Farming Systems and Modelling

Proceedings of a Workshop, Salima, Malawi, July 29-August 1, 2013

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The Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) program comprises three research-for-development projects supported by the United States Agency for International Development as part of the U.S. government's Feed the Future initiative.

Through action research and development partnerships, Africa RISING will create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

The three projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads an associated project on monitoring, evaluation and impact assessment.

Contents

ACRONYMS

Africa RISING	Africa Research in Sustainable Intensification for the Next Generation
AFSP	Agroforestry Food Security Program
CA	Conservation Agriculture
CIAT	International Centre for Tropical Agriculture
CGIAR	Consultative Group on International Agricultural Research
EPA	Extension Planning Area
FAO	Food and Agricultural Organization
GCFSI	Global Centre for Food Systems Innovations
GDP	Gross Domestic Product
HESN	Higher Education Solutions Network
ICRAF	International Centre for Research and Agroforestry
IITA	International Institute for Tropical Agriculture
ILRI	International Livestock Research Institute
LUANAR	Lilongwe University of Agriculture and Natural Resources
MSU	Michigan State University
PEER	Partnership for Enhanced Research Engagement
RDP	Rural Development Program
USAID	United States Agency for International Development

PREFACE

This report narrates the proceedings of the Africa RISING-Malawi farming systems and modelling workshop held from 29 July to 1 August 2013 at Sunbird Livingstonia Beach Hotel in Salima, Malawi. Key project collaborating partners and relevant stakeholders convened to take stock of the early results coming out of Africa RISING research in Malawi, and map the utility of modelling approaches as tools to explore farming systems functioning. The Global Centre for Food Systems Innovation (GCFSI) joined the workshop with 6 participants from MSU. Key objectives of the workshop were:

- To review findings from the region and case studies from Malawi of best bet options and technologies that support climate change adaptation and sustainable intensification
- To explore technology packages that could be used by farmers in contrasting agro-ecologies and farmer typologies (moving beyond the descriptive and exploratory phase), and
- To introduce to participants key concepts in farming systems modelling
- To explore potential new strategies for expanding the scope of Africa RISING research in Malawi during Year 3 and beyond
- Through various presentations and group discussions, we attempted to answer the questions:

1. What strategies could be used for research to produce pathways that substantially impact livelihoods
2. What are the key practical planning and decisions that can be facilitated through modelling to result in sufficient scope for driving sustained agricultural intensification pathways and climate smart agriculture?

The workshop came up with a number of recommendations, including expansion of research team to effectively capture the crop-livestock interactions in the farming systems, mainstreaming local value addition of grain legumes for enhanced household nutrition security outcomes, and consolidation and expansion of the action sites as opposed to introducing new action sites.

BACKGROUND

Understanding the farming systems we work in and applying decision support tools, including models, are fundamental towards advancing the link between concepts and reality. There is an increased recognition that a 'systems approaches' are needed to meet the challenges presented by the highly heterogeneous and complex smallholder farming systems in Africa. Experimental approaches that are participatory in nature are increasingly producing empirical evidence on the performance of agricultural intensification technologies with the most relevance to local farming communities. Effort must therefore be put to document the approaches, including the rich experiences in formats that can make replication across space more rapid. Overall we perceive the coupling of crop simulation modelling approaches to farming systems analysis as a viable vehicle to expedite knowledge accumulation, especially for complex environments.

This workshop reviewed our current understanding of farming systems functioning, and provided an opportunity for different stakeholders to debate on the most promising approaches for making technologies work better on smallholder farms. A good representation of faculty from Lilongwe University of Agriculture and Natural Resources (LUANAR), University of Malawi, Malawi Extension and MSU's Global Centre for Food Systems Innovation (GCFSI) enabled rich debates on appropriate pathways of engagement with farmers, to support farmer innovation around intensification and climate smart agriculture. With a wide range of technologies available and equally diverse stakeholders promoting the use of these technologies, the main concern is related to mixed messages emerging if there are no attempts to harmonise appropriate packaging of the technologies. In part, Africa RISING research aims to provide such pathways, and thus enable more effective delivery of products of research to diverse farming households.

WORKSHOP OPENING REMARKS

Professor Kanyama Phiri (Vice Chancellor, LUANAR)

The vice chancellor of Lilongwe University of Science and Natural Resources (LUANAR) welcomed all the participants to the Africa RISING modelling and Farming Systems workshop. In his remarks, he emphasised the long term relationship which exists between LUANAR (formally known as Bunda College of Agriculture) and MSU since 1990's, making the partnership on Africa RISING the more meaningful. Professor Kanyama Phiri highlighted the objectives of the workshop which included a review of current knowledge on agro-systems and how to make technologies more accessible to farmers under different biophysical production circumstances. He indicated that the USAID investments in both Africa RISING and the GCFSI would go long way to stimulate sustainable intensification practices in farming communities.

FORMAL WORKSHOP PRESENTATIONS

Professor Bekunda Mateete: Africa RISING Overview

The presentation gave a brief overview of Africa RISING program and the research approach in East and Southern Africa (ESA). The presentation outlined the program framework which can be obtained online http://africa-rising.net. Africa RISING operates in West Africa, East and Southern Africa and Ethiopian highlands, with three research for development projects supported by USAID as part of the US government feed the future initiative. Africa RISING research feeds into the CGIAR Research program CRP 1.2 for the Humidtropics, although research transcends through some semi-arid areas (CRP1.1). Africa RISING is expected to create opportunities for smallholder farming households through action research and development partnership to move out of hunger and poverty. This will

be achieved through sustainably intensified farming systems that improve food, nutrition and income security. The projects are led by International Institute for Tropical Agriculture (in West Africa, East and Southern Africa) and the International Livestock Research Institute (in Ethiopian Highlands). Prof Mateete clarified a number of questions on Africa RISING, including the duration of the program – 5 years- although works plans are supposed to be produced each year.

Dr Isaac Nyoka (ICRAF): Innovations in Climate Smart Agriculture- an overview

The presentation started with a brief background of ICRAF which started in 1978 as a Council to promote exchange about agricultural research in tropics. It became part of CGIAR in 1992. In southern Africa ICRAF operates in uplands and plateau areas of the miombo eco-regions. Its focus is mainly on general land degradation and increase in nutrition and income of smallholder farmers. ICRAF use trees to mitigate impacts of extreme events, soil fertility and long lasting carbon stocks, and providing quality fodder to livestock during dry seasons. Current agro-forestry innovations include fertiliser trees, fodder banks, fruit trees and woodlots. These innovations are applied as means of improving soil fertility, as well as controlling annual nutrient depletion in agricultural soils. It also encourages improved fallows for regeneration of soil fertility in areas with low population pressure. Improved fallows of Tephrosia have shown to give large biomass within one season. Conservation agriculture with trees (CAWT) addresses the challenge of crop residue retention. Some of the agro-forestry trees which are consumed by livestock also give an opportunity for smallholder daily farmers since they are nutritious and increase milk production for dairy cows. Dr Nyoka indicated that some agro-forestry species may accrue a lot of biomass but without direct edible components, adoption maybe a challenge.
Some of the questions and suggestions raised after the presentation were related to:

- Short term benefits of agroforestry practices
- which is better to intercrop with beans or with agroforestry trees
- agroforestry trees do not grow well on poor soils
- some agroforestry tree species have high polyphenol contents, and so may not be ideal

Dr Wezi Mhango (LUANAR): Best bets in Malawi - an overview

This presentation was about legume best-bets for both soil fertility maintenance and grain legume intensification. The central theme is on appropriate intercropping arrangements and crop rotations, and assessing acceptability by diverse farming households. Some of the factors which need to be considered when practising the above cropping systems are crop complementarity as well as the choice of component crops. Approaches used include baseline characterisation, farm trials, farmer exchange visits, nutrition education, field days, community based seed multiplication and seed pass on initiatives and interaction with policy makers. Results of modelling showed that intercropping increase productivity over time as opposed to continuous maize. In addition, technologies with multiple benefits are likely to be adopted by farmers. In all project sites, mother and baby trials were managed by lead farmers.
Questions were posed based on:

- Tillage practices - whether conservation agriculture can be integrated with best-bets
- Adoption studies -what attracts the farmer to adopt the technology apart from agronomic benefits?
- Farm typologies – which farmers adopt what?
- The role of markets for legumes to drive best-bets

Prof Ajit Srivastava: Global Centre for Food Systems Innovation (GCFSI) - MSU

This presentation started by highlighting some of the challenges in developing countries. These include population growth, land pressure, water security, energy security and rapid urbanisation. In response to that USAID categorised the challenges as being rooted in two fundamental concepts namely; science and technology and engaging the world. Through the Higher Education Solutions Network (HESN), USAID is funding MSU's GCFSI to carry out research on global food systems, especially in the contents of increased populations and climate change. The geographical focus of the GCFSI is Central America, Eastern Africa and South-East Asia. These challenges will be addressed using in 3 global mega trends research teams:

1. Population growth, climate change and land pressure
2. Rapid urbanisation and transformation of food systems
3. Workforce development for food systems transformation

To overcome the above challenges the centre will issue a competitive request for grant applications to pilot and study potential solutions to global food system problems, based on technology innovation, technology evaluations, and technology scaling up grants.

Prof Sieg Snapp MSU -Malawi Africa RISING

The presentation was about agricultural systems with focus on:

- Identification of opportunities for sustainable intensification in changing climate. This can be done using both indigenous knowledge as well as models.
- How best science can be linked to knowledge, and
- How to come up with pathways for scaling out innovations.

In terms of opportunity identification, a conceptual framework was presented where best bet options can be identified through participatory action research with farmers, analyse systems and opportunities as well as modelling the best-bet options. On scaling out, Prof Snapp indicated that this is about farmers trying new things over space and time. This is a way of giving farmers the capacity to innovate and adopt best bet options. This can be achieved through modelling over space in time where risk can be assessed as well as the impacts of innovations. Scaling out approaches can also be compared such as farmer field schools and extension guides. Farmer field schools, for example, may have limiting factors such as learning environment not conducive and also problems in finding good guides. However, a policy recommendation can be made to scale out through farmer field schools where farmers can be trained on agro-ecology issues, experimentation, as well as market linkages. Africa RISING Malawi is using a hybrid of approaches to make science make sense on farmers' fields.

Dr Regis Chikowo, Dr Sieg Snapp, Edward Mzumara, Isaac Jambo, Michelle Hockett and Alex Smith: Innovations with farmers through participatory action research: an intensification pathway

The presentation started by clarifying the confusion of the acronym PAR:

- PAR for Photosynthetically Active Radiation, and
- PAR for Participatory Action Research - the art of effective association with farmers and empowerment using soft skills to deliver knowledge on technologies.

The major crisis in sub-Saharan Africa is low productivity linked to land degradation. This is self-reinforcing resulting in a vicious cycle of poverty. Climate change is another extra load which is worsening the situation of farmers. While yield defining factors (temperature, radiation and crop characteristics are well understood by local farmer through experiential accumulation of knowledge, nutrients, water and labour availability will largely limit productivity on the farms as these are related to management regimes that farmers employ based on their resource endowment. Appropriate crop protection practices to control pests, diseases and weeds will ensure that farmers harness the potential within the technologies and produce more profitably on the farms. Some of these problems can be minimized through intensification by integrating legumes in rotations, maintain soil cover to protect top soil against erosion and maintain high soil water recharge. Under variable climate, intensified system can lead to surplus food production in favourable seasons and less shocks in future bad seasons. The presentation also demonstrated the behaviour of soil organic carbon over time with agricultural intensification.

On Africa RISING research strategy in Malawi, there are 4 intervention sites where clusters of farmers are experimenting different technologies and counterfactual (control) sites which are agro-ecologically as similar as possible with intervention sites. This design enables tracking the impacts of the project on intervention farms (communities) and the controls. The project is being implemented in Linthipe and Golomoti EPAs in Dedza and Kandeu and Nsipe EPAs in Ntcheu, focussing on crop diversification that necessarily includes grain legumes. A key driver for grain legume technology uptake buy farmers beyond the targeted experimentation, especially for soyabean and pigeon pea, could be based on empowering farmers to locally value add their grain legume produce for household consumption, thereby inducing local demand for the product before thinking of the external markets.

Michelle Hockett (MSU graduate student): Agricultural experimentation and Africa RISING: Field work preliminary analysis

The presentation focussed on three main research questions; how are Malawian smallholder farmers experimenting with new crops, varieties and technologies? What are the drivers of experimentation for these smallholder farmers? How can Africa RISING further support farmers through experimentation? These questions were answered through in depth follow-up interviews with 18 farmers, of which 14 were directly engaged with Africa RISING activities. A lot of lessons can be learnt from Africa RISING on how farmers are experimenting. Farmers exercise their choice by combining both local practices and new techniques. The Africa RISING project introduced new crops and cropping arrangements/combinations. Farmers have a chance to compare old and new technologies and make rational decisions on which technologies they would want to continue with. Farmer are also experimenting on residue management, fertilizer and manure techniques, sole cropping and intercropping techniques, spacing techniques and field maintenance techniques such as shifting ridges or weeding. In all cases, farmers expressed willingness to continue to experiment

There was further debate on the following points:

- would farmers participating in the Africa RISING interventions continue to do so at scale if seed support were to be removed or provided at market value
- Cost-benefit analysis of experimenting.
- Document changes in farmers' own fields as a result of Africa RISING activities in the action sites

On the issue of sample size used, the presenter indicated that the sample size was purposive with major focus on women and farmers with less than 2 hectares of land. The sample was taken from the previous quantitative study. The follow up visits did not require a gigantic sample size since it was strictly qualitative

Dr Desta Lusigeld (CIAT): Soil characterization

CIAT presented the approach that was used to characterize all the sites: the main objective was to identify some biophysical constraints as well as conducting agronomic survey. Approaches used include spatially stratified sampling around the mother trials. i.e. the site was 100km^2, the clusters were 1 km^2 and the plots were 0.1 hectare. Unfortunately, at the time of the workshop soil analysis results were not yet available.

Dr Asamoah Larbi (IITA Ghana): A taste of Africa RISING in West Africa

In West Africa, 80% of the activities by Africa RISING took place in Ghana and only 20% in Mali because of political instabilities. In West Africa, Africa RISING project is working with a lot of partners in different areas such as Africa rice (rice), AVRDC (Vegetables), IWMC (water), ILRI (Livestock's), CIAT (soils) and ICRAF . In 2012, a community analysis was conducted and some of the major crops which were identified by the farmers are maize, cowpeas, sorghum, millet, soya beans and vegetables among other crops. The livestock identified were goats, pigs, sheep and poultry among others. Crop production constraints which farmers are facing are limited access to credit, inadequate equipment for preparing land, low soil fertility, poor seed quality, erratic rainfall and drought, weeds such as striga, pest and diseases, poor storage facilities and technologies, lack of market access for some communities, and lack of equipment and technologies for crop processing. On livestock production, the major problems are poor veterinary services, high prevalence of diseases, internal and external parasites attack, in appropriate housing and feeding, in adequate water points, theft, lack of improved breeds, poor feeding especially in dry season, poor market access for some communities and lack of equipment for processing and poor processing technologies.

Edward Mzumara and Isaac Jambo: Getting feedback from farmers as a strategy to better align Africa RISING activities

The presentation gave an overview of how farmers in all the intervention sites evaluated the program and project activities in terms of what worked well, areas which needs to be changed and new treatment options. Farmers applauded the project on the seeds distributed which were high yielding, drought tolerant especially maize, marketable and early maturing. One of the pigeon pea varieties used (Sauma) was however medium to late maturing and did not fit well in the farming system. The location of mother trials across the action sites was convenient for farmers –the central location enabled easy access and learning to take place. In terms of communication amongst project stakeholders, it was efficient since farmers were learning in groups hence consistent messages were passed to them. In addition, chiefs were present in most of the meetings which is good for problem solving.

On evaluation of cropping systems, maize did well under different cropping systems whether as sole crop, or when intercropped with any of the legumes being promoted. Most of the legumes performed well as sole crops. Some legumes performed well when intercropped with maize or other legumes. Farmers were also given a chance to choose three treatments of their choice. The most popular one was sole maize with fertilizer. This was not surprising as it is a staple food of Malawi.However groundnuts and soya were more popular as second crop choice.

Dr Nathan Moore (MSU): The Role of Climate Models and crop production in East Africa

Crop production is largely driven by rainfall as the most important environmental factor, and there is need for better predictions of rainfall based on historical trends. Climate change is modelled using both statistical and dynamic models. Two steps in modelling are to reproduce historical data and to

make predictions. Key drivers of East African climate are the Indian Ocean/ITCZ/Monsoon and topography. Problems in analysing current data for climate pattern include low data density, complex terrain, lack of data for soil moisture (not recorded/no soil maps), long term precipitation data not available and poor spatial coverage i.e. weather station data too scattered making interpolations unreliable. Climate models numerically integrate equations of motion and thermodynamics. The presentation also attracted a question on whether nitrogen fertilizer can be an adaptive strategy to climate change. Despite increases in yield by applying more nitrogen, there is no convincing evidence that N application alone could be an effective pathway for copying with climate change. Some of the discussion points on climate change and farming systems were centred on appropriate validations of the models for them to be directly usable under local conditions.

Dr Regis Chikowo: Systems analysis and simulation modelling

Simulation is the art of building mathematical models and the study of their properties. Some of the variables used in systems analysis are state variables and rate variables. The theoretical phases of systems analysis include conceptual model formulation, quantitative model specification, model evaluation or model validation and model use. The main goal is to evaluate usefulness of the model. Three examples of elementary systems that can easily be modelled are:

- A car driving at constant speed
- increase in animal number per year, and
- a tank with an adjustable valve taking in water

Mathematical relations can be used to precisely determine the condition of the state variable ant any time from t=0. Using this principle, a combination of mathematics and crop physiology can be employed to study crop growth and develop simulation modelling tools. APSIM is one such platform that can be used to better understand crop growth while simultaneously applying farming systems principles. A vital component in the use of simulation modelling is the feedback obtained from users and availability of good experimental data for calibration and validation

Henry Kamkwamba (LUANAR): Growth amidst climate change through intensification, growth models – Economy-wide linkages from CGE and APSIM Modelling

The presentation started by underscoring the importance of crop diversification as a key ingredient to economic growth and poverty reduction in developing countries. Crop diversification and intensification have economy wide implication since they shift supply and aggregate demand. Some of the challenges outlined in the presentation included unavailability of appropriate data to combine APSIM simulations with computable general equilibrium (CGE) models to analyse the effects of sustainable intensification of agricultural production systems and the economy. Key questions which need to be considered when intensifying are: the direct production effects, economy wide costs and benefits, effects on poverty, who wins/who loses from intensification policies. Some of the questions and comments made after the presentation were as follows:

- How does the model CGE model consider endogenous shocks?
- How the model does include households that do not sell any agricultural products?
- Flexibility of using the model considering the amount of data it requires and the data problems.

On households that do not sell, the forward linkages in the model are more consumption based and they take care of consumption based activities.

PlacidMpeketula: Soil carbon mapping in Malawi: Potential for carbon sequestration (Thesis research work insights).

Currently Chancellor College in collaboration with MSU is working on soil carbon distribution and dynamics project in Malawi funded by NSF through USAID under Partnership for Enhanced Research Engagement (PEER). The project is based on the baseline on land resources evaluation survey which was conducted in Malawi from 1987 to 1990 by Food Agricultural Organisation (FAO). The main objective of the study is to understand the spatio-temporal patterns of soil carbon aggradation or degradation across at national scale. The project is also using geostatistical approaches to explore spatial distribution of soil carbon in Malawi and the impact of agricultural land management as it relates to food productivity and food security. Soil C is an important indicator of soil and land health and its maintenance or addition is critically important in mitigation and adaptation of potential climate change. The research will produce maps that estimate soil C stocks that are spatially resolved to give information at landscape scale and this can aid in the identification of hotspots where management interventions may be targeted.

Valarie Ota: Farmer feedback workshops - an example from participatory action research in Ekwendeni

A case study on sustainable intensification from Ekwendeni was presented to showcase how closing working with farmers can result in far reaching impact. This is based on the Soils, Food and Health Communities project. The follow up study wanted to establish “which farmers have been using which strategies/technologies and why?” and also assessing the environmental and social economic impacts of the strategies that were being implemented. The feedback targeted 56 households of which 34(61%) were women and 22 (39%) were men. The main reason for the feedbacks was to get insights from farmers which can inform future analysis. Some of the outcomes of the feedbacks were that in areas in large land holdings, more farmers were practicing sole whereas small land holdings were associated with intensive multiple-cropping. Among the recommendations were to promote vitamin rich crops, to include micronutrients in soil fertility analysis, to link crop diversification with diet diversity, include livestock and fish in the intensification strategy, and conduct cooking demonstrations and food processing.

Alex Smith: Linking farmer knowledge and systems modeling to climate change adaptation

This study is part of a PhD dissertation and hypothesizes that farmers’ management choices reflect their current knowledge of their farming system and there is scope for improvements through gaining new knowledge and technologies. Empirical research can identify patterns and necessary feed backs and farmer knowledge can be linked with research modeling performance of legume diversified systems under real farm conditions. The areas of focus in the presentation were farmers’ perceptions of climate change, farmers’ use of legume crops and benefits and risks of farmers’ experimentation. The study included visiting 325 farmers in both intervention and control sites of Africa RISING and open, closed and supplementary open ended questions were used to solicit information from farmers. Some of the farmers’ perceptions of climate change were less rain than in the past, rains end before crops maturity, impossibilities to stagger maize planting and early dry spells and flooding. On farmers’ use of legume crops, in all study sites legumes are grown and farmers are used to intercrop them with other crops with dominance (63%) in Linthipe and the least in Nsipe (46%). Furthermore, 49% of the legumes were intercropped on baby trials. In terms of fertilizer application, only 2.5% of plot with legumes planted as a sole crop were applied fertilizer. In order to model legume diversified systems under farmers’ conditions, there is need to balance between positive and negative effects under variable rainfall, in crop combinations used by farmers,

on soil representative of farmers' resources and under farmers input constraints. The major question is whether diversification of legumes can help to meet farmers' food needs. On farmers' experimentation, a lot of farmers were growing some of the Africa RISING promoted crops for the first time such as pigeon peas (75%), soya (35%) and cowpeas (20%). Experimentation is frequently cited as a positive attribute of Africa RISING where farmers are learning by doing on mother trials, comparing crops and varieties and learning from fellow farmers. On crop modeling as virtual experiments, participatory modeling is used where farmers choose cropping systems they wish to experiment with and they allocate land and resources to these systems. Farmers also build and run models by evaluating the outputs and design new experiments. The presenter finished by posing a question on whether models can directly support farmers' process of experimentation.

Dr Damion Kambewa (LUANAR): Extension for transformation

The presentation started by outlining how complex the world we are living in is and how it is rapidly changing in terms of market dynamics, climate variability, rising demand for food, quality conscious society, emerging new types of farmers, HIV and AIDS and environmental degradation. Some of the complexities include the degraded and unpredictable ecosystems such as caress cutting down of trees, drying up of lakes, increase in population and decrease in arable land. The extension services has responded to these problems through innovations and coming up with new ideas that fit the complex world. The challenge is that it is not always accepted by people. On the role of agricultural extension, extension approaches have been changing over time and currently we are on demand driven. All these efforts are done to transfer new technologies to farmers. As a way of rethinking extension, there is need to build capacity and capability of farmers. We can get closer to the desired results by understanding the participatory research processes and farmer to farmer diffusion of technologies. Innovations attract hard questions – shift of mindset and there is need for an innovation systems approach.

Some of the question and comments made after the presentation were as follows;

- How innovation platforms could be adopted in agriculture development?
- Why cellphones have been adopted faster without any extension messages than hybrid maize.
- How can extension workers change power dynamics between themselves and farmers?
- What is the ideal time to match the gap between farmers and scientists?
- Are nutritional aspects of extension available in agricultural extension methodologies?

Annily Msukwa and Owen Kumwenda (Ntcheu and Dedza districts): View from extension

In a question and answer session, the district agricultural extension officers (DADOS) for Ntcheu and Dedza districts, where Africa RISING is being implemented, were asked the following questions:

- What are the likely pull factors for possible increase in grain legume production in the districts? Is it research or market pull
- Among the several organizations working on legumes, are they complementary to one another?
- How are the extension messages from different stakeholders harmonized at district level to avoid conflicting messages?
- Researchers have noted that there is system of manure/compost making by farmers, in which more than 90% of the material used is grass; how effective in stimulating crop growth are the resultant 'manures' and what is the official advice given to farmers?

- How is the ministry making sure that most of these projects being implemented are sustainable?

In response, the DADOs indicated increased grain legumes production will come through increased access to seed and knowledge, hence the need for Africa RISING to expand activities. Currently, most of the stakeholders are just issuing seeds and they do not provide appropriate training. There are efforts at district level to try to harmonize extension messages from the NGO community, before such information gets to farmers.

Bunda College and Extension services: Local level processing of grain legumes –

While increase in production is important, there is need to improve nutritional status of farmers. This includes training on processing at local level. Soyabean is usually not consumed as beans but can be processed locally and make nutritional food products. From soya, there are many recipes that can be made such as soya porridge, nsima from cassava flour mixed with soya bean, soya milk which can be used as a substitute for cow milk at local level, soya sausages, soya cake, soya fried, soya yoghurt, soya biscuits, soya meat balls and soya coffee
On research point of view, there is need to concentrate on knowledge gaps.

- How can the increase in number of farmers locally processing soyabean be stimulated? There is need to trace this variable in intervention sites and control sites.
- What approach can be used in our nutrition objectives? There is need to sensitize farmers on nutritional benefits of their crops in the intervention sites.
- On utilization, there is also need to create links from production to marketing. Marketing and local processing together may drive production. In addition, we may also consider soyabean products as feed for poultry.
- There is also need to expand to horticultural crops together with potatoes with high nutritional value and the quality of protein.
- The hypothesis to be tested may be “more processing of soya may lead to more adoption of the crop”
- In Ekwendeni hospital nutritional component has recipe days where farmers share recipe with one another.

Prof Sieg Snapp: The way forward for Africa RISING

The presentation started with a sustainable intensification metrics and overall, Africa RISING has five axes for sustainable intensification for a given system which are productivity, economic, environmental, social and human/ health outcomes. Sustainable intensification can be achieved through doubled up legumes, as this is associated with improved fertilizer efficiency, soil cover, yields and protein availability to smallholder farmers. The presentation further outlined some of the policies in Malawi that complements Africa RISING efforts and other similar projects such as presidential initiative (nutrition, legumes and dairy), fertilizer subsidy and Malawi parliament consultations with LUANAR faculty on doubled up legume technology, legume crops and extension recommendations. The UN special rapporteur on food security report on Malawi highlighted doubled up legumes and USAID-Malawi Mission Integrating Nutrition in Value Chains will be using the doubled up legume technology to increase protein availability on farms. The livestock component is going to feature more prominently in the remaining 3 years of Africa RISING.

GROUP DISCUSSIONS

What are the new technology options that reflect local knowledge and the best science to support sustainable intensification?

During the discussions, the group looked at new technology options that can be included based on local knowledge and best science for sustainable intensification using improved varieties such as maize and legume intercrops with fertilizer and compost provided by farmers, doubled legumes and maize rotation with fertilizer, tephrosia vogeli (agroforestry) and box ridging using different arrangements, use of inoculum, close ridge spacing arrangements, residue incorporation and goat forage/ pigeon peas and compost recycling. The group also discussed on considering farmers local knowledge in ***drought tolerant Species and varieties***(Hybrid Maize (Africa RISING), sorghum, cowpea (Africa RISING, Cassava, finger millet, groundnuts, early maturing pigeon peas (short but indeterminate) June and September), ***Intercropping*** (maize and beans, groundnuts and soyabean), ***"Ant hills" and compost***, and ***Pest control (goats with "faeces spray" and plant spray), (cow dung for post-harvest) and tobacco.*** The new science proposed by the group includes crop livestock interaction; **Goats: high quality forage with technologies "cut and carry".** This gives extra benefits by increasing the quality of manure and decrease burning by farmers. In addition, the group proposed ***introducing Irish potatoes and sweet potatoes*** which may be provided by CIP and ***cassava*** which may be provided by IITA and these can be grown in high altitude areas. The third option was climbing beans and poles which may include agro-forestry and also pigeon peas and soya processing which can be implemented by ICRAF and CIAT respectively. Other new post-harvest technologies i.e. on legumes were also proposed such as aflatoxin management in groundnuts which can be done by ICRISAT, use of vacuum bags (Dr Bass, IITA), pest control in cowpeas such as Aphids etc. the other options were introduction of innovative seed banks, use of flint varieties and other storage technologies. On pest management, striga can be controlled using agroforestry technology such as tephrosia by ICRAF. The group also considered seed quality i.e. good storage mechanisms, priming and conducting training on seed quality. LUANAR can come in on food processing and nutrition.

What methods can be used to understand on farm variability and effects on productivity, risk, and sustainability of farming systems?

The group started by outlining some of the assumptions which include; focus on the farm, local space-time scales and the context in which a farm exists. On farm variability the group looked at farm characterization in space (neighbour effects) and came up with a set of indicators such as biophysical characteristics and socio-economic indicators. The methods proposed were participatory action research through use of farmer field schools, remote sensing to come up with imagery spatial mapping and spatial analysis with focus on geostatistics. On productivity effects, the group talked about production reducing factors such as weeds, diseases and pests. Other factors include micro-scale climate variability and soils factors. Some of the risks discussed were extreme events such as droughts, floods and fire. Other risks were climate change, market prices and shocks which include local scale factors, exogenous shocks and consumption patterns due to diversification and land productive capacity. The final risk was black swan events. On sustainability, the group came up with some indicators on failure to fail participatory action research such as social, environmental and economic. Other factors to insure sustainability include seed availability which can be done by introducing seed banks, matching and timing. The final issue on sustainability is extension training on conflicting methodologies to deal with persistence problems.

How do we integrate biophysical and social economic data in participatory action research?
This can be done through participatory research where biophysical and socio-economic data can be collected. This opportunity can also be used to get farmer preferences. Farmer typologies is also important in that it can help to categorise farmers based on their wealth status and this can help in understanding which farmers adopt which technologies and later inform planning of activities. This can be conducted through participatory rural appraisal by asking farmers what characterize well to do, medium or poor households. The key informant can also be interviewed to get their views. Some approaches to be used may be focus group discussions, village tours and quantitative research where we can collect both socio economic and production data. Farmer typologies can also be linked to choice of technologies by farmers using the following procedure. First an asset index can be generated for each and every household and more weight can be assigned to scarce assets. This index can be used to categorise farmers into percentiles. A production index can also be generated using a similar procedure and finally the asset index can be compared to production index.It is also imperative for any intervention to see the cost aspect of adopting each and every technology being developed. Cost aspects can be looked at by collecting socio economic data in terms of labour, fertilizer use, seeds and Income from sales. Towards the end of each trial, participatory trial evaluation can be done together with farmers. On biophysical data, soil, plant, other environmental variables and field management data must also be collected. All these socio economic and biophysical data will then be integrated in analyses and generate context specific recommendations.

Quality engagement (diversification) and integration of better-bet technologies in farming systems
The group prioritization was informed by activities that have been done in Year 2 and then choose from those that have worked. New options were also agreed to be added if they seem promising.

Climbing beans:
Climbing beans are high yielding and the beans and grain are good sources of protein and vitamins. There is need to figure out the maize varieties that should be intercropped with climbing beans. Some maize varieties have weak stems and the maize can be lodged. The major questions are "*are the farmers in the intervention areas already planting climbing beans? If so, what are the research gaps? Comment: farmers asked for* ***nanyati*** *variety (kidney beans, large seeded). Also check with CIAT for more options on climbers.*

Crop-livestock integration

In West Africa, there is a dual purpose of cowpea which can be used for both grain and fodder. Hence there is need to consult IITA to see if they have cowpea varieties for leafy biomass.

On the same crop – livestock integration, what research questions should be addressed? BUNDA-LUANAR should look at Poultry and if we are including the nutrition component (Bunda and DAES), **the by-products to feed poultry** should be from the processed crops

Spraying

Cotton-cowpea strip intercropping to control pests in cowpea. *(Comment: safety issues- can you eat the cowpea leaves sprayed with cotton pesticides?*

Expansion as a strategy of reaching more people, number of farmers to be included, location and environment, sustainability in terms of seed access and monitoring and evaluation strategy

Scope of expansion: whether within same sections or moving to new sections or EPAs

There is need to maintain focus on existing Sections and reach a larger proportion of farmers within those Sections. In addition, a new mother trial would be added per action site and the associated baby trials, with treatments informed by Year 2 experiences and farmer feedback. At the least, the Year 3 efforts would be double those for Year2. It would be established whether the period of exposure to experimentation is a significant factor by tracking the behavior of the phased-in experimenting farmer

Appendix A:

LIST OF PARTICIPANTS FOR THE AFRICA RISING-MALAWI FARMING SYSTEMS AND MODELLING WORKSHOP HELD AT LIVINGSTONIA BEACH SALIMA, 28 July-1 August 2013

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