and yield gap 2, between Y_p and actual farmers yield. Results showed that there is a large yield gap for forage maize in the region so that yield gap levels of 1 and 2 corresponded to 111 and 1262 g dry matter m^{-2} , respectively. Analyzing yield gap revealed that a combination of soil, genetic and management items were responsible in such large yield gap. Among the soil characteristics studied, soil organic carbon (SOC) was less than 1% in majority of the cases which seemed far less than the optimum level required to achieve high yields. Among the reasons for low SOC, were residue burning after crop harvest and low application of animal manure. Maize LAI was one the most important factors contributed to yield gap. The study showed that planting density, planting pattern and planting date were among the factors that contributed to less than optimal LAI and should be optimized to narrow yield gap. Irrigation interval was among the management factors that were responsible in yield gap. Our analysis showed that a major fraction of yield gap could be reduced through proper agronomic management and increased soil quality so that resources use efficiency increase. Narrower yield gap means higher yield and thus more investment in sustainable intensification of agriculture which is mainly consisted of poor farmers.

Keywords: Agricultural intensification, Crop model, Smallholder agriculture, Soil quality, Yield gap

Not presented: Increasing productivity and improving livelihoods in aquatic agricultural systems: a review of interventions

Castine, S.A., WorldFish; Sonali Senaratna Sellamuttu, IWMI; Philippa Cohen, Dorothy Chandrabalan, Bioversity International; Phillips, M.J, WorldFish, s.senaratnasellamuttu@cgiar.org

Aquatic agricultural systems (AAS) are food production systems in which the productivity of freshwater or coastal ecosystems contributes significantly to total household nutrition, food security, and income in developing countries (CGIAR 2012a). However, a range of stressors, including population growth, environmental degradation, and climate change, are acting upon these systems,

threatening the livelihoods and wellbeing of millions of people. The goal of the CGIAR research program on Aquatic Agricultural Systems (referred to in this paper as “the AAS program”) is to harness the development potential of aquatic agricultural systems to improve the livelihood security and well-being of an estimated 500 million poor people who are dependent on these systems (CGIAR 2012b). The initial target countries are Bangladesh, Cambodia, the Philippines, Solomon Islands, and Zambia. The AAS program has six objectives, one of which is to increase benefits to AAS-dependent households through environmentally sustainable increases in productivity. This working paper draws lessons from the target countries through a review of productivity interventions such as modifying habitats, harnessing underutilized productive resources, improving the integration of production commodities, supporting community-based natural resource management, and genetically improving strains. In total, we reviewed 20 productivity interventions. Although there was evidence in half of the cases reviewed indicating that interventions lead to improved economic outcomes, evidence linking productivity interventions with improvements to environmental, social, and nutritional conditions in households was scarce, particularly for the most marginalized groups of people. Further, reported outcomes were generally restricted to the time and place of particular interventions, and we found few reports of sustained or broader-scale outcomes achieved via longer-term, widespread uptake of the new methods or technologies. Aquatic agricultural systems commonly operate in highly heterogeneous ecological and socioeconomic conditions, so new methods or technologies need to be delivered and adapted to different contexts. In most cases, adaptations were not reported, potentially due to the short-term nature of projects relative to the longer time frames required for new technologies and methods to be adapted and spread to other farmers. The lack of sustained use of new methodologies or technologies highlights the importance of, first, implementing simple and appropriate technologies that do not rely on enduring external assistance, and second, ensuring that projects are farmer-led to facilitate appropriate adaptations during and after project interventions. Finally, in the 20 cases reviewed, there was a lack of robust data on changes in productivity, the distribution of benefits among individuals within communities, and environmental outcomes from interventions. To reach goals of reduced poverty and improved livelihoods in aquatic agricultural systems, it is necessary to understand how and in which contexts productivity interventions lead to development outcomes. Therefore, improvements in monitoring and evaluation systems are necessary. The resulting data will help researchers and stakeholders to design and adapt new methods and approaches that take into account productivity and environmental goals, and to manage tradeoffs between different options for resource use—tradeoffs that will increasingly emerge as competition for resources continues to intensify.

15:20 General Discussion

16:00 End of session

Theme 4 (cont'd): Conceptual Underpinnings - Sustainable Intensification and Systems Research - Dr. Simon Attwood & Dr. Michael Phillips

14:00 Improving banana agro-ecosystem productivity – Lessons for integrated systems intensification

Charles Staver, Bioversity International; Pablo Siles, CIAT; Oscar Bustamante, Universidad Nacional Autónoma de Nicaragua; Nelson Castellon, Consultant, Nicaragua; Sam Mpiira, NARO/Bioversity, c.staver@cgiar.org

Bananas are often found in complex mixed cropping systems. These cropping systems have been developed by rural communities based on experimentation and accumulated observation. Scientists commonly face such situations in working with smallholder agriculture. Households have abundant daily management experience under limitations of incomplete information and resources addressing multiple livelihood objectives in their decision making. Two recent projects implemented by Bioversity with national and local partners provide insight into the contributions of integrated system intensification with such households. These projects focused on the alternatives for improvement of smallholder banana productivity and value. Banana, intercropped in multi-strata coffee agroforestry by more than a million households in Latin America, offers multiple benefits, a monthly income, a shade easy to establish and manage, and food security. Farmer experimentation groups in Peru, Nicaragua and Honduras met with scientists over three crop cycles to analyze their fields as an

agro-ecosystem and to test alternative management practices to improve banana yield and value through integrated field intensification. In Central Uganda, in spite of poor soils and high pest pressure, bananas are a primary source of food and income. Households are increasingly challenged to increase banana productivity and production for nearby markets through the use of either traditional inputs (grass mulch, crop residue and animal manure). Three farmer groups worked with scientists to develop a prototype for increased manure production from zero grazed goats fed primarily with on-farm tree and shrub fodder. Three lessons were identified. First, direct engagement of farm households through participatory approaches provides real time understanding of complexity, risk and decision making. Second, an agro-ecosystem framework offers observational and analytical tools to synchronize ecological and production processes, but these must be combined with tools which contribute to farm management as a family enterprise to not only address cost/benefit and marginal returns, but also food security, dietary diversity and gender and generational equity. Finally, small farm viability depends on the local territory as well as the larger institutional context, including social capital, ecosystem services, knowledge access, governance and innovation. Examples of each will be highlighted.

Keywords: smallholder agriculture, coffee agroforestry, crop-livestock integration

14:20 Smallholder farming systems research in the Peruvian Altiplano

Roberto Valdivia, CIRNMA/CIP; Carlos León-Velarde, Victor Mares and Roberto Quiroz, CIP, corresponding author: Roberto Quiroz r.quiroz@cgiar.org

Farming communities in the Southern Peruvian Andes are exposed to high climatic variability and new social, economic and cultural drivers that brings about a high degree of vulnerability of production and food systems and livelihoods. Due to these new drivers, compounded by climate change, farming communities are moving to a situation of increasing vulnerability and reduced resilience, which could exacerbate poverty, malnutrition and natural resources degradation. For several years CIP and its partners in the Altiplano have been working with farming communities, applying a farming systems approach which included several analytical tools, farming interventions and educational strategies to enhance productivity, nutrition and income, reduce vulnerability and increase livelihood capitals and resilience. The diverse technological, nutritional and gender-oriented interventions implemented by the project together with the training of future farmers (school students) enhanced income generation, promoted food security and increased livelihood capitals, which significantly improved by 70%, from an initial index of 0.27 to a current of 0.43. Human, social, economic, cultural, physical, political and natural livelihood capitals were analyzed and all of them changed positively in response to the project interventions. All activities of the project were highly participatory, both in their inception and implementation, which has contributed to their apparent sustainability in the post-project period. It has been estimated that the ratio of monetized investment incurred by beneficiaries and the grantee organization, expressed in USD, was 5/1; however, a critical challenge for guaranteeing long term sustainability is the design and implementation of follow-up actions to provide support to the maintenance of the momentum generated by the project by the beneficiaries and to the extension of interventions to a large number of farming families and communities. We think that among other factors, sustainability of successful adaptation could be constructed on the basis of the high participation of women and youngsters in the project and the high in kind investment made by the beneficiaries of the project.

14:40 Systems research for climate smart agriculture: an example of coffee in East-Africa

Laurence Jassogne, Piet van Asten, IITA; Peter Laderach, CIAT-Nicaragua; Godfrey Kagezi, National Coffee Research Institute of Uganda (NaCORI), l.jassogne@cgiar.org

Climate smart agricultural practices for smallholder farmers have been described as practices that 1) in the short term improve the livelihood of smallholder farmers by either increase food security, improve risk management or increase income 2) in the long term help farmers to adapt to climate change and 3) if possible contribute to climate change mitigation through reduced greenhouse gas emissions. In order to develop such practices, a systems approach is necessary. We need to understand the opportunities and constrained of such practices at plot level, but also at household level, at community landscape level and at institutional level. Those levels are also nested and links, synergies and trade-offs between those levels need to be understood. Missing one of those levels

or link between those levels can lead to complete failure of the aimed long-term impact; which is climate smart agriculture.

In order to prove that such an approach is necessary for the development of climate smart agricultural practices, results from studies on coffee based systems in East-Africa will be presented. We will show that there is no 'silver bullet' solution and that optimized packages taking into consideration the variability of farm types and contextual settings are necessary to achieve more climate-smart systems.

15:00 A Situation Analysis of Small-scale Farming Systems in West Kenya Action Site of Humidtropics

Paul L. Woomer, WKAS Officer, Humidtropics; Canon Savala, Celister Kaleha and Moses Chamwada, plwoomer@gmail.com

A study was conducted in west Kenya to characterize the farming operations and household condition among smallholder farmers. This study serves in part as a SRT 1 Situation Analysis for the West Kenya Action Site of Humidtropics but is based upon a survey conducted by the N2Africa Project in 2013. The assessment consisted of a 12-page survey among 291 randomly selected households and compiled onto a single spreadsheet with 291 rows as cases and 98 descriptors as columns. Overall summary statistics were calculated, and then stratified by three criteria; household resource endowment, agro-ecological zone and sex of household head. A farming systems diagram was inferred from these results. Overall average farm size is 0.87 ha, family size is 6.8 persons and a majority of those interviewed were household heads (68%) and women (58%). A simple parameter of resource endowment describes weighted per capita field area per household member of about 1800 m². Household income is \$466 per year; food shortfalls last 110 days per year, and households produce 819 kg cereals, 211 kg grain legumes and 74 kg root crops per year. These households raised 2.5 cattle, 1.4 goats or sheep and 13 chickens, deriving annual incomes of \$78 from animal enterprise. The 39% of households with lowest resource endowment (< 1000 m² per capita) operate on only 0.34 ha per farm, earn only \$155 per year, suffer food shortfalls of 122 days per year, and households produce 326 kg cereals and 119 kg grain legumes. Of the three agro-ecological zones within the Action Site, the Midlands offers the greatest opportunity for interventions as the Lake Victoria Basin is drier and the Upper Midlands is becoming peri-urban. Large contrasts were observed between women- and men-led households, with the former on farms 0.4 smaller, annual income \$168 less, 18 additional days of hunger per year, with these households producing 248 kg less cereals and 94 kg less grain legumes. Organic resource availability was approximately 3.3 tons per year and allocated in a variety of ways, with women allocating three-fold more manure to grain legumes and most crop residues passed through livestock. These findings compare favorably to the four key entry points independently identified for the West Kenya Action Sites; Legume Integration, Striga Elimination, Crop Diversity and Animal Enterprise, and interactions between these entry points offer promising lines of farming systems research to Humidtropics scientists.

15:20 General Discussion

16:00 End of session

16:00 BREAK

16:30 SESSION 6 – POSTER PRESENTATIONS (Poster presenters are underlined)

Brief Introduction in Plenary followed by Interactive Exhibition

Theme 1: Conceptual Underpinnings of Systems Research

1. Situational Analysis in Northern Vietnam

Nguyen Duy Phuong, Tran DucToan, SFRI; TruongQuoc Can, SRD; Nguyen Thi Tan Loc, FAFRI; Nguyen Van Son, CASRAD; Steven J. Staal, ILRI, corresponding author: Nguyen Duy Phuong ndpptn@yahoo.com Presented by Lisa Hiwasaki, ICRAF/Humidtropics.

A Situational Analysis was conducted in northwest Vietnam, with the aim of providing a broad set of evidence to inform and tailor subsequent activities of Humidtropics, and to create a common understanding among all partners of the key issues and potential areas of intervention. Some 3.5

million people from 20 different ethnic groups live in northwest Vietnam of whom 85 % live in rural areas, and 39.2 % of whom subsist under the poverty line. Social inequality between rural and urban areas is clearly reflected in the poverty/income gap (2-20 times), education levels, and access to public services etc.

Farming systems in the northwest are dominated by smallholder households growing maize, rice, sugarcane, tea, coffee, fruit trees, and specialty vegetables such as cardamom, as well as keeping of livestock. Natural and planted forests are an important feature of the landscape, providing products for ethnic minority communities and wage opportunities. The region is mountainous and often steeply sloped, with most areas above 800 m in altitude.

Key findings of the analysis were: the continued large disparity between urban and rural populations in income, education and livelihood opportunities, with is confounded by differences by ethnicity community and gender; low agricultural productivity driven by soil degradation on the sloping land caused by monocropping and intensive cultivation in addition to limited use of improved technology; relatively high, although improving, child malnutrition levels including wasting, the most severe indicator of malnutrition; low prices and constrained market access that make it difficult for many farmers to increase their market orientation and incomes; and a compounding factor is the generally poor understanding and implementation of agreed policy frameworks.

2. Implementing Visual Tools for Decision Support in Production Systems Management

Mariana Cruz, Roberto Quiroz, Roberto Valdivia, José Acosta, CIP; Haline Heidinger, University of California at Santa Barbara; Carlos Hidalgo, Luis Arroyo, Eddison Araya, Vidal Acuña, INTA, corresponding author: Mariana Cruz m.cruz@cgiar.org Presented by Victor Mares, CIP.

The use of visual representation and virtual reality in agriculture provides an intuitive way to transmit complex information. Virtual labs can be developed for virtually visiting study sites, exploring hypothetical scenarios under different conditions and implementing educational and decision support tools. In this regard, the current work explores different applications of visual tools for enhancing information transfer in production systems management. First, a case study on environmental vulnerability analysis conducted at Pacayas's watershed, located in Costa Rica, is presented. Geographic Information Systems (GIS) modeling and virtual environments are linked to facilitate decision making in potato based systems. In this case, analysis of vulnerability of the basin in terms of surface runoff, soil erosion and nutrient losses, contingent on climatic, topographic, edaphic, land uses and management factors were evaluated using the Soil and Water Assessment Tool (SWAT). Critical scenarios were simulated for climate extremes considering a hypothetical increase of the amount of rainfall and changes in land use and potato management. Second, a virtual tour to the study site of the Altagro project, in the Peruvian Altiplano area, is presented. Scenarios of before and after project's intervention were recreated in an online virtual environment. The objective was to make accessible through a friendly interface the successful results of the project. In addition, an expert system on potato management was implemented on the virtual environment to provide decision support on potato based systems in the Altiplano. Moreover, we present the application of the potato's expert system as prototype in mobile technology linking visual tools and discuss implications of this useful visualization technique. The examples shown in this work illustrate how visual tools can be useful for improving the decision support in production systems.

3. Towards integrating agriculture and energy systems for smallholders in Nigeria

Mmaduabuchukwu Mkpado, Department of Agricultural Economics and Extension, Federal University Oye-Ekiti, Nigeria; Mkpado Ndidiamaka S., Department of Psychology, University of Nigeria, Nsukka, mmaduabuchukwu.mkpado@fuoye.edu.ng

Nigerian agricultural transformation requires adaptable innovation and technology to smallholders. A number of these technologies are emerging in integration of agriculture and energy systems. The paper examined the need for integrated systems in Nigeria and pragmatic strategies that will enable the up scaling and adoption of the integrated systems. The paper presented some models using diagrams for integrating agriculture and energy systems and strategies to make them appealing and practical for adoption by smallholders. Some of the models developed by reputable institutions and examined include: fish production integrated with irrigation of biofuel plantations, integrated livestock-fish production system, integrated commercial pig-fish production system, integrated

commercial livestock-biogas-fish production system, integrated agriculture and livestock systems - cereals-legume-livestock integrated farming systems as well as organic agriculture in a high intensification system. The models are practiced in China and Philippines among others and can be adopted in Nigeria. The use of contract farming, reenergized and redesigned farm settlement scheme as well as small and medium scheme investment programme will be helpful in the implementation. The paper examined strategies and models for using contract farming, reenergized and redesigned farm settlement scheme, small and medium scheme investment programme for the implementation and adoption in Nigeria. The paper calls for research and development of these models in Nigerian context and is optimistic that Nigeria can meet her food security needs by adopting the innovative models.

Keywords: Strategies, SMEs, Integrated Fish and Crop System, Bio-fuel, Irrigation, Food Security

4. The role of multistakeholder processes in systems research for development, the Kiboga-Kyankwanzi case in the Lake Victoria Crescent Zone, Uganda

Perez Muchunguzi, IITA; Tenywa M, Makerere University; Sole A, Van Asten P, IITA; Bakadde R, Agro-Empowerment Centre; Wandera J, NGO Forum Kyankwanzi; Ebanyat P, N2Africa; Olupot G, Makerere University; Lusembo P, Mugisa I, NARO, P.Muchunguzi@cgiar.org

Humidtropics was launched in Uganda at the beginning of August 2013. Four Action Sites were selected: Kiboga-Kyankwanzi, Masaka-Rakai, Mukono-Wakiso and Luweero-Nakasaske. Out of the four Field Sites, two are already activated and operational. In these two sites, the members that attended the national launching workshop volunteered to be the conveners for their field sites meetings.

This poster deals with Kiboga and Kyankwanzi, a crop and livestock dominated area. Some of the challenges that were identified do include; soil fertility loss, climate change, deforestation, excessive use of chemicals, and insufficient marketing structures among others. Some of the new ideas included; introducing farmers to financial institutions, involving stakeholders in planning, promoting agro forestry, promoting bulking as a marketing strategy, promoting post-harvest technologies and options, establishment of user demonstrations, encouraging co-funding by the stakeholders to improve sustainability, putting in place research and farmer linkages, as well as having means to exchange nutritional related information.

After six months of consultations with local government and other local actors, a platform was established covering Kiboga-Kyankwanzi districts. Multi stakeholders have been engaged in establishing their area based challenges and means to address them and thus increasing ownership of the program and related processes. In the crop dominated zone the system entry theme selected was: maize value chain with soybean in a rotation to feed livestock (pigs and/or chicken) with manure used to improve banana- agro forestry system. In the livestock dominated area emphasis is on improved productivity and profitability of the dairy cows.

Researchers are one of the stakeholders that are addressing the raised issues in an incremental manner. IITA in partnership with Makerere and N2Africa established maize soybean demonstrations fields that are looking at four pathways: farmers for feeding and market, schools for school feeding programs and private sector through making of feeds to link with the livestock and poultry component. Lessons learnt include the role of local administration and the fact that building incentives for private sector in a systems approach can take some time.

5. Determinants of Farmers' Choice of Crop Enterprise in the Floodplain Farming in Akwa Ibom State, Nigeria

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This study was carried out to evaluate the determinants of farmer's choice of crop enterprise in the floodplain areas of Akwa Ibom State, Nigeria. The objective was to determine the factors influencing farmers' choice of crop enterprise in the study area. A simple random sampling technique was adopted to select 340 respondents. Descriptive statistics and logistic probability models were the analytical techniques used. The result shows that 35% of respondents were in the age group of 31-40 years, only 1.2 % of them were between 15- 20 years. The mean age of farmers was 40 years. Women dominated the farming population with 56.5%, majority of the farmers 50.3% had 1- 5 persons. The result also indicated that majority of the respondents 33.8% had primary school

certificate. 42.9% of the respondents cultivated farm size of less than 0.4 hectare of farm land. The result indicates that farmers' age, gender, years of formal education and farming experience were significant determinants of choice of enterprises among the farmers surveyed in the study area. The null hypothesis (Ho1), which stated that socio-economic variables had no significant influence on farmers' choice of crop enterprises in the floodplain farm land of Akwa Ibom State was rejected. Therefore, we conclude that the decision to choose any of the two crop enterprises in the floodplain area were highly influenced by the variables mentioned above. The study recommends that training programmes on floodplain farming activities should be organized to improve farmers' choice making ability.

Keywords: Determinants, Farmers' Choice, Crop Enterprises, Floodplain, Akwa Ibom State, Nigeria

6. Determinants of output of crops and farmland management practices among smallholder farmers in Ikwuano Local Government Area, Abia State, Nigeria

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The study was conducted in Ikwuano Local Government Area (L.G.A) of Abia State. Seventy (70) farmers were randomly selected from the selected villages in Oboro Autonomous Community. Primary data was collected through the use of well-structured questionnaire and personal interviews. Data collected were analyzed using descriptive statistical and econometric tools. The study showed that farmers in the study area are young, energetic and able to adopt innovations with respect to farm management practices. More so, majority of the respondents are small-scale farmers with large family size having experience in farming activities. In addition, majority of the respondents are low-income earners that do not have access to capital. Majority (90%) of the respondents engaged in shifting cultivation followed closely by use of animal wastes (84%) and mixed cropping (78%). The use of more environmentally friendly inputs and management practices such as animal wastes; tree planting, mixed cropping is encouraged. This would assist in improving output of crops and reduce the effects of climate change on farm crops and farmland. Access to capital, education, household size, income and age were significant variables related to farm management practices. Inadequate land, lack of finance, high cost of farm inputs, pest and disease are the major constraints facing them on the use of farm management practices. Respondents should maximize the benefits of their large household size in order to reduce the cost on hired labor and to arrive at common decisions especially on farm management practices used, and on output of crops. Government should collaborate with agroforestry-based organizations to put in place price mechanism in order to reduce the cost of variable inputs. Similarly, Government should encourage relevant monetary institutions to put in place measures that will reduce lending rates and promotion of agro based cooperatives among farmers.

Keywords: farmland management practices, smallholder farmers

7. Develop a multidisciplinary-based approach to implement ecological intensification: the example of ponds fish-farming system

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The last few decades have shown high growth in global fish farming. Many conflicts arise due to competition for resource accesses and the place and roles of fish farming are regularly discussed within territories. Therefore, it is necessary to reconsider the development of fish farming in the context of a growing human population on a planet with limited resources, but also in relation to territorial issues. Within the framework of the ANR-PISCEnLIT project we aimed to adapt to aquaculture, the concept of ecologically intensive agriculture. This approach offers options to re-design aquaculture systems using biophysical and social mechanisms.

Our approach defines the ecological intensification of aquaculture as a process that considers agroecological principles, ecosystemic services supplied by the aquaculture ecosystem, and issues

facing different types of aquaculture worldwide. In a first step, we built an expanded framework to define the aquaculture ecosystem combining various ecosystem and territorial levels. Then, we performed biophysical and ecological assessments coupled with the analysis of the regional stakeholders and social perceptions of ecosystem services. Using the result of the first step, we used participatory approach to co-construct various scenarios of ecological intensification new practices with stakeholders and performed experiments with the selected practices. We implemented this approach into six regions selected to cover a variety of socio-ecological contexts in France, Brazil and Indonesia.

The project generated different levels of results. At a generic level, we proposed a general definition of ecological intensification of aquaculture. We then identified seven objectives to guide the adoption and the implementation of ecological intensification. Therefore, we proposed a set of indicators to monitor its application. At the site level, experiments showed the environmental and economic potential of practices based on nutrient recycling, the association of fish and/or plant species, and we proposed new production systems. Through learning processes during the various interactions with the stakeholders, the project also helped to modify the perception of the roles of aquaculture at the territorial level.

8. A comparison of farm typology approaches in northern Ghana

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Acknowledging the complex, multi-faceted nature of smallholder farming systems is a pre-requisite to successfully promoting activities leading towards sustainable intensification. Typologies are used as tools for navigating and making sense of farming system diversity by the Africa RISING project (Research in Sustainable Intensification for the Next Generation). This is achieved by classifying farms into groups according to their structural and functional features. The resulting 'farm types' may then be considered to constitute 'recommendation domains', to which project support may be targeted, thus maximizing the efficiency and scalability of interventions. Such a grouping exercise may be performed using various methods, depending on the purpose of the research and the underlying theoretical approach. Where quantitative techniques can provide reproducible and generalizable results, qualitative methods provide greater depth of understanding and are useful for contextualizing heterogeneity within the rural landscape. Because it is important that typologies meet the standards of science in which accuracy and objectivity are central, as well as the standards of project outcomes, which are dependent on the different needs and perceptions of stakeholders, assessing the value and (non-) complementarity of typology approaches is a vital step in ensuring that future work in the field remains both reliable and relevant. Therefore, this study aims to compare approaches to typifying the diversity of smallholder farming systems in northern Ghana, drawing on the results of an etic, researcher-defined classification and an emic, farmer-defined classification. The former was developed for Africa RISING 'intervention communities' in Ghana's Northern Region. The types were statistically generated using multivariate analysis, based on selected variables extracted from recent (2013) survey data. Results suggest six clusters, with farmers categorized on the basis of resource endowment and production strategies among other factors. The resulting farm types were validated in the field and compared to a second typology developed through joint analysis with local farmers. Participatory methods were used to ensure that the sense-making process was grounded in the perceptions and interests of the farmers and the resulting categories of farmers a recognizable reflection of local reality.

Keywords: farming systems analysis, heterogeneity, diversity, participatory research, hierarchical clustering

Theme 2: Sustainable Intensification

9. Farm-level assessment of an agroforestry system in family agriculture in northern Nicaragua

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The Quesungual Slash and Mulch Agroforestry System (QSMAS) is a promoted production system to increase agricultural and ecosystem production and diversity, while mitigating climate change, limiting land degradation and improving water efficiency in drought-prone hillsides in Central America. The system was consolidated in the early 1990s in close collaboration with farmers and technicians from FAO and other institutions, as an alternative to traditional and widespread slash and burn agriculture, which contributes to emissions of above and belowground Carbon, as well as to degrade land by erosion and fertility depletion. QSMAS consists of four main principles: i) No slash and burn: partial, selective, and progressive management of natural vegetation; ii) Permanent soil cover; iii) Minimal disturbance of soil; and iv) Efficient use of fertilizers. In this study, we analyze the potential impact of using QSMAS on agricultural productivity, nutrient balances, soil processes and income at farm-level in three farming systems in northern Nicaragua. Moreover we explore the effect of different farm configurations on these indicators by using a multi-optimization modeling parameterized combining on-farm experiments and socio-economic surveys. Our analysis shows that this system improved the yields of maize and beans; it also increased the income for the farmer, through secondary income obtained from selling wood, and reduced the erosion. We conclude that despite the benefits of QSMAS more studies must be carried out to understand the sustainability of trees after some years of slash and prune, and how QSMAS can be used with other crops.

10. Incorporating household dietary and nutritional needs in quantitative farming systems analysis

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Good nutrition is essential for human survival, development, health and wellbeing. Still a large proportion of global population is currently suffering from a lack of calories and/or (micro-) nutrients in their diets. The adequacy of diets of women and children being the vulnerable groups, depends both on within-household processes, priorities and food habits and on the supply of foods from agricultural systems, landscapes and markets. This complexity with multiple components and interactions warrants a systems approach to better match food supply and demand for improved nutrition. This research investigates different options for integrating knowledge from these originally very separate research fields. A conceptual framework of agriculture-nutrition linkages is constructed based on a systematic literature review showing the complexity of pathways from agricultural production to nutrition within a household. Several options for integration of a household nutrition component in farming systems analysis are identified, differing in level of complexity, such as simple nutrient- or more complex dietary pattern-based approaches, or proxies like dietary diversity indicators. The resulting integrative module for nutrition analysis is of intermediate complexity, but is flexible to enable adjustment to case-specific demands, and is able to use inputs from existing more detailed models and approaches for either diet formulation (e.g., including food habits, portion sizes) or farm configuration (e.g., cropping patterns, livestock management). The module is currently tested in case studies of the Nutrition-Sensitive-Landscape approach in Humidtropics action sites in Kenya and Vietnam.

11. Towards integrated analysis of gender relations in farming systems analysis

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Gender sensitivity in agricultural research and development is considered to be crucial for effectively contributing to gender equity, but also for improving the effectiveness of agricultural

interventions in terms of poverty alleviation and improvement of household nutrition. Yet farming systems research often neglects the analysis of gender relations even when working in the context of smallholder households. More than 30 years of research have repeatedly revealed that women hold an important role in smallholder agricultural production. In many cases, women contribute the bigger part of agricultural labor and are responsible for certain domains of production on which they have special local knowledge. Their responsibility for household nutrition has often been emphasized. Yet, because farming systems analysis and the modeling tools used for it often focus only on biophysical and economic data, women's special needs, preferences and constraints are not considered when innovations for the design or improvement of farming systems are developed. Therefore it is the aim of this study to integrate the analysis of gender relations in farming systems research.

The study focuses on the conceptualization, i.e. the identification of relevant gender issues and their causal relations based on literature review and expert interviews. This information was used to identify possible extensions or changes to whole farm models. So far, the inclusion of sex-disaggregated labor profiles as well as separate household units by gender seems promising. The conceptual part of the study was complemented by a two week pilot study in the Eastern Province of Zambia, location to the 'Sustainable intensification of maize-legume-livestock integrated farming systems in Eastern and Southern Africa' (SIMLESA) project, led by the International Institute on Tropical Agriculture and one of the three regional projects of the Africa RISING program (Africa Research in Sustainable Intensification for the Next Generation). Interviews with female farmers were conducted to complement detailed household characterizations performed with data on female labor burdens and intra household decision-making. These data will be used to test possible extensions for whole-farm models.

12. Increasing and stabilizing yields by ecological intensification of rice production systems on a gradient of complexity

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Co-cultures of plant and animal species combined with application of organic resources like manures and compost can support ecological processes of nutrient cycling and pest control in farming systems. This increasing complexity and application of traditional, local practices to design ecologically intensive systems may lead to higher and more stable yields even under more variable and extreme weather conditions. We conducted two experiments on East Java, Indonesia, to investigate the effects of enhancing the complexity of rice production systems by adding combinations of compost, (green) manures, azolla, ducks and fish on rice grain yields. Moreover, we investigated the processes governing nutrient cycling (water and nutrient flows) and pest and weed suppression by fish and duck activities. In both experiments, the increasing gradient of complexity resulted in increased grain yields and revenues. We found that the balance between the components was sometimes difficult to maintain. Nevertheless, the addition of azolla, duck and fish increased plant nutrient content, tillering and leaf area expansion, and strongly reduced the density of six different pests. In the most complex system comprising all components the highest grain yield was obtained, equaling or even exceeding the productivity of conventional rice production systems with artificial fertilizers and pesticide application. If smallholders can be trained, for instance in farmer field schools, to manage these systems and are supported for initial investments by credits, their livelihoods can be improved while producing in an ecologically benign way.

13. Productivity and Resistance to Aphids of Okra (*Abelmoschus* spp.) Accessions under Humid Tropical Conditions in Cameroon

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The cotton (melon) Aphid (*Aphis gossypii*) is one of the major production constraints on okra in sub-Saharan Africa and particularly in Cameroon. Resistant varieties could reduce the aphid infestation and thus increase productivity. Hence, this study was carried out to identify aphid resistant and high

yielding okra accessions with shorter growth cycle for cultivation in humid and tropical climates. Eleven farmers' varieties and four aphid-resistant accessions from AVRDC were evaluated from October 2012 to January 2013 at the experimental farm of the International Institute of Tropical Agriculture at Nkolbisson near Yaoundé in Cameroon. Field screening was done to determine resistance to aphids, days to 50% anthesis and days to 50% commercial maturity. Commercially mature pods were harvested and numbers recorded. Aphid population was monitored on randomly selected plants in each accession, and the data was expressed as the area under the infestation pressure curve (AUIPC). The AUIPC values for aphid population per leaf were subjected to a statistical analysis based on mean (m) and standard deviation (S.D.). Yield data was subjected to analysis of variance. Significant ($P < 0.05$) differences between varieties for productivity and growth cycle were found. Accession 'VI033824' was the most resistant to aphids (474 per leaf) whereas accession Babungo; was the highest yielding variety (13 pods per plant). Farmers varieties yielded from 5-13 pods per plant, considerably more than the aphid-resistant accession (1-4 pods per plant), but they were highly susceptible to aphids. Most farmers' varieties were classified as *Abelmoschus caillei* and were late flowering (60-100 days). The accessions with lower aphid infestations belonged to *A. esculentus* and early flowering (52-54 days). The high yielding variety 'Babungo' with moderate time to anthesis (60 days after sowing), was highly susceptible to aphids (1520 aphids per leaf). Hence, accessions having resistance or tolerance to aphids and earliness and those with high yield could be incorporated into breeding programs and integrated pest management strategy to enhance productivity, incomes and livelihoods of okra farmers in the humid tropics of Cameroon.

Keywords: *aphid-resistant accessions, farmers' varieties, yield*

14. Engaging youth and women in agricultural development

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Women and young people provide family and wage labor critical to farming. Yet they are often vulnerable or disadvantaged stakeholders in agriculture and rural development. However, issues related to gender and youth vary across countries and agricultural systems, even within countries. Such differentiation needs to be carefully taken into account when working towards gender equity and supporting the livelihoods of young people. Gender and agriculture has long been a core theme for the Platform. Women play a vital role as agricultural producers and as agents to ensure food security and nutrition. Yet relative to men, they have less access to productive assets, such as land, or services, such as finance and extension. Gender inequalities are a root cause of lower food production, lesser income and higher levels of poverty and food insecurity. Yet for agricultural growth to fulfill this potential, gender disparities must be addressed and effectively reduced. The critical contribution of women to agricultural development, food security and nutrition is widely understood and gender is integrated as a central part of the programmes of donor agencies. There are, nonetheless, different emphases: some donors take a 'women in development' approach fostering women's empowerment and their capacity to decide and act together and increase their voice through their own organizations; others focus more broadly on gender and relations between men and women in the household, in the broader community and in policy. Some focus more on promoting gender equity, while others now emphasize the importance of integrating gender equality in their approaches and programming. Women involved in agriculture and living in rural areas are often affected by different forms of social inequity that need to be addressed. This involves going beyond measuring the percentage of women among program beneficiaries to supporting empowerment, equality and rights. Special attention must be paid to women's workload and time use, sharing of benefits from development interventions and education especially of girls to promote voice, increased decision making power and disposable incomes.

15. The Potential for Integrating Vegetables into Staple Production Systems in the Humid Tropics of Ethiopia

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Vegetables are important for economic development, nutrition and health, and the sustainability of smallholder farming systems in Ethiopia. Although vegetable production does attract foreign direct investment, little information is available on the biodiversity and potential use of a wide range of

vegetable species as a major solution to hidden hunger and for income generation in Ethiopian agriculture. A study was conducted in West Shewa, Gurage and Hadiya zones and Yem Special District located in Ethiopia's humid tropics zone to characterize vegetable production, marketing systems and their potential for integration and diversification into farming systems. Data were collected using participatory primary survey techniques augmented with secondary data. Vegetable production is either integrated into mixed farming systems where crops such as tomato, beet, chard, lettuce, carrot, cabbage, onion, garlic, kale, sweet potato and hot pepper are predominantly grown as sole crops, or in relay cropping sequences where crops such as Ethiopian mustard and pumpkin are intercropped with maize. Although the area used for vegetable production has been increasing over the years due to greater consumer demand, productivity is lower than the potential yield due to agronomic, climatic and socioeconomic limitations. West Shewa, followed by Gurage, is the major vegetable-producing zones in terms of both area and volume. More than 31% of the total area and 25% of the total vegetable production comes from irrigated schemes, indicating the prospect for several production cycles per year, particularly off-season production for higher profits. Chard, cabbage, kale, tomato and carrot are among the top-ranked vegetables produced under irrigation in terms of volume of production. Preference for specific vegetable types and varieties is location specific. Recent enabling legal and policy frameworks have boosted investment in the sub-sector and increased the demand for vegetable seeds. Lack of access to improved seeds, high postharvest losses, lack of reliable market information and support systems, and low bargaining power of farmers on farmgate prices remain critical bottlenecks for successful integration and diversification of vegetables into existing farming systems. Increasing public awareness about the use of different vegetable species as a readily available source of micronutrients in diets will play an important role in diversifying food sources, reducing malnutrition, and contributing to household income of smallholders. Systems-oriented multi-stakeholder platforms, and targeted capacity-building initiatives to strengthen linkages among value chain actors, can help facilitate coordination of interventions to address identified bottlenecks.

Keywords: crop diversification, cropping systems intensification, dietary diversity, vegetable productivity, vegetable value chains

16. Cocoa agroforestry for increasing forest connectivity in a fragmented landscape in Ghana

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In Ghana, farmers perceive protected forests as land banks for increasing agricultural productivity to support subsistence living. This has led to fragmentation of existing protected forests. Two of such reserve forests namely Bia Conservation Area and Krokosua Hills Forest Reserve have been encroached through lumbering for timber and area expansion of no-shade cocoa production systems. The purpose of this study was to develop an integrated multi-disciplinary strategy to increase forest connectivity using cocoa agroforest corridors. Forest connectivity is defined in terms of gene flow between populations of animal and plant species between the two protected forests. We introduce the community level and national contexts of connectivity among the two forest areas, explaining the rationale behind in terms of the general importance of managing cocoa agroforest corridors to preserve connectivity for the endangered primates, the critical situation in the Krokosua Hills Forest Reserve, where the presence of admitted farms continue to increase degradation through rapid and widespread conversion of forests to farmlands and illegal encroachment in the Bia Conservation Area, where changes over the last 4-5 decades in wildlife habitats and the absence of buffer zone between the national park and cocoa farms have led to severe human wildlife conflicts with elephants causing severe damage to farms. Biophysical assessments involving satellite images for vegetation patterns, and expert data from a decision support system were used to select suitable sites for the corridor within a GIS framework. Socio-economic assessments of the opportunity costs of alternative farming systems to cocoa agroforestry in the delineated corridors show that while timber trees planted within cocoa agroforests settings would help offset the yield losses in cocoa shade-yield relationships compared to full sun-production systems, the on-farm benefits of cocoa agroforestry alone are insufficient to justify the adoption. Paying farmers premium

prices for cocoa and substantial off-farm environmental and ecosystem services under agroforestry systems can tip the balance towards adoption.

Keywords: Protected forests, biodiversity, cost-benefit analysis, geographic information systems

17. Sustainable Intensification of Potato in Non-Traditional Potato Growing Areas in Rice Based System for Increased Productivity and improved Livelihood of Poor Farmers in Humid Agro-Ecology of West Bengal, India

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The sustainable crops intensification of potato in West Bengal will provide opportunities for optimizing crop production per unit area with better farm income for farmers. A project was initiated to introduce new cropping sequence, potato - boro (summer) rice in same piece of land after harvesting of winter rice in low lands to increase remuneration of marginal farmers through farmer's interest group approach. The project site was selected in small & marginal farmer's dominant areas in Darjeeling District of North Bengal, India. The project was implemented through 30 farmers clubs in group led cultivation mode based on participatory approach. The farmers generally keep low land fallow after winter rice to grow boro rice under irrigated condition. A study was done on short duration winter rice followed by early maturing potato and boro rice through double transplanting technology. In this project the farmers were benefited in many ways, like a) the potato as bonus crop gave profit of US\$ 40000/HA as cash crop, b) conventionally, nursery bed of boro get affected by cold injury but here the problem was avoided as nursery bed advanced quite early by introducing early winter rice variety, c) the yield of potato recorded high and fetched good market due to early planting, d) the yield of boro rice was recorded high in double transplanting system and rice crop matured 15-20 days earlier. The farmers were getting time to grow *Sisbania* sp as green manuring before winter rice. Project in the first year through experimental cum demonstrations has motivated large number of farmers to adopt this profitable cropping sequence in coming years.

Keywords: Intensification, double transplanting, farmer's interest group, sustainability

18. Cropping Intensification and Profitability of Cassava-Based Farming Households in Cassava-Based Farms in Rivers State, Nigeria

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Nigeria is the world's largest producer of cassava with cassava being a main staple food as well as her leading cash crop. High productivity is crucial to both food security and poverty alleviation problems facing the country. Therefore, this paper was designed to evaluate the levels of cropping intensification as well as profitability and determinants of profitability of cassava-based farm households in selected cassava growing areas of Rivers State of Nigeria. A survey in design, data were obtained from 140 farmers via the use of structured questionnaire and analyzed using descriptive statistics, Herfindahl index and OLS multiple regression models (four functional forms). The lead equation selected after econometric diagnosis and theoretical evaluation was the Cobb-Douglas model whose R^2 was 0.87 and had an estimated F-ratio of 53.49 ($p < 0.01$). Results indicated that the crop production intensity index (Herfindahl index) recorded by the farming households ranged between 0.1 and 0.89 with a mean score of 0.52. Mean Gross Margin attained by the farmers was ₦122, 866.93 (US\$777.64) indicating that the farms were profitable. The levels of profitability were significantly determined by the magnitude of crop intensification, proxied by Herfindahl index (elasticity = 0.276, $p < 0.05$); household size (elasticity = 0.519, $p < 0.01$); educational status of the farmer (elasticity = 0.085, $p < 0.01$); and gender (1.523, $p < 0.01$). It was therefore recommended that, to boost sustainable production of cassava in Nigeria, farmers should be assisted and encouraged by government and non-governmental institutions to diversify their production base and encourage higher productivity through supply of improved and affordable inputs (e.g. improved seeds/seedlings and fertilizers); building of farmers' capacity in intensive crop

management technologies, improving access of farmers to education and extension services in a gender inclusive manner.

19. Improving the productivity of integrated tree cropping system in southwestern Nigeria

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Traditional agriculture in the tropical humid southwestern Nigeria is predominantly rain fed, small holder consisting mainly of permanent tree intercropped with arable. Steady growth of agricultural production for both staple and cash crops was observed since 1990 with declined in 1998. While all major staples recorded significant increases due to intensification of on-farm adaptive research by some relevant agencies, the reverse is the case for tree crops. Cocoa and other tree crops production have declined substantially in recent times owing to several agricultural complex constraints which have affected the morals of the farmers. A multi-stage sampling approach was used to select farmers in the process of surveying the on-farm constraints that have been inimical to improving tree crops production among the of small holder farmers in Ondo, Ekiti and Osun States with the aim of showcasing some of the constraints and suggesting possible approach to reducing their effect on productivity. While the average age of farmers across the selected states ranged between 54.00 ± 3.24 and 68.00 ± 2.98 they generally have some level of formal education which enabled them to effectively interact with the merchants. The average farm size of the respondents ranged from 0.85 ± 0.17 ha and 1.47 ± 0.13 ha with about 60 % of the land converted to arable crop production with traditional semi-intensive system associated with heavy labour use but lack of capital. All these have further impoverished the smallholder farmers, locking them into a poverty web. Constraints were observed to have originated from governmental, institutional, infrastructural, environmental and other complexes that needed to be researched upon to reducing their effects on improved productivity. The study noted the need for urgent interjection using integrated approach that will significantly reduce post-harvest losses and thus make ways to providing higher-value products for export. Farmers health have always been neglected while there have been significant able labour migration because the youth observed that the process had heavy drudgery effect with unusual low return. Intensification of production coupled high-input management technologies with effective resource use and appropriate crop combination that will also integrate livestock are hereby advocated for significantly improved tree crop productivity.

20. Land health surveillance for identifying land constraints and targeting sustainable agricultural intensification in smallholder's agriculture in Cameroon

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Food production will have to increase substantially to overcome the challenges of the fast growing demand for food, widespread hunger and malnutrition. Intensification to increase agricultural productivity is seen as one of the solutions and entails enhancing the capacity of soil to increase yields per hectare, increasing cropping intensity per unit of land, and changing land use from low value crops or commodities to those that receive higher market prices. Therefore, there is a need to establish the link between soil health and agricultural intensification. Soil health is a key indicator of the state of natural capital, and is an integrative property that reflects the capacity of soil to respond to agricultural management by maintaining both the agricultural production and the provision of other ecosystem services. A study was carried out in Cameroon to identify land constraints that affect agricultural intensification using the Land Degradation Surveillance Framework (LDSF). The LDSF is a spatially stratified, random sampling design framework that was used to characterise a sentinel site consisting of $10 \text{ km} \times 10 \text{ km}$ blocks and clusters of 160 plots. The approach makes use of systematic field surveys to collect soil information and other ecological parameters.

Our results showed that large parts of the cultivated lands have soils with good physical (texture) and chemical (soil carbon) compositions as potential but slope ($>10\%$) and high soil acidity ($\text{pH} = 5 - 6$) are the limitations that requires appropriate land management interventions (e.g. Liming to reduce acidity and soil conservation measures to reduce erosion) for the successful implementations of agricultural intensification programs in smallholder's agriculture in Cameroon.

Keywords: Soil health, land degradation, agroforestry, soil organic matter, soil nutrient balance, soil organic carbon, infrared spectroscopy

21. Participatory Yield Assessment of climbing and bush bean varieties under different management options in Malawi

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Common bean is a major component in cereal-legume cropping systems in high elevation areas of Malawi. However, due to poor agronomic practices used by the majority of farmers, yields are a paltry 0.5 Mg ha⁻¹, compared to attainable yields of 2 Mg ha⁻¹. The objective of this study was to investigate the effect of different management options (manure and fertilizer use, intercropping, staking options) on the yield of climbing and bush beans grown under on-farm conditions. Farmer-managed mother trials were set up in Kandeu and Linthipe, central Malawi, during the 2013/14 cropping season. The trials were laid out in split-plot design replicated three times, with bean varieties as main plots and management options as sub plots. Beans were planted as either sole or intercropped with maize, and fertilized with manure only, fertilizer or a combination of manure and fertilizer. Either stick stakes or pigeonpea as live stakes were used in climbing beans. Participatory technology selection was conducted to capture farmer preferences across gender groups and compare farmer selections with agronomic results. Bean varieties responded differently to management options ($p < 0.001$) in both climbing and bush beans. The management option of using stick stakes and manure produced the highest mean yield of 1.96 Mg ha⁻¹ whereas an option of using pigeon pea as live stakes produced the least (0.74 Mg ha⁻¹). There was a significant interaction between varieties and management options ($p < 0.05$). MBC33 produced the highest mean yield (2.56 Mg ha⁻¹) when manure and stick stakes were used, whereas DC86-263 consistently yielded largest when NPK fertilizer was added. Also, MBC33 produced largest yields (1.89 Mg ha⁻¹) under sole cropping ($p = 0.025$). In bush bean, SER83 was responsive to management options which had a component of manure. Overall farmer selection pattern favoured intercropping to sole cropping. Further studies are being done to evaluate system productivity in terms of land equivalent ratio, relative yield total, and nutrient output per unit land area.

Keywords: Cereal-legume cropping systems, bean varieties, management options, Africa RISING

22. Transition of Land Use/Land Cover to Agroforestry to Restore a Degraded Land: A Case of Zongi Village Agroforestry System, Tigray, Ethiopia

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One of the major problems threatening human lives in the highlands of Ethiopia is land degradation. The synergy of human land use, steep slopes and erosion has being a serious threat to the country's ecosystems. However, land rehabilitation programmes such as tree planting on farm lands and hill-side planting have been established to try to rejuvenate the debilitated lands. In order to characterize and quantify the transformations, a study was carried out in Zongi village, in Tigray Region of northern Ethiopia. This study used a combination of remote sensing data, field observations and information from local people to analyze the patterns and dynamics of land-use/cover changes for 29 years from 1984 to 2013. To map out and monitor the changes that have occurred over time (29 years), field work (2013) and multi temporal Landsat imageries of 1984, 1999 and 2013 were used. Conventional method of pixel-based supervised image classification was used for Landsat image of 2013 while hybrid method of unsupervised and supervised classification was employed for Landsat images of 1984 and 1999. Community's perception and ecological time-lines were used to explain the driving forces linked to the changes. From the results obtained from the study, the major land use/cover changes were: (1) Adoption of Agroforestry systems, (2) Continuous increase in areas with varying vegetation cover over the years and, (3) Continuous decrease of blanket land use types. The drivers of the observed changes were linked to the introduction of land rehabilitation initiatives, Government consensus with the community and were complemented by growing awareness of landowners.

23. Vegetable Supply Chains in Ghana: Production Constraints, Opportunities and Policy Implications for Enhancing Food and Nutritional Security

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In 2013, nutrition captured the international spotlight in an unprecedented way in spite of persisting global hunger and undernutrition challenges. Vegetables can make an important contribution to food and nutritional security and can enhance livelihood of marginal and smallholders due to their high farmgate values per unit area. Besides their economic, nutritional and medicinal importance, traditional African vegetables are considered valuable because of their ability to fit into year-round production systems. A study was undertaken within the humid tropics agro-ecological zone in cocoa belt of Ghana to identify the potential for vegetable integration and diversification into cocoa-based farming systems. The study also examined the production constraints, investigated the utilization pattern of vegetables and assessed current government focus on vegetables and related bottlenecks. Field surveys involving interviews with 788 vegetable producers selected from cocoa growing areas of the Ashanti and Western Regions respectively in Ghana complimented with focus group discussions and field observation were used for the study. The most common vegetables produced in the two regions were tomatoes, pepper, garden eggs and okra, although cabbage and onion are also cultivated by a few farmers. Carrots, amaranth, and beans, were found on a small scale in Ashanti Region. Vegetable cropping systems were sole cropping, relay intercropping or multiple cropping where different vegetables were cultivated on separate plots. A sizable number of farmers integrated these vegetables into cocoa production either on separate fields or on the fringes of the cocoa fields. About 80% of vegetable growers sold their produce whilst 20% used vegetables for home consumption. A major constraint is lack of farmer access to high quality improved vegetable seed cultivars. Production and consumption of vegetables, particularly traditional African vegetables which can substitute for more than 100 parts of standard vegetables is important for nutrition of households. Additionally, diversification of cocoa farming households into vegetables constitutes an important agricultural livelihood diversification strategy. Together, these will contribute to attaining income and nutritional related Millennium Development Goals. The knowledge of production, utilization patterns as well as current government focus on vegetables and related bottlenecks will provide policy makers opportunity to address them.

Keywords: food security, Ghana, nutritional security, production constraints and vegetable supply chains

24. Measuring Capacity to Innovate using Outcome Evidencing

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This poster describes how AAS is organizing to measure capacity to innovate. The system CRPs have agreed to measure capacity to innovate in terms of improved capacity of system actors to: 1) identify and prioritize systems problems and opportunities; 2) to invest, test, experiment and adapt, and assess tradeoffs between alternative social and technical options; and 3) to network, learn and share knowledge. The AAS starting point for measurement is that increased capacity to innovate is useful through its manifestations, in other words through the sparking new innovation trajectories or altering the course or rate of established trajectories. Therefore, for AAS our main indicator of increased capacity to innovate is 'early and emergent change (in innovation trajectories) to which AAS has contributed'. We identify these changes through outcome evidencing that prospects for early outcomes to which we believe AAS has contributed. Once identified, we look for patterns of outcomes that suggest an emerging innovation trajectory to which AAS has contributed. In other words we look to see whether outcomes are starting to cluster together and interact in causal pathways that have the potential to lead to wider and deeper change. Once identified we then carry out an evaluation to forensically examine the causal pathways (i.e., theories of change) to establish whether and how our interventions built capacity to innovate and how capacity to innovate worked as a mechanism to lever change. In this way we expect to be able to show not only that, for example, AAS built the capacity of system actors to network, learn and share knowledge, but what it was about this capacity that led to change. Our program theory is that by answering the 'how it works' question across our interventions across hubs will allow us to increasingly do more with less, to become increasingly better at identifying ways to help people better help themselves.

Keywords: Theory of change, outcomes, innovation trajectories, mechanisms, evidence

25. Agricultural Credit for Integrated Systems Improvement

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Over-lending to farmers is likely to cause significant harm, both to the farmer and to providers. One of the most critical lessons learned from overheated credit markets is the difficulty borrowers have in realistically assessing their loan repayment capacity. Practical experience and behavioral research indicates that borrowers have difficulty judging their loan repayment capacity and are prone to predictable cognitive biases that contribute to over-borrowing. Providers have a duty to ensure that they do not take advantage of these tendencies. The most important way to do so is through credit processes that analyze consumer capacity to repay. The entire credit process should be designed with this in mind, and other internal systems should provide further reinforcement. As over-indebtedness appears in markets that are especially competitive or expanding rapidly, it is also important for providers to participate in market-level initiatives to prevent over-indebtedness, such as the development of credit reference systems. Elements of prevention of over-indebtedness include: the farmer underwriting process, loan terms and conditions, sales techniques, staff incentives, monitoring systems, and market initiatives. Farmer underwriting process, an analysis of their capacity for creditworthiness. This assessment will typically include a careful analysis of the borrower's existing cash flow, with considerably less emphasis on additional cash flow anticipated as a result of any new borrowing. Collateral and guarantees can be used as a secondary source of repayment and as confirmation of the borrower's commitment to repay, but the lending decision should be made on the basis of repayment capacity.

Keywords: agricultural credit process, over-indebtedness, integrated systems improvement, credit reference systems.

26. Production Indices and Profitability Analysis of Integrated Fish Farming (Fish, Rice, Poultry) Production

Tosan Fregene, E. K. Ajani, B. O. Omitoyin, and A. O. Onada, Department of Aquaculture and Fisheries Management, University of Ibadan, tosanfregene@yahoo.co.uk

The need to improve the productivity of small holder agricultural farm in Nigeria in order to combat environmental degradation to meet projected food demand, have made scientists to adopt multi – disciplinary systems approach to food production. This has brought about the idea of integrated fish farming in which crop or/and animal husbandry is combined with fish farming, utilizing natural resources efficiently and the resources recycled in order to maintain or increase production. This study was therefore aimed to assess the productivity and profitability of integrated fish farming system as a method of increasing food production. An integrated combination of fish, rice cum poultry was studied for production performance and profitability for a period of one year. The cost of construction and acquisition of all the fixed inputs were recorded. Variable inputs and revenues were also monitored and documented for the period of operation of the investment. Budgetary and profitability analysis were used to estimate profitability of the system under study, while cash flow analysis assessed its viability. In-depth interview was used to collect information on single system of production of rice, fish and poultry. This served the purpose of comparing the productivity of single system with integrated system. The result of profitability analysis of fish integrated with rice and poultry revealed that the gross margin, net income, profitability index and cost benefit ratio were ₦295,536, ₦204,834, 0.23 and 1.3 respectively. Integrated fish farming was more profitable than unitary system of farming as it ensured a spread of financial risk for its varied and diversified nature in rearing of fish, animals and crops.

Keywords: Integrated Farming System, profitability, rice, catfish production, poultry

19:00 DINNER

Conference Program: Day 3 – March 5

8:30 SESSION 7 – PARTNERSHIPS AND INSTITUTIONAL ARRANGEMENTS FOR INNOVATION, SCALING UP AND IMPACT

Recap of Day 2: *Sustainable Intensification in Systems Research - What does it really mean?*

Keynote 8: Dr. Fergus Sinclair, Systems Science Leader, ICRAF, F.Sinclair@cgiar.org

Systems science at the scale of impact: reconciling bottom up participation with the production of widely applicable research outputs

Tax payers and philanthropists fund agricultural research for development and they are demanding tangible impact from their investments. Research outputs need to impact millions of people and hectares. But the vast numbers of farmers and land area that the green revolution did not transform are heterogeneous in both ecological and socio-economic terms. Neither conventional reductionist approaches, nor participatory research, alone, can address this fine scale variation, although both are part of a new research 'in' development paradigm that can.

This new paradigm rediscovers formal systems methods, discarded in the shift to participatory research over the last quarter of a century, and focuses them, on large scaling domains that embrace variation. Participatory research, by definition, focuses on those participating. We cannot expect innovations customized for one community to scale up and out. Processes and methods may be replicable, but if that is all that is scaled up, then each new project has to re-invent the wheel, rather than benefiting from locally relevant research done elsewhere.

Tackling the heterogeneity of local circumstances requires research on a far larger scale than funding currently allows, but this level of funding is routinely invested in agricultural development, that often proceeds without much evidence on the most cost-effective means to reduce poverty or improve food security. By embedding research 'in' development praxis, we can solve these two problems at once and accelerate development impact by learning as the development process unfolds.

Here, a co-learning cycle is set out with pragmatic examples of its application in Africa, Asia and Latin America. The cycle integrates advances in spatial and information sciences together with planned, nested-scale, comparisons to allow generalization of where innovations emanating from participatory research can be scaled up and out to. It has profound implications for how participatory research and development are both implemented, demanding new private and public partnerships. What emerges is a far broader participation base, enabled through innovations in crowd sourcing of data and opinion, to assess performance of options across a range of contexts. The options are hybrid, combining technologies with market and delivery mechanism interventions, and, policy and institutional reforms.

Keywords: research in development, co-learning, planned comparisons, scaling up, scaling out

Presenter: Julienne Kuseu, Capacity Strengthening Programme Assistant, CORAF/ WECARD

A paradigm shift in agricultural research for development: Innovation Platforms as a vehicle for change and impact in Smallholder Agriculture in West and Central Africa

Aboubakar Njoya, Julienne Kuseu, CORAF/WECARD; Sidi Sanyang, Harold Roy-Macauley, AfricaRice, julienne.kuseu@coraf.org

CORAF/WECARD in its search for options for an effective research for development tool that improves the uptake of agricultural technologies and innovations by small scale farmers and entrepreneurs adopted a paradigm shift – Integrated Agricultural Research for Development (IAR4D). The IAR4D aims to catalyze a process that hastens the simultaneous generation and adoption of technologies and innovations including practices and policies in agriculture value chains, food systems and natural resource management, using multi-stakeholder innovation platforms (IPs). The IPs comprises diverse social and economic operators with a common objective, interdependent interests, and roles; all working together in a value chain, food system and or natural resource management. In total CORAF/ WECARD is facilitating 212 IPs along commodity value

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chains range from crops, livestock, fisheries, and Natural Resources Management. As a decentralized and demand driven local innovations systems, IPs have demonstrated their effectiveness in fostering adoption of innovations and technologies through the creation of a conducive environment enabling actors to operate transformational change in their activities, and most importantly to reach a greater number of smallholders. The CORAF/WECARD facilitated IPs under Dissemination of New Agricultural Technologies in Africa (DONATA), has delivered outcomes that changed livelihoods of smallholder. The maize and cassava IPs in the 14 DONATA participating countries involving 41736 smallholders (44% women) for example, have addressed technological, organizational, and institutional innovations over time but not consistently. Both maize and cassava yields and the incomes of the smallholder farmers have significantly increased. Furthermore, enhanced intra-and inter-actor relationships and behavioural change were observed among the diverse social and economic operators in the IPs. There was trust between processors and farmers in buying and selling quality grain maize as well as increased access to credit by farmers. Incomes of emerging farmer seed entrepreneurs also increased as well as access to and use of quality seed maize by resource poor stallholders. In the same vein, the use of the multi-stakeholders and collective learning / innovation processes with its national networks to scale-up and scale-out the best innovations by the Plantain Innovation Platform involving 1,488 IP actors (43% women) with increases of 72% in yields.

However, the facilitation of IPs remain a key challenge in value chains and food systems and CORAF/WECARD has put in place, a group of competent and skilled trainers and mentors to train and coach IP facilitators and practitioners in multi-stakeholder processes and value chain approaches including but not limited: start-up of an IP; facilitation of IPs; knowledge and information documentation and learning; governance and leadership, to name but a few.

Keywords: innovation systems, innovation platforms, IAR4D, Value Chains, competence and skills enhancement, SSA-CP, DONATA

10:30 BREAK

11:00 SESSION 7 – (cont'd)

Presenters: Dr. Cees Leeuwis and Seerp Wigboldus

What kinds of 'systems' are we dealing with? Implications for System Research and Scaling?

Cees Leeuwis, Knowledge, Technology and Innovation group, Wageningen University, cees.leeuwis@wur.nl

In Humidtropics and other CGIAR Programs we speak a lot about 'systems' and 'systems research', and we contrast this to other kinds of research. As evidenced by the wide range of terminologies available (e.g. farming systems, agricultural systems, social systems, innovations systems, socio-ecological systems) we do necessarily have a shared understanding of the kinds of systems we are dealing with. To complicate things further, there exist different scientific traditions of 'systems thinking' (e.g. hard systems thinking, soft systems thinking, critical systems thinking and complex systems thinking). That is: even when and if we talk about systems with similar entities and boundaries, there are different conceptualizations of how such systems function, how they change and how they may be influenced through interventions, including research interventions.

This presentation aims to provide some order and clarity in this discussion, and will argue that different kinds of systems perspectives are relevant to different situations. This is followed by a reflection on what this implies for how a program like Humidtropics, could or should operate in different situations, and on whether and how it may legitimately distinguish itself from other types of CRPs.

Presenters: Dr. Marc Schut and Murat Sartas

A New Documentation and Learning System for Multi-stakeholder Processes in Integrated Systems Research for Development Interventions

Murat Sartas, IITA/Wageningen University/Swedish University of Agricultural Sciences; Marc Schut, IITA/Wageningen; Cees Leeuwis, Wageningen University, m.sartas@cgiar.org

Multi-stakeholder processes have the potential to contribute to the effectiveness of research for development (R4D) interventions. Quantitative assessment methodologies based on the differences of detailed pre and post intervention cross sectional data analyses have been utilized to measure the net impact of the multi-stakeholder process. However, the results failed to indicate sufficient evidence on the specifics of the intervention and their impacts on the process. Furthermore, stakeholders hardly participated in reporting and analysis of the data, the results were generated only at the end of the process and the approach captured a big share of the intervention budget. On the other hand, case studies focused on the specific elements of the intervention and the processes dynamics. Although they were cost effective and suggested a few key factors for the contribution of the process to R4D interventions, they do not provide a basis for generalization. The absence of sufficient characterization of the context is considered insufficient in providing strong evidence for decision-making. This study describes a new documentation and learning system that addresses major shortcomings of the two above approaches. It argues for a contextualized learning system based on an integrated approach to documentation, reporting and analysis of the multi-stakeholder process. The system uses participatory, short time loop, simple and cheap documentation and reporting tools to capture the process dynamics and their impact on intervention outcomes. Each multi-stakeholder event (not only formal multi-stakeholder meetings) is captured by a designated documentation person. That data is entered in a (partly) online repository that provides inputs for comprehensive data analysis. Text and social network analysis offers an important opportunity to increase the effectiveness of the multi-stakeholder process in improving the contribution of R4D interventions to achieving development outcomes.

Keywords: Monitoring and evaluation, effectiveness, integrated systems, RAAIS, mixed methods

Roundtable Discussion - Dr. Lisa Hiwasaki, Dr. Latifou Idrissou, Dr. Chris Okafor and Dr. Rein Van der Hoek

Institutional Constraints and Opportunities in Implementing Integrated Agricultural Research for Development (IAR4D)

Falguni Guharay, Wendy Godek, Rein van der Hoek, CIAT; Chris Okafor, Latifou Idrissou, IITA; Lisa Hiwasaki, ICRAF, r.vanderhoek@cgiar.org, c.okafor@cgiar.org, l.idrissou@cgiar.org, l.hiwasaki@cgiar.org

Humidtropics is working with the goal of improving overall agricultural productivity, and transforming lives of rural poor in the target regions. This is being achieved through integrated systems approaches in Research for Development (R4D), with a focus on sustainable intensification and capacity to innovate. The program is based on five Flagship Projects, one on a thematic crosscutting basis, and four on area basis covering East and Central Africa Highlands, West Africa Humid Lowlands, Central Mekong and Central America and the Caribbean. Activities in the area based flagship take place at selected Action Sites and started with situation analysis on human development, natural resource management, production systems, and markets. Collective analysis of the processed information resulted in the convergence of stakeholder interests with Humidtropics goals and impact pathways and gave rise to national R4D platforms as a key space for up- and out-scaling.

Program actions are focused on smaller territories often based on predominating farming systems and include the establishment of innovation platforms or learning alliances, spaces where collective analyses and learning journeys based on local information are initiated and supported. Activities including local partner organizations, farm families and international research centers seek to enhance local knowledge and innovation systems generating a vision safeguarding natural resources and landscapes, generating innovations to face vulnerability, building equitability, and supporting rural families and communities.

Various constraints including economic, human capacity and attitude/culture affect innovation and change. Recommendations relate especially to raising awareness on these constraints among the platform members. Gender equity and nutrition issues need to be prioritized to adhere to the overall vision of Humidtropics. The potential for scaling of innovations is evidenced by the wide range of potential receivers and it is important to consider strategies early on how innovations can be shared with the broader community, among members of the national R4D platforms, innovation platforms

and beyond. Learning modes of organizations need to be considered. Data collection methods need constant revision to avoid inconsistencies.

Keywords: Humidtropics, Situation Analysis, R4D platforms, learning alliances, scaling of innovations

Table Discussion - Challenges for Partnerships and Institutional Arrangements

13:00 LUNCH

14:30 SESSION 8 – POSTER PRESENTATIONS (Poster presenters are underlined)

Brief Introduction in Plenary followed by Interactive Exhibition

Theme 2: Sustainable Intensification (cont'd)

27. Evolution of Bangladesh “gher” floodplain farming systems and challenges for productivity and resilience

Manjurul Karim, Golam Faruque, Rayhan Hayat Sarwer, Kazi Ahmed Kabir, Barman Benoy and Michael Phillips, WorldFish, M.Karim@cgiar.org

This paper describes an important aquatic-agricultural farming system in south west Bangladesh – the “gher” system. These systems are rice fields converted to aquaculture through excavating a shallow canal on the periphery of the rice field and using the soil to raise the surrounding dikes, allowing for the diversification of the farming system from rice only to freshwater prawns, rice, fish, vegetables and brackish water shrimp. These highly dynamic systems have evolved in response to a number of stimuli and constraints including taking advantage of growing markets for high value products (fish and vegetables), technological advances and fluctuating salinization. This paper examines the evolution of the gher system from its rice field origins to a diversity of highly product and profitable systems. Case studies are drawn from three distinct aquatic agricultural systems: a low salinity freshwater prawn dominated system; an intermediate salinity mixed prawn and shrimp system, and a high salinity shrimp dominated system. Cropping intensity, productivity and profitability are found to be highest in the diversified low and intermediate salinity systems, and considerably lower in the high salinity system, where cultivation of rice and vegetables is no longer possible. The paper considers the current and future opportunities and challenges to the further intensification and scaling of this aquatic agricultural system.

28. Integration of Maize Lethal Necrosis Disease Management in Crop/Livestock Intensification to Enhance Productivity of Smallholder Agricultural Production Systems in East Africa - an Africa RISING Approach

MB Jumbo, D Makumbi, G Mahuku, CIMMYT; M Bekunda, I Hoeschle-Zeledon, IITA. Presented by Janet Njeri Kimunye, CIMMYT, corresponding author: MB Jumbo b.Jumbo@cgiar.org

Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) is implementing research activities in East Africa (EA) using a Crop/livestock intensification approach to improve the productivity of smallholder agricultural systems in the region. Preliminary results on variety selection during the 2012 cropping season revealed that varieties are not a significant factor in bridging the current maize yield gap, while good agronomic and natural resource management are critical factors. This implies that the use of improved crop varieties combined with good crop and natural resource management in crop/livestock intensification would significantly improve the productivity of smallholder agricultural systems. However, the outbreak and rapid spread of Maize Lethal Necrosis (MLN) in EA has emerged as a big challenge to maize production and has significantly affected the productivity of smallholder maize based agricultural systems as well as the commercial maize production sector. Thus, the presence of MLN is a great set back to such improved systems and compromises achieving the anticipated progress. MLN results from mixed infection of maize plants with Maize chlorotic mottle virus (MCMV, genus Machlomovirus) and potyviruses and it has been established that it is Sugarcane mosaic virus (SCMV) in combination with MCMV causing MLN. Results from initial screening of a large volume of pre-commercial and commercial maize varieties from EA have shown that most of the varieties are highly susceptible but some maize inbred lines and hybrids possess moderate tolerance. To improve the resilience of crop/livestock smallholder production systems and enhance their productivity, the International Maize and Wheat Improvement Centre (CIMMYT) through Africa RISING program is evaluating

over 2,000 maize varieties for resistance/tolerance to MLN and determining their agronomic adaptability in Babati, Tanzania. We believe maize varieties with resistance to MLN will significantly contribute to the resilience of the crop/livestock smallholder production systems.

29. Dual-purpose sweet potato for improving smallholder production systems

Carlos León Velarde, Roberto Quiroz, CIP; Presented by Victor Mares, CIP, corresponding author: Roberto Quiroz r.quiroz@cgiar.org

Sweet potato (*Ipomoea batatas*) is cultivated in the humid tropics and warm temperate regions wherever there is sufficient rainfall to support their growth. Over 95 percent of the global sweet potato crop is produced in developing countries (CIP, 1984). It is grown for different purposes: human consumption of roots and leaves, animal feeding, and industrial products like plastics and biofuel. Vines, foliage and un-saleable or damaged roots are frequently used to feed animals in Latin America, Africa and East Asia. Demand for feed, fodder, fuel, and traditional supplements are increasing and competing with human needs. Sweet potato (SP) offers a viable alternative to satisfy different demands by using it as a dual-purpose crop. Nineteen clones were selected on the basis of the roots/vines (R/F) ratio for animal feeding and human or industrial use. A modification of traditional crop management consisting in different cutting frequencies was evaluated. Results have shown that cuts at about 75 days of growth reduced root production by 27% while vine production was increased by 25.1%, increasing total biomass by 11-19.5%. This cutting regime provided biomass to be conserved as silage to be used alone or as a supplement for pig feeding, as well as roots for different uses. The utilization of SP stands by grazing/foraging pigs caused no significant effect on soil structure or organic matter content, but brought about significant increments in soil nutrients: nitrogen (25%), phosphorus (50%) and potassium (41%). Grazing/foraging or confined swine fed on SP plus silage and a protein supplement showed no significant difference in weight gain between the grazing/foraging treatments but penned pigs gained 17.5% more weight.

30. Optimizing Growth and Yield of Maize, Pigeonpea and Fodder Trees in Kongwa and Kiteto Districts, Tanzania

Anthony Kimaro, ICRAF; Patrick Okori, ICRISAT; Elirehema Swai, Agricultural Research Institute, Tanzania; Ahazi Mkoma, Sokoine University of Agriculture/ICRAF; Mathew Mpanda, Abdala Liingilie, Martha Swamila, ICRAF - Tanzania Country Programme, corresponding author: Anthony Kimaro A.Kimaro@cgiar.org

Low crop yields and limited supply of high quality livestock feeds are among the main development challenges facing farmers in semi-arid Tanzania. To address these problems, farmers under the Africa RISING project in Kongwa and Kiteto Districts are integrating maize, pigeonpea and *Gliricidia sepium*. Pigeonpea is a fairly new legume crop in these Districts, requiring both adaptability and agronomic studies to guide farmers on the best technology options (plant variety and combinations), which can optimize farm productivity. We employed the participatory variety selection approach to identify adaptable pigeonpea varieties. These were then tested on farms under various intercropping arrangements with maize (Pure stands, 1:1, 1:2 and 2:1) and/or *G. sepium* (Pure stands, Maize+Pigeonpea, Maize+Pigeonpea+*Gliricidia*) to assess options for optimizing growth and yields of crops and fodder supply. Two pigeonpea varieties (ICEAP0057 and ICEAP 0054) were selected by farmers based on superior growth and grain yield. Overall maize grain yield ranged from 1.5-1.9t/ha in Kongwa and from 1.7-2.9t/ha in Kiteto, reflecting higher potential in the latter. Relative to monoculture, yield of maize was reduced significantly (30-40% in Kongwa and 30-40% in Kiteto) by pigeonpea intercropping. Similarly pigeonpea diameter was reduced by 30-40% in Kongwa and 43 - 55% in Kiteto. However, no difference was noted in maize yield reduction among the tested planting combinations; suggesting that farmers may benefit more by adopting the 1:1 ratio which has the highest number of plant populations. Results of pigeonpea grain yield are not yet available to assess crops at a farm level based on land equivalent ratio and vector analysis techniques. At the 1:1 ratio the reduction of maize grain yield was similar in both sites (~40%) but for pigeonpea it was 40% in Kongwa and 55% in Kiteto. This would reflect a relatively higher vigorous growth of maize in Kiteto, the high potential site. Our results suggest that farmers may compromise up to 50% of both maize yield and pigeonpea's growth when these components are grown simultaneous in mixture. However, overall farm productivity is higher in intercropping than monocultures and it may be optimized at a planting ratio of 1:1 for maize and pigeonpea.

31. Exploring niches for livestock intensification in farming systems in Malawi

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Dairying in smallholder farming systems can be intensified to improve livelihoods. The biggest constraint faced by resource-constrained smallholder dairy farmers in Malawi is limited of high quality but cheap dairy feed. The use of high quality pasture grasses and protein-rich leaf meal from leguminous plants (trees and annual legumes) are a low-cost option that is increasingly being promoted in the region. A study was conducted among 100 smallholder dairy farmers practising zero grazing to inventory feed sources currently fed to dairy cows and to identify niches that could potentially be used to increase feed and fodder production. We also determined the current milk yield as an indicator for feed quality and quantity. All farmers fed their cows on grass collected from dambo (wetlands) and on crop residues (mainly maize stovers and groundnut haulms) during the dry season. In some cases farmers travelled between 5-10 kilometres in search of dambo grass. Fifty-nine per cent of the farmers supplemented their feed resources with cultivated pastures such as Napier (46%) and Rhodes grass (13%), and 30 per cent with tree leaves of *Gmelina arborea*, *Toona ciliata*, *Melia azedarach*, and *Sesbania sesban*. Only 5 percent of dairy farmers utilized all feed sources. The cultivated pastures were grown along farm boundaries and as buffers between fields and dambos. Almost half of dairy farmers planted along contour bands. Seventy-five per cent of farmers were engaged in storage of crop residues for feed in quantities of 20 to 30 kilograms bales. However, stored feed was not adequate to meet recommended numbers of 300 bales for one cow per year. Average milk produced was 14 litres per day per cow with a range of 4 to 35 compared to potential of 40 litres. We conclude that the quality of feed sources (dambo grass, maize stover and some of the tree leaves) fed to dairy cows is largely of low quality and therefore affects milk yields. Better quality forages and fodder trees could still be grown in the available spaces within farms.

Keywords: Dairy farming system, inventory of current feed sources, low-cost option leaf fodder feed for increased milk production

32. Trees on farms enhance ecosystem service provision in Sub-Saharan Africa

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It is expected that countries in Sub-Saharan Africa (SSA) will be greatly affected by global environmental change through increased water stress and pest incidence which coupled with population increase may cause land degradation and reduced yields. There is much interest in the role that trees play in the provision of ecosystem services (ES) that can sustain productivity gains from agricultural improvement, but an urgent need to evaluate the evidence for this. We reviewed 360 journal articles (published between 1995 and 2013) for ES provision by trees in agricultural landscapes in SSA. This revealed information on 15 ES from studies carried out at 205 sites in 23 countries that covered arid (2%), semi-arid (53%), sub-humid (25%) and humid (21%) agro-ecological zones. The most common ES reported were food provision (24%) and nutrient cycling (24%). Data on food provision were strongly biased towards the influence of trees on crop production; data on provision of fruits and nuts were seldom reported. Trees were also recorded as providing fodder (5%), wood (4%) and green manure (3%), supporting soil fertility (13%), and regulating water flow (10%), pests (6%), carbon flux (4%), microclimate (3%) and soil erosion (1%). Most studies only reported on one or few ES, reflected in the numbers (percentage). Low percentage means few studies rather than low importance of the ES.

Beneficial effects of trees were evidenced in 61% of the studies reviewed while 15% reported a decline in ES and 24% found no effect of trees. Beneficial effects were identified most frequently in semi-arid zones where they were associated with enhancing water and nutrient cycling. Depending on tree species and context, decline in crop production was noted as a key trade-off against other beneficial ES provision, brought about by soil moisture depletion, increased pest infestation, and exhaustion of nutrients. This highlights the need to manage trade-offs amongst impacts of trees on ES provision by deploying management options that reduce competition and increase complementarity. Management options involve costs, and so benefits to the farmer have to exceed costs for them to be viable, which in many cases may require payments for non-provisioning ES.

Keywords: Agricultural productivity, Agroforestry, Ecosystem service, Sub-Saharan Africa

33. Sources of income and demand for Micro-financing for Agro-enterprise investment among rural women in Abia State, Nigeria

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The study focused on sources of income and demand for micro financing for agro-enterprise investment among rural women in Abia State, Nigeria. It specifically assessed the socio- economic characteristics of the woman involved in micro financing, examining the types of agro enterprise presented for micro-financing, assessing the volume of loan demanded and amount disbursed to the rural woman, determining factors that influence their agro enterprise investment, and identifying the constraint against income generation and agro enterprise investment among rural women. Primary data were obtained from 80 respondents who were randomly selected from two (2) microfinance banks in the agricultural zone. The two-microfinance banks were purposively selected. This selection consisted of 40 beneficiaries and 40 non-beneficiaries. Well-structured questionnaires were used for data collection from the respondent and the Micro Finance Banks. Data analysis was carried out with the use of such statistical and econometric tools like means, percentages, frequency table and multiple regression analysis. The results of the study show that the mean age of the beneficiaries and non-beneficiaries were 35.9 years and 47.5 years respectively indicating that they are young. Furthermore, the study shows that the Bulk of the women are married, smallholder farmers and literate. All the respondents that had access to microfinance were members of cooperatives. About 75 percent of the 90 percent that applied for between N1000 - N99999 of the beneficiaries got the range of money applied for. More so, 10 percent and 7.5 percent of beneficiaries that did not apply for between N100000 - N199999 and N200000 - N299999 respectively were granted microcredit. This could be due to their level of credit worthiness as perceived by the micro finance banks. The Regression result shows that age, level of education, value of asset, savings, and interest payment were significant variables influencing agro enterprise investment. Delay in release of loan, not easy, finding a guarantor, insufficient amount of loan, irregularity of loan disbursement and high interest rate as the major constraints facing beneficiaries of micro finance banks that operators of microfinance banks in the state should work hand in hand with cooperatives in selecting beneficiaries for micro financing in order minimize the ills in credit administration and to ascertain the character of the respondents. More so, the interest on the loan given should be reduced in order to attract more new clients to the banks for investment funds and finally developing the entrepreneurial capabilities of the women.

Keywords: Micro financing, agro-enterprise investment, rural women

34. Aqueous Productivity: an enhanced indicator for agricultural water management in the monsoonal tropics and dry lands

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In both dry land areas and humid tropical regions that are characterized by monsoonal climates with pronounced dry seasons, water scarcity can seriously limit agricultural and livestock production; therefore, an important consideration for increasing system productivity in these contexts is how to manage water effectively across wet and dry seasons to maximize dry-season water availability, and efficient use of that water, for crops and livestock.

Systems-level exploration of water allocation and management processes can be focused on smallholder production, e.g. considering how to improve the efficiency of water use for livestock, or could extend to the community or river basin scales, where agricultural demands may compete with other uses for water. At any scale, effective indicators for measuring water performance are needed to guide strategy formulation and water allocation processes. One such indicator that has gained prominence is water productivity (WP), defined as the 'ratio of the net benefits from crop, forestry, fishery, livestock, and mixed agricultural systems to the amount of water required to produce those benefits'. Though widely implemented, the WP concept encounters significant limitations when applied in systems where water has multiple uses or high levels of re-use. WP is furthermore highly scale-dependent, making comparisons across scales and systems difficult. This research forwards 'aqueous productivity' (AP) as an alternative water performance indicator that addresses the significant limitations in the WP approach and improves productivity estimations

for water in integrated systems. AP, similarly to WP, is expressed as a ratio of economic benefit to water volume, but is determined by linking various components within a hydro-economic system via water flow interactions.

The AP conceptual framework and methodology are presented, and an example system illustrates the method's ability to estimate the spatiotemporal distribution of the productivity of water through a monsoonal system. The utility of the method in assisting water management processes in monsoonal or dry land areas is subsequently considered.

35. Gender and Investment and Assessment Strategies in Innovation Systems, the Case of Papa Andina, Peru

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Small-scale producers in the Andean region of South America are particularly vulnerable to socio-economic changes, drastic environmental variations and biodiversity loss brought about by processes of globalization and climate change. In the Andes, population growth and increased affluence have led to increased demand for more and higher quality foods. The critical challenge is to improve small farmers' access to dynamic markets for high-value food products. Such access can contribute to poverty reduction, food security and the sustainable use of natural resources, including biodiversity. Assessing gender issues in community and family contexts and investing in activities to address these issues, are crucial to the success of small-scale farmers' efforts to harmonize agricultural innovation and promote social equality of all actors involved in agriculture. Gender analysis for agricultural innovation assessment implies achieving tangible goals such as income generation for women farmers, but it is also about mobilizing knowledge to deal with deeply embedded power-based relations and roles, which are often legitimized by strong agricultural traditions, beliefs and prejudices. In this particular case, the Papa Andina initiative had among other things a desire to improve women's income generation activities. Therefore, gender analysis was used in planning, monitoring and evaluation and this was organized in a way that combined collecting sex-disaggregated data with iterative assessment activities that continuously readjusted the project to sharpen its focus on income generation for women and gender relations. The inclusion of a proper analysis of gender determined main aspects that need to be considered in the future; women's concerns and needs as well as the recognition and considerations and women's innate innovations.

Keywords: Gender research, Andean agriculture, native potatoes, small-scale agriculture, innovation, agricultural systems, women, indigenous people, economic empowerment, participatory action research, international potato center, value chains

36. Participatory evaluation of productivity and farmer preferences of selected Napier grass (*Pennisetum purpureum*) accessions in northern Tanzania

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In Tanzania, livestock feed availability is one of the major problems hindering livestock productivity. This is caused by large fluctuations in the quality and quantity of forage due to seasonality, limited available pasture land and degraded soils. Therefore, farmers have inadequate feed resources to meet the optimum feeding requirements of their cattle. In mixed crop-livestock production systems, integration of improved forages for livestock feed is often neglected relative to food crops, yet livestock can make a positive contribution to whole farm productivity. More specifically, sustainable integration of forages such as Napier grass (*Pennisetum purpureum*) and legumes can increase feed availability and quality, hence cattle productivity, and improve soil fertility through biological nitrogen fixation and soil erosion control.

A participatory variety assessment study was conducted in three villages in Babati district of Tanzania during 2014, to quantify yields and identify the selection criteria used by farmers to select Napier grass accessions. A total of six accessions (KK2, KK1, ILRI 16837, ILRI 16835, ILRI 16803 and ILRI 14984) were grown and harvested after 1 month on three field trials replicated three times per plot. Participatory assessment involving 77 farmers was conducted on the field trials managed by farmers using a rating and voting exercise. Farmers ranked their preferred Napier grass accessions and their selection criteria were documented. Agronomic data on yield (t ha^{-1}), height

(m) and number of tillers per stool were collected from the field trials to establish the most productive accessions.

The number of leaves per tiller, number of tillers per stool, tolerance to drought, regeneration period after harvest, and plant height were the five key criteria used by farmers to select and rank Napier grass accessions. Hairiness was not an important consideration since farmers fed any available feed resource due to severity of feed shortage. Farmers ranked Kakamega (KK) 2, ILRI 16835, ILRI 16837 and KK1 as first, second, third and fourth best accessions respectively. However, ILRI 16835 produced the highest yield (mean = 1.77 t ha⁻¹ (DM); sd = 0.93). Irrespective of the dry matter (DM) yield showing no significant difference between the accessions (mean = 1.40 t ha⁻¹ (DM); sd = 0.97), the number of tillers showed a significant ($P < 0.001$) positive relationship with dry matter yield for all the 6 accessions. About 54% of farmers appreciated the new strategy of planting Napier grass on the contours showing an indication of potential for integrating fodder crops in the maize based farming system of Babati district.

Keywords: Napier grass, forage, livestock, sustainable intensification

37. Local knowledge of farmers on challenges and opportunities for sustainably intensifying integrated tree-crop-livestock systems in two villages in Western Kenya

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Local knowledge refers to what people know about their natural environment based primarily on their own experience and observation. This study sought to understand the local knowledge of smallholder farmers in Western Kenya on the challenges and opportunities for sustainable intensification of integrated tree-crop-livestock systems in order to identify where there were disparities, synergies and complementarities with scientific knowledge. Local knowledge was elicited and analyzed using the Agro-ecological Knowledge Toolkit (AKT) methodology and software. Participatory rural appraisal tools were used including semi-structured interviews and focus group discussions. Interviews were processed, broken down into unitary statements, and entered into knowledge bases using the AKT5 software for evaluation and analysis.

The study was carried out in four villages in densely populated areas of Western Kenya where the dominant type of farming was integrated tree-crop-livestock smallholding systems. Stratification was based on topography, land size and farmer's age. These factors were hypothesized to have influence on local knowledge. Farmers were purposively selected per stratum in each site. The objectives were to (i) map the resources that the communities depend on and when they are available, (ii) assess land use, livelihood strategies used and how each gender participates, and (iii) characterize existing land uses and drivers of land use change. Women mainly provided farm labor while men were involved in migrated labor for remittances. From preliminary findings, it was evident that land scarcity was causing continuous land use and decreased soil fertility, hence low crop yields and increased food insecurity. Striga weed was a major challenge on most farms and farmers attributed its occurrence to use of inorganic fertilizers. Trees were mainly found along boundaries and around homesteads due to small land sizes. Farmers felt exploited by the brokers who bought their products.

This context-based knowledge will help to customize interventions and define critical entry points for sustainable intensification of integrated farming systems in the larger Western Kenya.

Keywords: Local knowledge, Agro-ecological Knowledge Toolkit, integrated farming systems, Kenya

38. Below and aboveground pigeonpea productivity in a novel doubled-up legume cropping system across three agro-ecologies in central Malawi

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Use of legume species that biologically fix nitrogen, provide high protein grain, and recycle nutrients through deep capture is one approach that has shown promise for sustainable intensification of cropping systems in Malawi. However, empirical data on root and shoot biomass additions through shrubby legumes has largely remained scarce. Field experiments were set-up across three

agro-ecologies in central Malawi, during the 2013/14 cropping season. Pigeonpea was planted as a sole crop or in an additive intercrop system with soyabean, groundnut or cowpea, a novel system that is referred to as the doubled-up legume technology. The system is hinged on the initial slow growth of pigeonpea, facilitating growth of companion crops as if sole cropped. Additionally, a maize-pigeonpea intercrop was included. Six months after planting, representative pigeonpea plants across treatments were cut at ground level, and above ground components separated into stems, twigs and leaves. Roots of the same plants were excavated for the 0-0.2, 0.2-0.4 and 0.4-0.6 m layers within the effective zone of the pigeonpea planting station, with a surface area of 0.75 m x 0.9 m, for 0.135 m³ soil volume per layer. Across sites, pigeonpea above ground biomass was largest for sole pigeonpea with 12.24 Mg ha⁻¹, compared with 2.39 Mg ha⁻¹ for the pigeonpea/maize intercrop. The pigeonpea/groundnut and pigeonpea/soyabean intercrops had 10.10 and 6.05 Mg ha⁻¹ pigeonpea aboveground biomass, respectively. Root biomass was largely confined to the 0-0.2 m layer, with trends similar to that for aboveground biomass. Root biomass ranged 0.65-1.62 Mg ha⁻¹ for the 0-0.2 m layer, 0.013- 0.12 Mg ha⁻¹ for the 0.2-0.4 m layer, and a maximum of only 0.023 Mg ha⁻¹, for the 0.4-0.6 m layer. At below 0.2 m depth, fine pigeonpea roots were dominant, being an essential attribute for nutrient and water uptake rather than soil organic matter replenishment. We conclude that intra-specific competition in a well fertilized pigeonpea/maize intercropping system is rather large, while pigeonpea productivity in a pigeonpea/groundnut system is comparable to sole cropped pigeonpea, with additional grain benefits. The Africa RISING program is promoting later system for enhanced land productivity on smallholder farms.

Keywords: Biological N₂-fixation, pigeonpea, soil organic matter, sustainable intensification, root biomass

39. On-farm Testing of Improved Legume Varieties and Management in the West Kenya Action Site

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More effective integration of grain legumes into small-scale farming systems is a priority within the East African Action Area of Humidtropics. In west Kenya, we seek to refine management options that advance biological nitrogen fixation (BNF) within these systems. Field activities continued during the "short rains" growing season in 2013-2014. A stakeholder planning meeting was conducted where farmer groups and county extension leaders identified a simple technology test involving legume varieties, fertilizer use and rhizobial inoculation as key management considerations. Two legumes, soybean (*Glycine max*) and climbing bean (*Phaseolus vulgaris*) are considered underexploited within current maize-based smallholder farming systems. Cooperators received a field protocol and accompanying inputs and installed a 169 m² farmer-managed technology test comparing two crop varieties (either soybean SB19 and cv Squire or climbing bean Tamu and Rwanda Red) Sympal (0-23-16) fertilizer and BIOFIX inoculant containing *Bradyrhizobium japonicum* strain USDA110. Farmers collected data on nodulation and yield. Data were compiled and summary statistics and economic analyses performed. Twenty-three of 27 cooperators submitted data, 16 using soybean, four using climbing bean and three with both. For soybean, inoculation and fertilizers resulted in 15 additional root nodules plant⁻¹ (+150%) with +41% crown nodulation and +49% red interior pigmentation. Squire outperformed SB19 when both fertilizer and inoculants were applied, producing 2399 (+348) kg grain ha⁻¹. Similar trends were noted for common bean (+17 nodules plant⁻¹) and Tamu outperforming Rwanda Red (2165 kg ha⁻¹ +664). Production costs of soybean ranged between \$200 and \$580 per ha⁻¹ depending on management intensity and offered up to \$972 net return (benefit: cost 2.7). Production costs were greater with climbing bean owing to reduced response to inputs and the need for trellises, offering net returns up to \$595 ha⁻¹. Soybean performed well in the Lake Basin and Midlands, but less so in the Upper Midlands (>1500 masl). Residual benefits from symbiotic N fixation were estimated at 52 and 82 kg N ha⁻¹ for bean and soybean, respectively. Indeed, these legumes hold promise for systems improvement.

Theme 3: Innovation Systems

40. Access to Information and Financial Services in the Innovation Platforms in the KKM PLS of the SSA CP

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The concept of Integrated Agricultural Research for Development (IAR4D) used the Innovation Platforms (IP) to address the observed low level of productivity and consequent underdevelopment among the poor farming households in sub Saharan Africa. This paper addressed the question of whether greater access to information and financial services in the IPs ensured higher levels of productivity for participants. We utilized a panel data from the baseline and midline data obtained from the KKM PLS of the SSA CP in West Africa. The data was obtained from twelve Innovation Platforms (IPs) of the three Task Forces (TFs) making up the Kano-Katsina-Maradi Pilot Learning Site (KKM PLS) of the sub-Saharan Africa Challenge Programme (SSA CP) to assess the food security status of the Integrated Agricultural Research for Development (IAR4D). Altogether, the analysis was carried out on 600 households in the PLS. Both descriptive analysis and the probit regression models show that members of the IPs had greater flow of information and as such more access to productive resources. More members of the IPs received more training and were exposed to greater number of and more varied topics in agriculture than non-members. About a third of the members had access to adequate financial resources especially through the IPs. More than half of the households saved their money, with b members of IPs saving more than non-members. Probit analysis revealed that age of household head, education and membership of IPs significantly increase the probability of their savings. More of the households who are members of IPs saved more over time.

In essence the formation of IPs has a significant effect on both access to information and financial services by the rural poor farmers and as such have the greater potential to leverage them out of poverty.

41. Co-design of improved climbing bean technologies in Uganda

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Numerous technologies to improve agricultural production in Africa are available, but uptake of these technologies among smallholder farmers is often poor. Reasons for poor uptake are diverse and cannot be addressed by agricultural research and extension alone. What can be done in agricultural research is to make sure that the technologies offered match the needs, objectives, opportunities and constraints of users of the technology. Technologies may be designed from a researcher's perspective with yield maximization as main goal, but farmers often have different production objectives or lack resources to invest in agriculture. Developing technologies together with the users of these technologies to create a range of options which address the diversity among farmers may enhance technology uptake. At the same time, using participatory approaches to develop technologies in large-scale development projects targeting hundred thousands of farmers remains a challenge.

The research-in-development project N2Africa (www.N2Africa.org) focuses on the dissemination of grain legume technologies in 11 countries in Africa. Within this project, a study was set up with the objective to develop a range of legume technology options for a diversity of farmers within such a large-scale project. The study focuses on two areas of Uganda where N2Africa works with climbing beans. Demonstrations of different varieties, inputs and staking methods for climbing beans have been established and are evaluated during the season by farmers of different farm types (based on resource endowment and gender), using the farmers' own criteria. These evaluations form the basis for technology co-design whereby farmers, extension officers, agronomists and researchers develop a range of production technology options for climbing bean, acknowledging the different aims, priorities and possibilities of farmers of different farm types. In subsequent seasons, farmers' adaptations of the demonstrated climbing bean practices in e.g. staking methods, input application or intercropping arrangements are monitored to refine the technology options. Principles derived

from this engagement with a limited number of farmers of different types could then be out-scaled within the larger N2Africa project.

Keywords: Co-design, adoption and adaptation, climbing bean, staking methods

42. Improving Tree Crop Systems in Nigeria and Cameroon Action Sites: the Humidtropics Perspective

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Tree crop systems are the dominant farming system of the southern Nigeria and Cameroon where Humidtropics, an integrated system research program has two action sites located. Humidtropics in West Africa seeks therefore to improve the lives of smallholder farmers whose livelihood depends on these systems through integrated system approach. Platforms are established at action sites and field sites levels where Research for Development (R4D) takes place. Group discussions during the setting up of the innovation platforms in the field sites and Rapid Appraisal of Agricultural Innovation Systems (RAAIS) conducted with R4D platform members were used to fast track the systems components, their constraints and the research priorities in Nigeria and Cameroon action sites. For farmers, private sector (input dealers, marketers, processors, transporters, etc.), NGOs and civil society, government representatives and researchers from universities and research centers, members of the platforms, the prioritized constraints in tree crop systems improvement are political, institutional and technological in Nigeria action site whereas in Cameroon action site they are technological, institutional and economic. These constraints are related to agricultural system and beyond. Therefore, research for development to improve tree crop systems in these two action sites should focus on productivity increasing, better natural resources management and institutions enhancement.

Keywords: Tree crop system, R4D/Innovation platforms, Action sites, Field sites, Nigeria, Cameroon

43. Experiences and process followed based in a system research approach for development in the Mukono/Wakiso R4D Platform, Uganda

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Humidtropics was launched in Uganda on the 1st and 2nd of August 2013 and since then the program was been implemented in two of the four sites selected (Kiboga-Kyankwanzi, Masaka-Rakai, Mukono-Wakiso and Luweero-Nakaseske) in the launching workshop.

Mukono/Wakiso districts were selected as one of the sites and since January 2014 many activities have been taking place to implement the program.

This poster represents all the steps followed to implement the program in Mukono/Wakiso field site, from the inception meeting to the creation of the innovation platform (IP) and all the activities organized by the platform to be able to implement the researchable entry points in the field. These research entry points were selected in a system based on vegetables, piggery and poultry, agroforestry and banana.

Each platform works as a unique structure as the members of the platform are who are leading the process in each site. Therefore this makes the activities, challenges, opportunities and results very distinctive from platform to platform and there is need to explain them separately for each site.

Humidtropics has been a learning process since its beginning. It has been a challenge to move forward so many stakeholders together however, step by step its implementation have been taking place and the ownership of the program has made, up to this moment, this process very successful.

44. Farming system patterns: cluster analysis from the Humidtropics baseline survey in Western Kenya

Nils Teufel, Esther Kihoro, Collins Adoyo, Carlos Quiros, Jane Poole, Mark van Wijk, Aziz Karimov, ILRI, corresponding author: Nils Teufel n.teufel@cgiar.org Presented by Randall Ritzema, ILRI.

The strategic research team SRT 1.2 within Humidtropics was mandated to conduct baseline surveys and typology analyses for action sites. Such a survey was conducted at the western Kenya

site in Kisumu and Vihiga counties between May and August 2014 to better characterize farming systems, determine typologies and identify entry points for Humidtropics interventions. A total of 400 households randomly selected from 20 sub-locations were interviewed, collecting data from male and female household members separately with a tablet-based implementation of the ImpactLite household questionnaire. The multiple variables captured in this baseline survey, including cropping patterns, livestock systems and indicators for value-chain integration, income, wealth and nutrition, provide a wide scope for determining variation and similarities amongst the studied households. Cluster analysis is used to define relevant and useful household groups based on the most efficient combination of variables considered in this analysis. Further, these groups are plotted by their geographical locations, indicating their geographical dispersion and allowing for investigating their correlation with other geographic indicators. Results from this analysis will considerably improve the opportunities for targeting Humidtropics interventions through a better understanding of farming systems in the target areas, in particular through patterns of income sources, market orientation and farming activities. They will also provide the basis for ex-ante assessments of proposed interventions, for instance through simulation modelling approaches. Finally, the typologies identified through this approach will allow for a fruitful discussion with other collaborators within Humidtropics, involved in generating typologies by other approaches.

Keywords: humid tropics, western Kenya, baseline, farming systems characterization

45. The stepping-stones to success: how we achieved co-investment and reflective learning in multi-stakeholder platforms in Uganda

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Utilization of systems approach using multi-stakeholder platforms as modality of intervention has been increasingly experimented in agricultural research in tropical zones. Recent research findings indicated strong evidence of the positive contribution of research for development (R4D) and innovation platforms (IP) in increasing the impact of research for development interventions. However, specific factors of the platforms leading to higher impact are yet to be discovered. This study assesses the success factors for achieving high ownership and high stakeholder engagement in Humidtropics R4D and IP platforms located in Mukono-Wakiso and Kiboga-Kyankwanzi using a mixed method approach. It represents the synthesis of the key informant interviews as well as the results of analysis of the structured surveys administered to a big diversity of the stakeholders. It argues that critical success factors for achieving high co-investment and high reflective learning in the multistakeholder platforms are existence of ownership by non-research stakeholders, shared leadership responsibilities between intervention actors and entrepreneurial platform members and sensitivity to desired facilitation functions in determining facilitators.

Keywords: Systems approach, multi-stakeholder platforms, critical success factors, R4D, IP

46. How innovation platforms can facilitate sustainable intensification? Insights from multi-level systems research in West-Africa

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As new instruments for agricultural policies, innovation platforms (IP) are experienced for over a decade. They reflect the evolutions in frameworks for thinking the drivers of agricultural development. Notably, researchers are supposed to become actors among others and no more be the only ones to produce useful knowledge. In West Africa, IPs are mainly promoted in two forms: “value chains approach-based” IP that aim at improving productivity, competitiveness and markets, and “agricultural research-oriented” IP that aim at designing and transferring new agricultural

practices. In both cases, researchers still face many demands for designing, implementing or facilitating IPs.

In order to explore the pertinence of these instruments as regards sustainable intensification processes (SI) in west-African savannah, the ASAP research platform gathering five national and international research centers (IER, IDR, CIRAD, CIRDES, INERA) organized a seminar in Bobo-Dioulasso in 2013. The objectives were to take stock of i) systems research results on innovation processes that contribute to SI, ii) lessons from the experimentations of IPs set up in different countries (Burkina, Mali, Niger, Senegal). Then we explored the possible functions of IPs in SI processes and we examined implications for researchers to achieve the high expectations that are being laid at their door.

Two main functions have been identified, according to the nature of innovations and the step of SI process itself: 1) either SI is breaking with the dominant agricultural model. IP functions are threefold: give sense to SI; create multi-actor partnerships based on long-term commitment to change and a way to collectively go-on through adaptive management; facilitate farmer-led innovation processes. 2) Or SI is in continuity with dominant agricultural dynamics. IP mainly aims at accelerating innovation processes through the facilitation of informal multi-actor arrangements and of knowledge exchanges between converging local innovation systems.

We showed how the diversity of systems research methods produced by ASAP research platform enables to produce useful tools and knowledge to help the implementation of these different IPs. However we also highlighted a number of areas for future research and capacity building issues for researchers if they are to play their part to the full.

Keywords: sustainable intensification, innovation processes, innovation platform functions, change management, research challenge, west-Africa

47. Fuzzy Cognitive Mapping for Innovation Platforms and Research in Development

Wim Paas, Wageningen University (Farming Systems Ecology); Perez Muchunguzi, Anna Sole, Dieuwke Lamers, Piet van Asten, IITA; Moses Tenywa, Department of Agricultural Production, Makerere University; Jeroen Groot, Wageningen University (Farming Systems Ecology), corresponding author: Wim Paas wim.paas@wur.nl

Fuzzy Cognitive Mapping (FCM) combines mind maps with fuzzy logic to assess the (causal) relations among phenomena and processes. The strengths of these relationships are used to assess the impact of changes on the system as described in the mind map. FCM features a quick and low cost semi-quantitative systems analysis at different scales that visualizes the complex reality around interventions. Moreover, FCM can strengthen participation and ownership in platform processes. Consequently, converging to promising integrated scenarios at an early phase in the platform process could be achieved by using FCM. In addition, the inclusion of feedback loops in FCM enhances the learning process of stakeholders regarding (integrated) systems thinking. FCM was tested in two Humidtropics innovation platforms in Uganda: Kiboga-Kyankwanzi and Mukono-Wakiso. Both one-day sessions commenced with an exercise at farm level that was followed by an analysis at regional scale. The participants first listed important phenomena and processes relevant to problems encountered in the case study area, and subsequently identified interrelations and the strengths of these interactions. This joint effort and the visualization of the result in a cognitive map helped the platform members to improve their understanding on how to proceed in the platform process. Sensitivity analysis with the FCM-software (FuzzyDANCES) further supports systems understanding and can be used to improve the fuzzy cognitive map. We think that FCM can be applied from the start onwards in the Innovation Platform process, with regular revisiting the cognitive maps to monitor changes in understanding of the problems at stake. At the same time, targeted research could support the subjective base of fuzzy cognitive maps with more objective information.

Apart from improving the function for FCM in innovation platforms, we try to involve FCM in methodologies that support the scaling out of interventions. Parallel to this, we look how FCM can fit in a portfolio of narratives and quantitative (model) approaches targeted at systems improvement and development.

Theme 4: Scaling for Impact

48. Characterizing adopters of sustainable intensification innovations: Evidence from Africa RISING program in Malawi and Tanzania

Beliyou Haile, Carlo Azzarri, Cleo Roberts, IFPRI; corresponding author: Beliyu Haile b.haile@cgiar.org Presented by Jeroen Groot, Wageningen University.

Supporting the world's projected nine billion people by 2050 necessitates increased production of food, feed, and bioenergy sources. This in turn is expected to put significant pressure on the environment and natural resources on which millions of poor people rely heavily and directly for their livelihood. Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) is a research-for-development program that aims to create opportunities for smallholder farmers to move out of hunger and poverty through sustainable intensification of their farming systems. Given the program's focus on demand-driven innovations that are likely to identify best-bet interventions to reach the highest possible number of beneficiaries, successful scaling up of the program necessitates evidence on what works and for whom. Using geographic information systems and household survey data from two of the program countries – Malawi and Tanzania – we examine the characteristics of villages and households targeted by the program and compare them with non-program villages and households randomly selected from the general population. We find target villages to differ from non-target villages along some biophysical and economic dimensions, such as access to market and agricultural extension services. We find beneficiaries in both countries to differ from non-beneficiaries along several dimensions. We find beneficiaries to be better educated, have larger family size, own more farm and household durable assets, have bigger land size, are more likely to own livestock, and have better quality housing, among other things. Beneficiaries also used more agricultural inputs, were more likely to practice intercropping and crop rotation and had higher yields in the previous harvesting season. These findings highlight the need to rethink targeting criteria for Africa RISING and other systems-based innovations, something that could potentially bear severe implications upon scaling up. Not only could adoption rates of agricultural innovations be low, but subsequent outputs and outcomes may not be as high when being scaled up to the broader population that may not be as well-off.

Keywords: Sustainable intensification, innovations, targeting, scaling up

49. Using the participatory research and Extension approach to promote sustainable agriculture in Borno State, Nigeria

Kamara Alpha, IITA; Paul Amaza, Department of Agricultural Economics & Extension, University of Jos, Nigeria; Jim Ellis-Jones, Agriculture-4-Development, a.kamara@cgiar.org

Rural livelihoods in Northern Nigeria have often been undermined by food insecurity, poverty and rapid environmental and natural resource degradation. This paper provides a case-study of a project, aimed at improving these livelihoods, using a participatory research and extension approach involving the active participation of farmers, researchers, extension agents, local policy makers and the private sector. Options for improvement based on researcher-managed trials on a range of new crop varieties and management practices were tested by community-selected farmers on their farms, resulting in other farmers trying some of the technologies. At the same time individual farmers were supported as community-based seed producers. Government extension agents played a key role in facilitating the process and encouraging farmer-to-farmer extension and technology adoption. By linking farmers to markets, adoption of improved production technologies was enhanced. Over a 4-year period PROSAB made a significant contribution towards improving food security and reducing poverty in target communities. The success illustrates the potential for research, development and private sector partners working closely with local communities to foster sustainable and just alternatives to improving livelihoods through advancing social and environmental causes in what has now come to be regarded as an “innovation systems” approach.

Keywords: Sustainable, participatory, partnerships, community-based, agriculture

16:00 BREAK

International Conference on Integrated Systems

16:30 SESSION 9 – THEMATIC PARALLEL SESSIONS – PARTNERSHIPS AND INSTITUTIONAL ARRANGEMENTS FOR INNOVATION, SCALING UP AND IMPACT
(Abstract presenters are underlined)

Theme 1: Performance and Impact of Multi-Stakeholder Innovation Platforms - Dr. Cees Leeuwis & Dr. Lisa Hiwasaki

16:30 **Opportunities for higher impact agricultural research for development - A systematic review on a generic theory of change linking multi-stakeholder platforms to development outcomes and available tools**

Murat Sartas, IITA/Wageningen University/Swedish University of Agricultural Sciences; Marc Shut, IITA/Wageningen University; Linley Chiwona Karltun, Swedish University of Agricultural Science; Piet Van Asten, IITA; Cees Leeuwis, Wageningen University, m.sartas@cgiar.org

Utilization of systems approach using multi-stakeholder platforms as modality of intervention has been increasingly experimented in agricultural research in low and low middle-income countries. Recent research findings indicated strong evidence of the positive contribution of research for development (R4D) and innovation platforms (IP) in increasing the impact of research for development interventions. However, available evidence on factors of the platforms leading to higher impact is contextual and generic lessons from the experience on platforms are hardly available. A major constraint creating the lack of generic lessons is the absence of a common generic theory of change linking multi-stakeholder platforms to development outcomes. A second constraint is the highly scattered efforts for research tool developments on the effectiveness of the platforms in achieving development outcomes. This review aims to create a systematic synthesis of the available evidence base linking multi-stakeholder platforms to development outcomes as well as of the research tools utilized for creating the evidence base. The systematic review is conducted following guidelines of Cochrane collaboration. It covers not only original research papers but also quality reports and books produced by the development actors in R4D landscape. The resources will be analyzed using Bayesian meta-analysis or EPPI method depending on the type of the qualified resources identified in the literature search. Generic theory of change linking multi-stakeholder platforms to development outcomes as well as the tool set that can be utilized to customize the generic ToC for geographically bounded livelihood systems will be suggested for informing R4D interventions and ongoing discussions on measurement of the impact of multi-stakeholder platforms.

Keywords: Systems approach, multi-stakeholder platforms, theory of change, tool, systematic review

16:50 **Innovation Platforms, Gender relations and Household food security in the KKM PLS of the SSA CP**

Adeolu Ayanwale, FARA; Olarinde Luke, Ladoke Akintola University of Technology, Nigeria; Fatunbi Oluwole, Adewale Adekunle, FARA, aayanwa@yahoo.co.uk

Compounding the rural household poverty status among the farming communities in the sub Saharan Africa is the unequal intra household gender relations. The Integrated Agricultural Research for Development (IAR4D) used the Innovation Platforms (IP) to address the observed low level of production and consequent household food insecurity resulting from low level of adoption of agricultural innovations among the poor farming households. This paper addressed the question of whether Female Headed Households (FHHs) in the IPs can be more food secure if granted improved access to productive resources as conceived in the IP. We related the food security status of both FHH and Male Headed Households (MHHs) to the bias in access to productive resources of the households. We utilised a panel data from the baseline and midline data obtained from the KKM PLS of the SSA CP in West Africa. The data was obtained from twelve Innovation Platforms (IPs) of the three Task Forces (TFs) making up the Kano-Katsina-Maradi Pilot Learning Site (KKM PLS) of the sub-Saharan Africa Challenge Programme (SSA CP) to assess the food security status of the Integrated Agricultural Research for Development (IAR4D). Altogether, the analysis was carried out on 600 households in the PLS. Both descriptive analysis, the ordered probit and the logit regression models show that the FHHs were more likely to be food insecure than MHHs. Among the FHHs, de jure FHHs are more food secure than de facto FHHs. The FHH who

are members of IPs were able to improve on their food security status over the period of analysis. The results confirm that experienced farm household heads who engage in addition enterprises and are members of IPs are more likely to be food secure. Therefore a detailed knowledge of the household dynamics in the FHH and MHH as well as encouragement of participation in IPs could assist speedy attainment of improved food security for rural households generally.

17:10 **Development Trajectories of Innovation Platforms in Lake Kivu Action Site**

Sospeter Nyamwaro, CIAT-Uganda; Buruchara R, CIAT-Kenya; Tenywa MM, Makerere University Uganda; Mogabo J, Rwanda Agricultural Board; Wanjiku C, CIAT-Rwanda; Kalibwani R, Bishop Stuart University, Uganda; Twebaze J, Kabale, Local Government Uganda; Fatunbi AO, Adekunle AA, FARA, s.nyamwaro@cgiar.org

Integrated Agricultural Research for Development, which has its roots in both integrated natural resource management and innovation systems, has generated impacts in Sub-Saharan African smallholder agriculture. As a concept, IAR4D has been actualized into practice through Innovation Platform approaches. Innovation Platforms (IPs) were formed and operationalized in various sites in SSA. IPs are mechanisms for integrating innovations in three basic areas including technological, institutional and infrastructural areas. Seven thematic areas formed the focus of technological interventions, which included productivity, natural resource management, policy, markets, product development, nutrition and gender. Institutional interventions involved areas like credit / finance, information / communication, insurance, input supply, policy, markets (market linkages, processing and packaging), product development, and gender and nutrition. In Lake Kivu definite areas of intervention revolved around productivity, NRM, and markets and policy. Normally IPs are expected to begin their activities from the market end, which is crucial for the functionality and stability of the system. The market end determines the engagement of partners in the platforms and also the business plans for the platforms, technology-enhancing productivity, value addition development and NRM development trajectories. The objective of this paper is to review and learn about the development trajectories of the IPs in the Lake Kivu Action Area. Knowledge learnt can be scaled to other places and get used to formulate a strategy for scaling up in Africa. The review mainly uses qualitative approaches in terms of literature review and synthesis, intelligent observatory research and case studies to arrive at some results, conclusions and recommendations. It is already observed that IPs in Lake Kivu area were developed in two generations. The first generation IPs were formed on the basis of agro-ecological considerations and the second generation IPs were formed on the basis of market access, all of them with one entry value chain enterprise. Since then the IPs have developed into different institutionalization levels with multiple enterprises, regardless of the ways in which they had been formed. The IPs appear to be meeting their short, medium or long term objectives.

Keywords: *Innovation platforms, IAR4D, development trajectories, Lake Kivu, Value chain enterprises, Themes*

17:30 General Discussion

18:00 End of session

Theme 2: Approaches to Scaling - Dr. Ann Degrande & Dr. Boru Douthwaite

16:30 **Theory of change as lever of change**

Boru Douthwaite, Marina Apgar, Rodrigo Paz, AAS/WorldFish, b.douthwaite@cgiar.org

This paper describes how AAS is using theory of change (ToC) to increase the likelihood that research goes to scale. Our starting point is that people act on based on their mental models of how change happens, in other words people work with implicit theories of change all the time. Running causal scenarios in our heads is part of what makes us human; however we rarely make them explicit to others. Accordingly, our ToC approach is to facilitate ToC workshops to collectively share and make explicit our ToC about how we think our research will lead to impact on the poor and marginalized in hubs in which we work, use the ToC for planning and then bring stakeholders back periodically to reflect on whether the theory matches experience, and adapt the theory and subsequent implementation plans accordingly. Participants reflect on evidence and experience from implementation, collected by direct involvement in the field and process documentation. Our use of

ToC can be understood as participatory action research on how change happens. The theory behind our use of ToC is collective inquiry builds participants' ability to plan, implement and adaptively manage interventions and gain a greater sense of collective efficacy. Making people more aware of how change happens, and the agency they have, will empower them to increasingly work together to find solutions to their own problems, leading to beneficial and sustained change at scale. AAS is testing this theory as part of its research on how research in development levers change at scale.

Keywords: Change at scale, participatory action research, change, adaptive management, motivation

16:50 **Farmer-to-farmer extension in Cameroon: practice, opportunities and challenges**

Sygnola Tsafack, Ann Degrande, ICRAF/Humidtropics; Steven Franzel, Brent Simpson, Michigan State University, T.Sygnola@cgiar.org

The past decade has seen a renewed interest in investment in agriculture and particularly extension; however, policy makers would like to see extension systems that are more participatory, cost-effective, and sustainable. Farmer-to-farmer (F2F) extension is such an approach in which farmers share knowledge on agricultural innovations within their communities; however, evidence demonstrating their superiority over old approaches is hardly available and there are concerns in the literature on the capability of farmers to take up extension.

This paper examines experience of 25 organizations with the F2F extension approach in Cameroon. Results show that most extension services involving farmers in their extension strategies are local NGOs (60%). Forty-one percent found the F2F approach the most effective amongst other methods used. The main reasons for adopting F2F extension were reaching more farmers and increasing sustainability and efficiency, while building farmers' capacity was considered as less important by the organizations surveyed.

In terms of gender, 28% of the field staff working with lead farmers was female and 37% of lead farmers were women; however, the high variability of these numbers did not allow drawing conclusions about whether F2F extension is more gender-sensitive or successful in reaching women farmers than other methods. Seventy-six percent of the organizations stated that their LFs were not receiving a salary, suggesting that other non-financial factors are motivating LFs. The results showed that motivations to become and remain a LF are similar but their importance changes slightly, which has important implications for the design of effective F2F extension approaches because different support mechanisms are needed at different stages in the career of a LF.

Increased coverage and adoption at low cost were among the main benefits of the F2F approach mentioned in the study. Selection and motivation of lead farmers remains a major challenge, as it largely affects the success of the F2F extension strategy. At the end of the paper information is provided on opportunities that could be explored to improve the motivation and effectiveness of lead farmers and sustainability of farmer-led extension programmes.

17:10 **What drives agroforestry adoption in Cameroon?**

Degrande Ann, Chiatoh Maryben, Nimino Godwill, Ngaunkam Precilia, ICRAF/Humidtropics, Cameroon; Franzel Steven, ICRAF, Kenya; Place Frank, IFPRI, A.Degrande@cgiar.org

Despite the growing body of literature on factors affecting adoption of agricultural innovations, understanding adoption in a way that would facilitate the design of more effective extension systems remains challenging.

In Cameroon, research on tree domestication with a view to increase incomes and enhance resilience of rural communities by cultivating indigenous trees and marketing the produce, started in 1998. Its success has been widely reported. However, most evidence on its adoption and livelihood benefits has been anecdotic or qualitative. The present study therefore aims to analyze in a more comprehensive way and recommend ways to accelerate adoption of tree domestication and other agroforestry technologies by farmers in the humid zones of Cameroon.

A total of 720 households were interviewed in 72 villages, representing different agro-ecological zones, levels of market access and agroforestry dissemination efforts. Trends in adoption were examined by gender and agro-ecological zone and information on planting of improved trees on

farm was collected. The study also looked at dissemination pathways, with specific emphasis on sources of information and farmer-to-farmer sharing of knowledge and skills.

Tree propagation and planting of improved trees were the most widely adopted techniques. Soil fertility management and fodder trees were primarily practiced in the humid savannah zone. Male-headed households adopted more than female-headed, but within households, women were actively involved in the practice of most agroforestry technologies. Marketing and post-harvesting processing were adopted under conditions of collection action. No meaningful differences were found in terms of age of household head, household size, farm size, experience with farming or wealth indicators between adopters and non-adopters. However, results showed that membership in farmer organizations, contact with extension services and exposure to agroforestry information significantly facilitated adoption. Moreover, farmers, men and women alike, who practice agroforestry techniques, shared this knowledge mainly with fellow farmers within and beyond their villages, although to different extent depending on the technique.

The importance of grassroots extension mechanisms and farmer-to-farmer dissemination came out very strongly in the study. It is thus recommended to strengthen the role of community-based organizations in agroforestry extension and encourage exchange of information and skills between fellow farmers.

Keywords: agricultural extension, gender, grassroots organizations, tree domestication, rural advisory services

17:30 General Discussion

18:00 End of session

Theme 3: Institutional and Methodological Issues in Working in Multi-Stakeholder Settings - Dr. Bernard Triomphe & Dr. Marc Schut

16:30 Engaging local stakeholders in more inclusive innovation processes. Lessons from a review of innovation experiences in African smallholder agriculture

Bernard Triomphe, CIRAD UMR Innovation, France; Anne Floquet, University of Abomey-Calavi, Benin; Brigid Letty, INR, South Africa; Geoffrey Kamau, KARI, Kenya; Ann Waters-Bayer, ETC Foundation, Netherlands, bernard.triomphe@cirad.fr

Within the context of the EU-funded JOLISAA project (Joint Learning in and about Innovation Systems in African Agriculture), 13 experiences about agricultural innovation involving smallholders and their partners were assessed in Benin, Kenya, and South Africa.

The assessment framework focused on key dimensions of the innovation processes and their dynamics, such as the actual nature and domain of innovations, stakeholders and their roles, innovation triggers and drivers, phases and effects. Among them, the 13 cases covered a wide diversity of experiences: designing a certified value chain for the sustainable exploitation of Aloe in Kenya, the emergence of value chains for producing and processing soybean-based food products in Benin, or also managing sustainably an invasive tree species by developing a certified charcoal market in Kenya.

Innovation triggers and drivers were multiple and changed dynamically and often unpredictably during the innovation process. For external stakeholders, likelihood of offering a technological fix to an existing problem and availability of funding were key triggers. For local people, access to input and output markets was consistently a powerful trigger and driver. Interestingly, local innovation dynamics seemed both to pre-exist and also to develop as a result of external intervention, even though formal R&D institutions seem hardly aware of, and interested in, the local innovation landscape.

Based on JOLISAA experience, several policy lessons and recommendations were put forward. For one, innovation needs to be looked at as a continuously evolving bundle of innovations of various kinds being developed by both local and external stakeholders over long time frames.

Consequently, open-ended, flexible approaches to innovation development are needed with the potential to engage meaningfully with local stakeholders and favor joint learning, thus contributing to develop enough local capacity to lead and sustain the innovation process. External R&D interventions need to build on local initiatives and knowledge before engaging in externally-driven innovation development. Finally external R&D interventions need to design from the onset realistic

ways for innovation processes instigated within the protected and well-supported artificial environment offered by projects to continue after initial interventions and external funding have stopped.

16:50 **Leveraging instructional design and learning theories to improve productivity in smallholder systems: The FEAST experience**

Iddo Dror, Lukuyu, B., Duncan, A., Blummel, M., ILRI, i.dror@cgiar.org

Feed for livestock is often cited as the main constraint to improved productivity in smallholder systems, yet uptake of feed technologies remains relatively low. The Feed Assessment Tool (FEAST) is a set of electronic forms and accompanying documentation designed by scientists from the International Livestock Research Institute (ILRI) to help research and development practitioners working in the agricultural sector conduct farmer-centered diagnoses by providing a more systematic means of assessing current feed, related strategies and analytics to inform the development of new strategies. The main forms of the FEAST tool are built on Microsoft Excel, but feature a more visual, more intuitive interface than typical spreadsheets.

To date, FEAST training for practitioners has consisted of 3-day, face-to-face sessions conducted on-site in host countries, facilitated by members of ILRI's staff. While the growing popularity of the FEAST tool is seen as a positive development, the increasing demand for training has placed a considerable strain on ILRI's staff, to the detriment of other activities, and perhaps also limits the dissemination of the tool to all those who can benefit from it. Meanwhile, there is a sense that 3 days of traditional classroom instruction might not be sufficient to adequately address the major concepts and skills necessary for the participants' success in the field.

ILRI, as part of its contributions to the CRPs on Livestock & Fish and Humidtropics, has decided to convert the existing materials into a blended learning course with both online and offline modules, and a re-designed face to face component, to provide a more effective learning experience to more participants in less time than current methods / resources allow, reduce the burden on current facilitators while ensuring consistency and accuracy of instruction even if less experienced facilitators are enlisted to deliver the classes, and better track the performance of class participants. The poster/presentation will cover the process followed, explain why and how to reformat and refine course materials, and provide an overview of effective development of eLearning and blended learning materials in the context of systems research developing countries.

For more information, visit: www.ilri.org/FEAST

Keywords: FEAST, Capacity Development, instructional Design, E-learning, blended-learning, ICT4D

17:10 **Entry points for innovation for sustainable intensification of agricultural systems in Central Africa**

Marc Schut, IITA/ Wageningen University; Cyrille Hicintuka, ISABU; Sylvain Mapatano, DIOBASS; Leon Nabahungu, RAB; Perez Muchunguzi, Chris Okafor, Emmanuel Njukwe, Piet van Asten, Bernard Vanlauwe, IITA, m.schut@cgiar.org

Strategies for intensification of agricultural systems require integrated analyses of constraints and opportunities for productivity, natural resource management and institutional innovation. Stakeholder participation is an essential success factor for integrated analyses and achieving development impacts. Involving farmers, policymakers, and private sector or development partners provides a richer picture of constraints for intensification, and offers a more solid basis for exploring innovation strategies that are acceptable for different stakeholder groups.

To identify entry points for innovation to intensify agricultural systems in Central Africa, multi-stakeholder workshops were organized in Burundi, Rwanda and DR Congo. Workshop participants identified, categorized and prioritized key constraints and opportunities for innovation using the Rapid Appraisal of Agricultural Innovation Systems (RAAIS) workshop methodology.

Results demonstrate key constraints for intensification of agricultural systems are mainly of economic and institutional nature. According to workshop participants, the majority of these constraints are caused by a lack, or poor functioning, of policies and rules (e.g. for input distribution) and the absence of capacities and resources (e.g. access to credit), and require interventions at the national level. Addressing constraints faced by government would have a positive effect on solving constraints faced by other stakeholder groups. Workshop participants indicated that 67% of the

constraints require institutional research for development (R4D) activities. Key entry points for innovation include the development and implementation of strategies for tree-crop-livestock integration (productivity innovation), Integrated Soil Fertility Management (natural resource management innovation), and enhanced collaboration between different stakeholder groups in the agricultural sector (institutional innovation).

Responding to stakeholder constraints has important implications for agricultural research and development organizations in the region. First, addressing economic and institutional constraints would require a shift away from R4D that focuses on productivity increase and sustainable natural resource management at farm or community level. Our data shows that constraints at these levels cannot be solved in a durable way if constraints at higher integration levels are not being addressed simultaneously. Increased investments in R4D activities that can foster institutional innovations are essential.

17:30 General Discussion

18:00 End of session

Theme 4: From Farm to Landscape and Further: Integration of Scales - Dr. Herve Bisseleua & Dr. Victor Mares

16:30 From farm to landscape and further: Increasing the capacity for integrated research system and innovation

Herve Bisseleua, Humidtropics, IITA/ICRAF, H.Bisseleua@cgiar.org

The demand for food is expected to more than double by 2050. This increase in demand will also mean an increase in supply, much of which will come from an increase in production. Such an increase in production might only meet the demands of the rich and not the needs of the poor or the undernourished if it is not followed by an increase in distribution, accessibility and affordability. Intensification or 'sustainable intensification' may destroy the ecological integrity of entire landscapes, without benefiting those in need of more food. Agricultural policy and redoubling agribusiness as usual would have a massive impact on the environment, without insuring food security or food sovereignty. To avoid such perverse outcomes, clear consideration, from the outset, is needed regarding who is going to benefit from intensification, and via which mechanisms. At the landscape scale, systems as a whole need to be assessed for their efficiency and resilience in producing a portfolio of useful goods and services from freshwater to food (and export) crops. This paper encourages the use and further development of a broader range of system methodologies (and system thinking in general) as well as system learning approaches to articulate landscape management with farming systems and propose strategies of agricultural landscapes to relate farming practice, natural resources and local development. Finally, we discuss how the landscape management by farming systems can help to structure the interaction of agronomy with other disciplines, such as agribusiness and community development, sociology, geography, landscape ecology and territorial development.

Keywords: Agricultural landscape, farming system, system learning, sustainable intensification, system research, territorial development

16:50 Scaling-up of Productivity Enhancement in Rainfed Agriculture

Suhas P Wani, KV Raju, K Krishnappa, KL Sahrawat, ICRISAT, corresponding author: Suhas P Wani s.wani@cgiar.org Presented by K.H. Anantha, ICRISAT.

Globally rainfed agriculture covers 80% of area and contributes 60% of the global food needs. Rainfed tropical areas are the hotspots of poverty, malnutrition, food insecurity; and these areas are also prone to land degradation and water scarcity. Rainfed areas as well as small farm holder farmers are more vulnerable to the impacts of climate change. Despite large strides made by research for upgrading dryland agriculture, the productivity of dryland agriculture has not increased over the decades. There is a challenge for enhancing agricultural productivity and production in dryland areas for achieving food and nutritional security with growing water scarcity and impacts of climate change.

Large yield gaps in rainfed agriculture exist as the current farmers' field yields are lower by two to five folds compared to achievable potential yields, and are due to lack of knowledge sharing with the

farmers from the researchers. ICRIAT and its partners have developed farmer-centric community watershed management as an entry point for sustainable intensification of rainfed agriculture. The assessment of watershed programs has revealed that large potential exists to improve the impacts of 2/3 of the watershed programs in the country as only 1/3 of the programs were performing above average by adopting participatory approach, low cost rainwater harvesting structures to address the issues of equity, for enhancing water productivity for increasing productivity and profitability of the farmers. Increased tangible benefits as well as ownership of the program implemented by the small farmholders are crucial for success. The model was assessed as a scalable and scaled-up further at the district level through Andhra Pradesh Rural Livelihoods Program (APRLP) and Sujala watershed program. As a result, new watershed guidelines at the national level were released in 2008; and since then, this model has been scaled-up in India.

Similarly, productivity enhancement initiative using soil nutrient mapping as an entry point has been developed and scaled-up as Bhoochetana in Karnataka state of India. The innovative, institutional arrangements for knowledge sharing as well as for a holistic approach from diagnosis of the constraints up to disposal of the increased produce through institutional and policy options has benefited 3.65 million farming families in the state. The increased crop yields by 20-66% with a benefit cost ratio of 2 to 14:1 for individual farmers has benefitted farmers of the state to the tune of Rs. 1267 cores from 2009-2013 through value of increased crop production. The results of two scaling-up approaches, learnings and drivers of success will be discussed.

17:10 Enhancing dynamic systems research by activating integrative perspectives on processes of scaling up in agricultural development and innovation

Seerp Wigboldus, Wageningen University; Marc Schut, IITA/Wageningen University; Katharina Schiller, Onno Giller, Laurens Klerkx, Marijn Poortvliet, Anne Marike Lokhorst, Cees Leeuwis, Wageningen University, seerp.wigboldus@wur.nl

Scaling up as part of agricultural development and innovation involves more than a mere “finding out what works and then doing more of the same”. It usually involves a range of complex dynamics of interacting actors, processes and factors. Success and failure of scaling up not only relate to whether something goes to scale or not, but also to wider (positive and negative) implications and impacts of such scaling up. However, most systems research methodologies do not pay specific attention to understanding scaling processes. The multi-level perspective on socio-technical innovation, which is part of the reference framework for Humidtropics, offers opportunities for better understanding innovation and scaling processes. However, in the context of agricultural research and development it requires further elaboration and adaptation to better connect to the realities involved in scaling up innovations.

As part of SRT3, the responsible scaling research theme is undertaking studies which use a research approach involving a practice-oriented elaboration of the multi-level perspective. It helps to ‘unpack’ what is involved in processes of scaling up and what/how actors and factors relate to conditions for success. We describe the research approach, its methodological options, and illustrate initial application from a study on scaling up agro-ecology in Nicaragua and from a study on scaling up ‘green’ rubber in China. The case studies demonstrate the value of the approach for studying processes of scaling up. The approach activates an integrative/systems perspective on relevant actors and factors related to potential success and failure of scaling up, it helps to understand targeted scaling processes in a wider context of other scaling processes, and then helps to strategize for what may be considered as context-sensitive and ‘responsible’ scaling. E.g. in China we identified a need to facilitate stronger collaboration between stakeholders who were each trying (so far unsuccessfully) to scale up aspects (e.g. alternative crops, mixed cropping) of what ‘green’ rubber relates to, a need to take roles of smallholders much more seriously in strategizing for scaling up, and a need to not only look at what happens in rubber, but to adopt a wider landscape perspective.

Keywords: Agricultural innovation, Scaling up, Integrative perspectives, Research methodologies

17:30 General Discussion

18:00 End of session

19:00 DINNER RECEPTION WITH ENTERTAINMENT

Conference Program: Day 4 – March 6

8:30 SESSION 10 – FORESIGHT IN SYSTEMS RESEARCH FOR DEVELOPMENT IMPACT
Recap of Day 3: What Challenges Surround Partnerships and Institutional Arrangements?

9:00 **Presenter: Dr. Dolapo Enahoro**, PIM/ILRI, D.Enahoro@cgiar.org

Foresight Modeling to Guide Sustainable Intensification of Smallholder Systems

Concerns about the future of a global food and agricultural economy under threat from economic, socio-political and climate-related shocks has triggered renewed interest in the use of integrated foresight analyses to address questions of food supply and availability. With support from the CGIAR research program on Policies, Institutions and Markets (PIM), the Bill and Melinda Gates Foundation, and other donors, much attention is being paid to the development of tools and methodologies for assessing biophysical and economic dimensions and long-term prospects for global agricultural production and food security. This presentation outlines foresight analysis work within the CGIAR's Global Futures and Strategic Foresight program, highlighting the development and application of a quantitative modeling framework to address questions of technological innovation, climate change and agricultural productivity. We discuss the capacity of the modeling platform for carrying out long-term projections of commodity markets and for evaluating the use and availability of key natural resources in agricultural production (e.g., land, water). We point to some applications in which we quantify the country-level implications of global commodity interactions on agricultural incomes, nutrition, and related indices, and illustrate how this can serve as a useful way to guide research efforts and investments that are aimed at increasing productivity and production in agricultural systems. An example is provided of recent efforts to disaggregate the model's representation of global livestock production into representative systems so as to improve its applicability. In this presentation we also suggest possible future directions in which the modeling platform of data, models and methodologies can be improved and linked to other activities so as to better address trade-offs, synergies and externalities relevant to sustainable intensification and smallholder agriculture. The institutional arrangement underlying the foresight analysis work is briefly outlined in the context of its potential for fostering cross-program collaboration and providing leverage to enhance systems-focused quantitative analyses.

Keywords: Global, foresight, sustainable intensification, smallholder agriculture, systems research

9:15 **Presenter: Dr. Randall Ritzema**, ILRI, R.Ritzema@cgiar.org

Agricultural futures in the humid tropics: A multi-scale approach

Timothy P. Robinson, Randall S. Ritzema, Nils Teufel, Mark T. van Wijk, ILRI; Robin Bourgeois, GFAR; Mark Lundy, CIAT; Cees Leeuwis, Wageningen University; Iddo Dror, ILRI; Ingrid Öborn, ICRAF/Swedish University of Agricultural Sciences; corresponding author: Tim Robinson
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Growing populations, income gains and urbanization are translating into increasing demand for agricultural products, and this growth is particularly strong in Africa and south-east Asia. Growing populations, income gains and urbanization are translating into increasing demand for agricultural products, and this growth is particularly strong in Africa and south-east Asia. Based on current projections we will need to feed a larger, more affluent global population of over 9 billion in 2050, equating to a potential 70 percent increase in global food demand. This growth will take place in the context of changing climates and increasing scarcity of natural resources. The role of poor, rural agricultural communities in this growth is uncertain and the research proposed here aims to enhance understanding of what that role might be, and the types of innovation that may be needed to optimize that role.

There is a number of ways to consider the future in the agriculture sector. While typically taking a systems approach, these methods vary in terms of spatial scale, geographic precision and temporal scale. At one end of the spectrum are the global, long-term projections of demographic, economic, land use and climate change under different scenarios. At the other end are participatory, community-based foresight approaches that explore people's short-term aspirations and concerns, and the opportunities and constraints affecting the achievement of desirable outcomes. At an

intermediate level, both spatially and temporally, scenario analysis based on detailed farm household survey data, can be utilized to enhance projections of the effects of innovations, to strengthen the linkages between scales, and to clarify relationships across systems. We propose to explore combination of these approaches to contemplate possible futures in two contrasting areas: western Kenya and north-west Vietnam. Global and regional projections will provide the broad context; analysis of household data collected using the IMPACT Lite survey instrument will be used to explore the geophysical and economic plausibility of proposed scenarios; and participatory approaches will be undertaken with selected communities in these two areas to explore people's hopes, fears and expectations regarding their agricultural and livelihood futures. Lessons from each approach will be consolidated with a view to driving the research, innovation and policy and institutional contexts required to steer agricultural development along socially desirable and economically and ecologically sustainable pathways.

9:30 **Presenter: Dr. Michael Phillips**, WorldFish, M.Phillips@cgiar.org

Future-smart research agendas: Engaging and empowering local stakeholders through foresight

Ranjitha Puskur, Sarah Park, WorldFish; Robin Bourgeois, Global Forum on Agricultural Research; Sharon Suri, Michael Phillips, World Fish; corresponding author: Ranjitha Puskur r.puskur@cgiar.org

The future is marked by uncertainty. Whilst the future cannot be predicted, it can be systematically explored and better decisions can be made in the present time with an eye to the future. Exploring the future has the potential to unveil new paths, options, and unexpected effects of our decisions. However, there is an inequitable capacity to use foresight as a systematic, systemic, participatory and multi-disciplinary approach to explore mid- to long-term futures and drivers of change. For example, whilst foresight offers a research focused approach to understanding how poverty and food security issues may play out over the coming decades, those most directly affected (e.g. farmer and civil society organizations in developing countries) lack critical capacity in foresight. How could they then be expected to play a proactive role in shaping research agendas and development policies at local, national and global scales that affect their futures?

To address this challenge, GFAR is engaged in supporting a grassroots foresight initiative across the world, led and managed by farmer organizations. This foresight approach combines a structural analysis of factors of change and a morphological analysis leading to the crafting of contrasted and plausible scenarios of the future. Scenarios are a foundational step in using the future to guide societal choices and define actions.

The CGIAR Research Program on Aquatic Agricultural Systems (AAS) is collaborating with GFAR in the development and implementation of a multi-scale foresight based engagement with stakeholders associated with aquatic agricultural systems. This foresight process, based on the principles of engagement and empowerment of poor and marginalized farming communities as a tool for transformation, is coherent with the RinD approach applied by AAS. As a first step in a multi-year foresight process, in 2015 AAS and partners will pilot participatory scenario building activities to explore plausible futures in two of its flagships – Asia's Mega Deltas and African inland waters. Findings from this will contribute to defining, refining and prioritizing the research agendas for these aquatic agriculture systems and feed into the GCARD 3. This will also help inform future-focused research and development policies, practices and investments to shape pathways towards desired futures.

Keywords: aquatic agricultural systems, foresight, Asia's Mega Deltas, African inland waters, scenario-building, civil society, farmer organizations

9:45 **Opportunities and Challenges in Using Different Approaches to Foresight in Systems Research**

Brief Introduction in Plenary followed by Facilitated Discussion

Panelists: Dr. Dolapo Enahoro, PIM/ILRI; Dr. Randall Ritzema, ILRI;
Dr. Michael Phillips, WorldFish; Dr. Marie de Lattre-Gasquet, CGIAR Consortium

10:30 BREAK

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11:00 SESSION 11 – FUTURE DIRECTIONS: HOW TO TAKE SYSTEMS RESEARCH FORWARD?

Dr. Richard Thomas, Drylands

Dr. Patrick Dugan, AAS

Dr. Kwesi Atta-Krah, Humidtropics

Brief Presentations by CGIAR Research Program Directors in Plenary followed by an Interactive Panel Discussion

12:30 LUNCH

14:00 OFFICIAL CLOSING SESSION

Key Messages and Summary of Conference

Closing Remarks

16:00 FIELD VISIT

Tour of IITA Campus facilities and installations (optional)



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Notes:

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