BOOK of ABSTRACTS

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THEME 1 ENHANCEMENT OF FOOD AVAILABILITY THROUGH MECHANIZATION AND PRECISION AGRICULTURE

ROLE OF MECHANIZATION AND PRECISION AGRICULTURE IN FOOD AVAILABILITY IN THE CONTEXT OF SMALLHOLDER FARMS

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ABSTRACT

Agricultural mechanization has been one of mankind's greatest achievements and was absolutely vital to building our modern societies. It allows both the larger farmer and the smallholder to improve both food quantity and food quality while making their lives easier. Proper mechanization usually increases productivity, allowing more land to be farmed, more crops to be produced per year, or higher yields. It often provides better crop growing conditions or better techniques for dealing with pests.

Local situations vary widely. Several examples of mechanizations and their effects are described. Given the vital need for increased food production, further appropriate advances in mechanization are needed worldwide.

Historically, agricultural mechanization for smallholders has often had difficulties due to inappropriate mechanization, lack of supporting infrastructures, and equipment reliability problems. Improved equipment engineering, computers, and communications, including the internet and cell phones, reduce these problems. It is also shown how digital manufacturing and advances in diagnostics and logistics will improve agricultural mechanization for smallholders.

One recent advancement is spatially-variable crop production, often known as precision agriculture. Precision agriculture accounts for the inherent spatial, and sometimes temporal, variabilities in water, soils, plants, and pests. Smallholders often already benefit by accounting for variability in animal agriculture. They can also often achieve benefits by similarly considering variability in plant agriculture.

Some examples of mechanization and precision agriculture for smallholders are presented. Although not applicable to all cases, some broad generalizations and recommendations for the future are made. Mechanization, including precision agriculture, can contribute to economic, environmental, and social sustainability in the rural areas. It is a useful tool to meet the need for food security.

PROFILING THE CONTRIBUTION OF AGRICULTURAL ENGINEERING TECHNOLOGIES TO MECHANIZATION OF SMALLHOLDER AGRICULTURE IN UGANDA

Joshua Wanyama[1]*, Noble Banadda[1], Florence Kiyimba[2], Samuel Okurut[2], Ahamada Zziwa[1], Isa Kabenge[1], Charles Mutumba[2], Peter Tumutegyereize[1], Allan Komakech[1], and Nicholas Kiggundu[1]
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[2]Agricultural Engineering and Appropriate Technology Research Centre, National Agricultural Research Organization, Kampala, Uganda

ABSTRACT
Developing countries are grappling with numerous challenges including feeding rapidly growing populations, alleviating poverty, protecting the environment and mitigating adverse impacts of climate change. For the coming years, one of the main agricultural development agenda for Sub-Saharan Africa (SSA) should be to increase agricultural productivity and production to achieve food security through agricultural mechanization with Agricultural Engineering Technologies (AETs) as major inputs. However, there is paucity of information on the status of existing AETs and their contribution to mechanizing smallholder agriculture which is crucial to effective planning and strategy formulation. Therefore, the overarching objective of this paper is to review past and present status, constraints to adoption and future of AETs in Uganda in the context of mechanizing smallholder agriculture. Several proven AETs have been developed through research institutions such as Uganda's National Agricultural Research Organization (NARO) and Universities in different areas of farm power and mechanization systems, agro-processing for value addition; renewable energy systems; water harnessing and utilization and other emerging agricultural engineering fields. The future of AE technologies in Uganda is hinged on the interaction of AE technologies with key drivers that include policy, social, cultural, economic, environmental, vocational skills development, innovation protection, research and institutional partnerships.

FARM MACHINERY DEMAND AND POWER REQUIREMENT FOR MECHANIZING SMALL RICE FARMING IN KAMPAR REGION, INDONESIA

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ABSTRACT
Farm machinery is one of important power sources for performing various farm operations today. The availability of adequate farm machinery is essential for providing sufficient power on farm. Thus, the various farm operations can be well-mechanized and can contribute in overall improved productivity of crops. This study attempted to examine the farm machinery demand and power requirements for small rice farm operations in Kampar Region, Indonesia. Data were collected through field survey in the selected rice production centers in the region. The interviews with involving farmers, government extension staff and machinery suppliers were conducted in 2015. The results showed that small type of farm machinery is mostly demanded by farmers, including power tillers, power threshers, and rice milling units (RMUs). The machine is suitable to farm conditions which are small in size and purchasing power of farmers. However, the number of farm machinery available was not sufficient to provide power requirements for mechanizing overall rice farm operations. Public financial support and private sector involvement are strongly needed to promote farm machinery use among small scale farmers.

STRATEGIES FOR ENHANCEMENT OF APPROPRIATE-SCALE MECHANIZATION FOR SUSTAINABLE INTENSIFICATION

Alan C. Hansen
University of Illinois, Urbana, IL USA

ABSTRACT
Appropriate-scale mechanization is urgently needed for advancing sustainable intensification (SI) involving smallholder farming systems. The objective of this presentation is to describe recent efforts to

engage with four developing countries situated in South Asia and in East and West Africa with the purpose of launching innovation hubs in each country representing a centralized zone of activity, knowledge, training and innovation to support the process of sustainable intensification through appropriate scale mechanization. This project is associated with the USAID funded Feed the Future Sustainable Intensification Innovation Lab. Farmers and other stakeholder are involved in the process of identifying the greatest needs for mechanization. This presentation reports on progress made during recent visits to each of the countries, Bangladesh, Cambodia, Ethiopia and Burkina Faso, involving carefully planned workshops and field visits that have yielded strong participation of stakeholders as well as the prioritization of potential research and development projects on mechanization and opportunities for tertiary and outreach capacity building. The workshops typically included 30-40 participants representing a broad range of stakeholders who gave their input in the different sessions and contributed to identifying the main challenges and the highest potential mechanization opportunities. Presentations were solicited from in-country representatives describing the current status of mechanization as well as government and NGO efforts in addressing mechanization. The workshops, combined with subsequent visits to field sites, provided opportunities for identifying critical mechanization needs relative to targeted value chains. A process of setting priorities was carried out and three to five opportunities/tasks were selected based on the input of the participants. During the field visits the tasks were reviewed further in the light of the field observations and finalized by the end of the visit.

ENGINEERING SOLUTIONS TO ENSURE FOOD SECURITY: AN ECONOMIC PERSPECTIVE

Kathy Baylis, Ben Crost, Craig Gundersen*, University of Illinois, Urbana, Illinois USA

ABSTRACT

To alleviate food insecurity across the world, a wide array of approaches are needed to address both the challenges facing food access by ensuring people have sufficient resources to obtain food, and food availability by ensuring a sufficient food supply. A vast literature has emerged within economics to identify effective and ineffective efforts to alleviate food insecurity. For example, on the demand side, studies have examined the efficacy of different food assistance programs and, on the supply side, studies have demonstrated the potential benefits to removing trade barriers or adopting new production technologies.

An exciting new area where multiple efforts are being proposed and designed to address food insecurity from the supply side is in the broad arena of reducing post-harvest loss. The set of innovations hold great potential to decrease losses from field to plate, and make substantial inroads into alleviating food insecurity. There have not been, however, many economic analyses of these innovations. This research lacuna is unfortunate insofar as these innovations are only likely to be adopted if there are shown to be economically viable, and even if adopted, may not substantially decrease food insecurity. In this presentation we address this lacuna through two broad paths.

First, we provide a systematic economic framework which will allow us to discern whether a particular intervention has the potential to be adopted, reduce post-harvest loss and improve food security. Of particular importance is identifying cases where there are missing markets that may lead to opportunities for the use of new technologies. Even when there are not missing markets, there may still be opportunities for technologies to be usefully implemented. Within all of these discussions, we also note that implementations of certain technologies may actually lead to increases in food insecurity and we identify the conditions under which this may occur.

Second, we apply out framework to analyze data from a recent survey conducted in India. We identify the existing incentives facing farmers and traders to adopt various technologies that reduce the volume and value of grain lost. Further, we explore how technology adoption and use is correlated with household food security.

POST-HARVEST MECHANIZATION OF MILLET CULTIVATION HELPS ALLEVIATE DRUDGERY AND IMPROVE CROP QUALITY AND YIELD

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ABSTRACT

Millets are a group of grasses found mainly in the arid and semi-arid regions of the world. Millets are of particular importance because of several advantages: Firstly, they are hardy crops that can withstand harsh climates better than rice orwheat and need less water. Secondly, they can grow on skeletal soils unlike other cash crops that need fertile soils. Fortunately, they do not need synthetic fertilizers and thus have less impact on the environment. Thirdly, they do not attract pests. Lastly, they are more nutritious than rice/wheat. Despite their nutritional superiority and low production costs; the total area under millet cultivation in developing countries such as India has been decreasing. While this decline can be attributed to several factors; drudgery involved in post-harvest operations is the most stated problem in India and other countries. The challenges faced by the farmers in millet cultivation arise during the harvesting and post-harvesting (PHT) stages. The tasks of threshing, de-husking and drying are labor intensive, long, tedious and drudgery-prone processes. Reducing drudgery by mechanization of post-harvest processes will help to promote cultivation of millets in India. After intervention at the harvest stage by implementation of improved sickles, women reported a reduction in drudgery resulting from less bending. If available, tractors made the harvest process simple and efficient. After intervention at the post-harvest threshing stage, farmers reported a reduction in drudgery associated with tedious and labor intensive traditional practices including road threshing. Minimizing damage to the grain helped increase the final yield and selling price of the crop. After intervention at the post-harvest dehulling stage by introduction of rubber roller dehullers, farmers reported a reduction in drudgery associated with traditional dehulling practices and emery mill. Minimizing the breakage of millet grains that are cleaner resulted in higher yields and selling price. After mechanization of post-harvest operations, the yield of millets increased from 796 kg/ha to 1604 kg/ha. We are currently developing strategies and means of promoting the use of a rubber roller dehuller on a larger scale at the farm level in India. The achievement of such a task would lead not only to the alleviation of drudgery but also would increase the contribution of millets towards ensuring food security.

Acknowledgements:

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APPROPRIATE SCALE MECHANIZATION FOR BIOMASS UTILIZATION FOR SUSTAINABLE FOOD PRODUCTION

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ABSTRACT

India produces an estimated 500-550 million tonnes of crop residue annually. The conversion of crop residue into energy can lessen country's reliance on imported fossil fuel and also reduce problems associated with poor residue management. To properly manage crop residue and convert it into a sustainable energy resource, a number of approaches have been developed and commercialized in the country. A rapid composting involves creation of windrows consisting of crop residues and cow dung. The

fast decomposition is attained in windrow method with the application of compost inoculum consisting of four lignocellulolytic fungi and uniform mixing with the help of specially designed compost turner cum mixer, a trailing and offset type machine The turning after every 15 days helps maintaining the thermophilic phase with temperature range of 60-70°C during composting. This process reduces the time of quality compost preparation from 120-140 days to 45-60 days. As the ready compost may contain a lot of undesired material hampering quality. a compost sieving machine comprising of an automatic belt feeding mechanism and a compost separator for separating the finer grades for different uses has also been commercialized .

Management of paddy straw in combine harvested field is another big challenge due to large scale crop residue burning which has become a menace in many parts of India. A paddy straw collector-cum-chopper has also been developed for managing stubbles. Commercially available balers in India are technically and economically suitable to countries with small landholding.

Densification of roughage-based crop residues diet supplements such as molasses, concentrates, minerals and salts in compact, ready to eat feed block is an effective solution for animal feed management. A package of technologies comprising of complete feed block formation machine in capacity range of 125 kg/h to 4000kg/h including mobile unit with accessories have been commercialized. Such feed blocks have one year shelf life, could be transported economically over long distances and stored in large quantities in less space. These technologies have been extended to different parts of India and neighbouring countries. Gasifier-based power plants using briquettes made of crop residues are providing a great solution for off-grid decentralized power plants of 8-15 MW. These technologies have great potential for developing countries keeping the socio economic conditions of the people of these regions.

OPEN FORUMS

Open Forums will address questions related to the way forward and opportunities for global partnership.

Group 1 **Global Engagement and Active Partnerships to Address Grand Challenges**

Facilitator: Lalit Verma, University of Arkansas - USA

Panelists: Claus Sorensen, EuroAg Eng President - Denmark
Vijaya Raghavan, CSBE President - Canada
Erik Schmidt, NCEA - Australia
Yoshisuke Kishida, AMA - Japan
Omar Trujillo, ACTA - Columbia
Adewumi Babatunde, NIAE – Nigeria
Linus Opara, AgroAg Eng – South Africa
M.O. Faborde, West African Society of Agricultural Engineers
Indra Mani, Indian Society of Agricultural Engineering
Tadeusz Juliszewski, CIGR President
Maynard Herron, ASABE President

Location: Auditorium

An open forum to share locally relevant issues, challenges and opportunities from participating countries is proposed. The forum will consist of an overview of the ASABE Global Initiative and a few short presentations representing different continents/regions of the world, followed by a discussion period. The forum will bring together representatives engaged in engineering, technology, policy, economics, etc. of projects related to sustainable food, energy and water systems. Innovation, appropriate technology, implementation, funding, commercialization and policy matters will be covered. The goal is to share and react to regional challenges with proposed solutions and identifying future course of action.

Group 2 **Policies and Innovations for Productive Sustainable Food Systems**

Facilitator: Ann Steensland, Global Harvest Initiative – USA
Darrin Drollinger, ASABE – USA

Panelists: Andre Westerveld, Sub-Saharan Africa, Elanco Animal Health - South Africa
Tony Esmeraldo, DuPont Pioneer - South Africa
Stephanie Midgley, Western Cape Department of Agriculture - South Africa
Mark Moore, AGCO Corporation - USA
John George, Agricultural Engineering Associate – USA
Andrew Bennett, Monsanto Company – South Africa
Barbra Muzata, DuPont Pioneer

Location: Simons

This Open Forum session will highlight technologies and strategies that increase the productivity of food systems in a way that is economically viable, socially responsible and environmentally sustainable. It will provide attendees with a deeper understanding of the policy context within which food systems operate and how these policies influence public and private sector investments in agricultural innovation and value chain development. This session will also include a presentation of Global Harvest Initiative's 2016 Global Agricultural Productivity Report® (GAP Report®) which focuses on five policy areas for productive sustainable food systems: investing in agricultural R&D and extension, embracing science-based and information technologies, enhancing private sector involvement in agriculture and infrastructure, fostering capacity for regional and global trade and cultivating partnerships for sustainable growth.

Group 3 Actors and Impacts of Global Postharvest Loss Prevention Initiatives

Facilitator: Robert A. Easter, University of Illinois - USA
Panelists: Rafael Gavilance Flor, Rockefeller Foundation – Kenya
Prasanta Kalita, University of Illinois at Urbana-Champaign – USA
Dirk Maier, Iowa State University – USA

Location: Stenneberg

This ADM Institute for the Prevention of Postharvest Loss sponsored forum will highlight global postharvest loss prevention initiatives currently undertaken by various public, private, and philanthropic organizations. The attendees will learn about the postharvest loss issues in different parts of the world and current initiatives being taken to curb those problems. They will also learn about actors and strategies various organizations are adopting to reduce global postharvest losses. Additionally, this session aims to highlight current and future opportunities and how to get involved to help smallholder farmers by reducing their losses, increasing their income, and enhancing their lives and livelihood.

THEME 2 ENHANCEMENT OF FOOD AVAILABILITY THROUGH WATER MANAGEMENT

ROLE OF WATER MANAGEMENT IN FOOD AVAILABILITY IN CONTEXT OF SMALLHOLDER FARMS

Everisto Mapedza
International Water Management Institute (IWMI), South Africa

SMALLHOLDER WATER MANAGEMENT INNOVATIONS FOR IMPROVING FOOD SECURITY IN SUB-SAHARAN AFRICA

Joshua Wanyama[1*], Noble Banadda[1], Isaya Kisekka[2], Allan John Komakech[1], Nicholas Kiggundu[1], Ahamada Zziwa[1], Isa Kabenge[1], and Charles Mutumba[3]

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ABSTRACT

Ensuring food security for a rapidly growing population is most critical in low-income, food-deficit countries of Sub-Saharan Africa (SSA) where an estimated 70% of the population comprises of resource-

poor farmers living on small fragment family gardens where soils have over the years become impoverished, in environments that are prone to drought, soil erosion and epidemics of pests and diseases. Addressing these constraints to crop productivity is a monumental challenge that warrants, among other things technological interventions to increase yields. Therefore, smallholder water management innovations are regarded as a promising solution to boost levels of agricultural productivity in SSA under the added pressures resulting from climate change and growing demands for water from other sectors. The question still remains, however, which options or combinations are promising in which agro-climatic and social physical settings? Based on assessment of various research findings and reflections from bright spots, arguments have been developed so as to highlight promising options of improved water management strategies in dissimilar zones. The study finds that water harvesting (off-farm and on farm), low-cost irrigation pumps and small scale irrigation systems, wise use of wetlands for irrigation, conservation farming can boost food security for millions of smallholder farmers in SSA. An integrated and holistic approach to water management that involves a comprehensive package including trade, inputs and markets is recommended. Creation of an enabling environment is a prerequisite for a wide dissemination of these proven smallholder water management options.

IMPROVING 'ON-FARM' WATER MANAGEMENT IN AUSTRALIA THROUGH THE USE OF CROP MODELS

Allan S. Peake[1,*], James R. Hunt[2], Zvi Hochman[3]
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La Trobe University, Bundoora, Australia
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ABSTRACT

Crop model application is typically categorised into use as tools for research, management and education. In Australia, crop models are being deployed 'on-farm' for each of these purposes in relation to crop water resources in both dryland and irrigated farming systems, impacting the majority of farmers in Australia either directly or indirectly. This paper demonstrates the breadth of application of crop models to farm water management in Australia, with the aim of increasing profitability and managing seasonal variability.

In dryland farming systems, management of stored soil water is important due the strong relationship between stored soil water at sowing and yield. The concept of stored soil water is communicated simply by encouraging farmers to view soil as a 'bucket' that holds water available to the crop, which can vary in size between the extremes of 350 mm and 40 mm between crops and soil types. Measurement of soil water available at sowing is used to initialise crop models, which are then used to forecast probable yield distribution in response to the range of potential seasonal conditions (derived by using up to 100 years of climate records). Single crop simulations have then been used to determine probabilities of response to N fertiliser, sowing dates, plant densities, cultivar maturity and grazing time. At a regional level, yield gaps are being benchmarked to challenge farmers to improve their crop management practices.

Similar model applications are being extended in irrigated farming systems. Recent irrigated crop model research has examined the importance of soil water and precipitation in determining optimum whole-farm deficit irrigation strategies for single seasons, and whole-farm multi-crop rotation strategies to maximise profitability of irrigation water use. Within both dryland and irrigated farming systems the appropriate application of models within their known operating capabilities remains a constant challenge, as the simplicity of conducting simulation experiments often masks the difficulty involved in correctly parameterising complex systems models.

An emerging use of crop models in Australia is their linkage to sensors (e.g. soil water) in an effort to increase accuracy, manage paddock variability and translate sensor derived data into grower-relevant economic indicators. Although at an embryonic stage, both opportunities and challenges in developing the methodology for 'model-data fusion' are discussed.

AGROCLIMATE MOZAMBIQUE: ADAPTING AGROCLIMATE FOR CLIMATE SMART AGRICULTURAL MANAGEMENT IN MOZAMBIQUE

Clyde Fraisse
Agricultural & Biological Engineering, University of Florida, Gainesville, Florida USA

ABSTRACT

Projected changes in mean climate conditions and in climate variability are likely to increase disruptions in food security at local, regional, and global scales unless cropping systems are resilient and adapted to those changes. Climate forecasts and decision support systems can help producers adapt to expected climate patters and reduce risks faced by an agricultural enterprise. The AgroClimate web-based information and decision support system (http://AgroClimate.org/) was developed to help agricultural managers in the Southeastern USA to reduce production risks associated with climate variability. AgroClimate provides climate information and tools that relate climate and crops, providing information to reduce the chances of climate related problems, and to take advantage of favorable conditions to crop production. As drought, floods, heat stress, and disease incidence have been reported as major challenges faced by growers in Mozambique, a version of AgroClimate for the region (http://mz.AgroClimate.org/) was created. It takes advantage of the strong influence of the El Niño-Southern Oscillation (ENSO) phenomenon to anticipate expected weather patterns based on the ENSO phase. The AgroClimate Mozambique has two main components, the first one is a section with local information and news related to climate, and the second one is a set of dynamic tools which are based on spatial data provided by CFSR, CFS and FEWS-Net datasets provided by the National Oceanic and Atmospheric Administration (NOAA) combined with local crop information. The tools currently available on the website include short-term forecasts, climate summaries and statistics for each ENSO phase, and optimal planting dates for tomato based on ENSO information. Future tools include optimization of irrigation management and tomato disease control based on expected seasonal climate variability. This project has been funded by the USAID Cooperative Agreement No. AID-512-A-11-00001 Trilateral agreement on improving food security and nutrition in Mozambique.

FORECASTING WATER STRESS AND YIELD TRENDS

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ABSTRACT

Agriculture is the largest water consumer, with 70% of global water withdrawals being used for irrigation. Water scarcity issues are being exacerbated by drought and population increases, making efficient water resource management in agricultural production increasingly important. The objective of this paper is to evaluate the use of short-term weather forecasts for agricultural drought prediction. A crop-specific, linear regression drought analysis technique was used in this study. This study takes place in the Upper Colorado River Basin (UCRB) located in West Texas. Five parameters associated with agricultural drought (precipitation, temperature, biomass production, soil moisture depletion, and transpiration) were ranked

and used to estimate cotton yields. The yield percentiles were used as a drought index. Precipitation and temperature were forecasted with a two-week lead time using probable scenarios based on historical data. The other three parameters were estimated using the SWAT model. Forecasts were generated for each week of the growing season from 2010 through 2013. Comparing the parameters using the forecasted weather data to those using the observed weather data revealed that four out of the five performed satisfactorily. However, the soil moisture depletion forecasts were unsatisfactory. The forecasted cotton yields and drought index both performed satisfactorily, indicating this forecasting method may be used for decision making related to agricultural water management including irrigation timings.

IMPROVING DRY SEASON IRRIGATION IN THE EASTERN GANGETIC PLAINS

Erik Schmidt*-and Michael Scobie
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ABSTRACT

The Eastern Gangetic Plains, which include the Nepal Tarai, Bihar and West Bengal regions, is one of the most densely populated, poverty stricken belts in South Asia. Behind this persisting poverty are deeply entrenched social structures of class and caste, with a high incidence of inequitable landlord-tenant relations. This is combined with poor access to irrigation water in the dry season, limited irrigation capacity and low agricultural innovation. Earlier research in the Indo-Gangetic basin established the interactions between poverty and access to water.

This paper introduces approaches currently being trialed with an aim to improving, in particular, woman, marginal and tenant farmer access to and use of water resources in the dry season. Baseline socioeconomic and biophysical parameters have been collected in a total of six villages in Bihar and West Bengal (India) and three in Saptari (Nepal). Due to the more developed irrigation infrastructure in Bangladesh, a further six villages in Northwest Bangladesh are also being studied for comparative purposes. The approaches are an integration of social, institutional, and appropriate water management and irrigation technological interventions. The technological interventions include optimizing existing infrastructure (diesel and electric pumping), trialing and demonstration of alternate technologies, including small scale solar, micro irrigation, and pond renovations. Improved water management strategies such as irrigation scheduling, mulching and conservation tillage are also an important part of the project.

This paper highlights a range of integrated approaches to improve access to water for irrigation and the impact this makes on livelihoods and community resilience.

SUSTAINABLE WATER USE UNDER CHANGING LAND USE AND CLIMATE VARIABILITY FOR GLOBAL FOOD SECURITY: CASE STUDY OF MKOMAZI RIVER BASIN

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ABSTRACT

The challenge of climate change and human anthropogenic activities on the water cycle is a major scientific problem facing the modern science of water. Understanding the occurrences, prevalence and responses of the catchment area to rainfall and droughts, is important in order to manage and utilize the water resources in an integrated manner. This study examine the hydrological responses in term of spatial and temporal variation of water resources allocation in the Mkomazi river basin in determining farm product net return with proxy variable that is expected from available scarce water resources allocated. The catchment area is situated around 29°17’24’’E and 29°35’24’’S @ Lot 93 1821, derives its source from

the upper Drakensberg mountains and draining an area of about 4 400km^2. The water resources in the area is already in competition for supply to irrigation site, commercial afforestation, tourism and recreational activities, as well as paper production industry. The employed methodology of agent - based evolutionary algorithm (AEA) using multi-agent systems within an evolutionary framework, where individuals water user in the catchment area are represented by the virtual agent which acted based on its belief and learning experience in cooperation, competition, communication and social learning among other agent in Netlogo environment gives better insight into the impacts of water resources allocation strategy for maximizing or optimizing societal returns toward enhancement of food availability through water management. The result is of utmost importance in planning, restoring and deriving optimal societal benefit from the available scare water resources in any river basin with similar attributes to the study area in establishing a minimum baseline for water requirement in a farmland.

This study offers the water resources manager and irrigation farmers to have a tool to work with in determining their net production return from available scarce water resources where past data records are sparse under the aspect of changing land use and climate variability.

THEME 3 POSTHARVEST AND VALUE-ADDEDE PROCESSING FOR EFFICIENT FOOD UTILIZATION

ROLE OF POSTHARVEST AND VALUE-ADDED PROCESSING IN FOOD UTILIZATION IN CONTEXT OF SMALLHOLDER FARMS

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POSTHARVEST STORAGE TECHNOLOGY FOR FRUIT AND VEGETABLES APPROPRIATE FOR USE BY SMALL SCALE FARMERS IN SOUTH AFRICA

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ABSTRACT

This study identifies the causes of postharvest losses in fruit and vegetables in relation to small scale farmers in South Africa and how their understanding can improve food security at household level. This article also describes the factors that cause losses, the cooling technologies that are used to minimise losses, and proposes alternative energy sources for cooling methods. High postharvest losses are experienced by farmers involved in small scale production due to physiological deterioration as a result of technical, biological and environmental factors. The challenge for small scale farmers in South Africa is the management and control of environmental factors. If these factors could be contained, then sufficient supplies of fresh produce would reach the consumer thus improving both household income and nutritional status. There are already existing modern cooling technologies that are available but these are capital intensive and require electricity which is not always available to small scale farmers. Cooling technologies are here explored extensively and evaporative cooling is suggested for small scale farmers. Appropriate cooling storage and food security go hand in hand. The study also considers alternative power sources for cooling technologies and how these can be integrated with cooling technologies in a bid to minimise losses and improve both income and food security at household level in South Africa. This is because low-cost and adequate cooling technologies are unavailable to the average small scale farmer. However, there is scope

for evaporative cooling which is simple and cheaper technology, especially, if it is coupled with a renewable energy power source.

MODERN POST-HARVEST STORAGE TECHNOLOGIES HELP REDUCE POST-HARVEST LOSSES OF HORTICULTURE CROPS IN INDIA

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ABSTRACT

One out of every eight individuals in the developing world goes to bed hungry. As the global population increases, it is predicted that by 2050 the amount of food that we produce now has to be roughly doubled to feed the world. One of the strategies that is often the first choice considered, is to increase the production by increasing the amount of cultivable land and using intensive agricultural practices. Such agricultural practices have been deemed as degrading to the environment. This warrants the development of sustainable agricultural practices that are eco-friendlier to ensure food security and conservation of the environment. Post-harvest losses as it currently stands account for almost 27-40% of the total food produced globally, with almost 50% of the produced food going to waste in developing countries. Cutting down on such food wastage is very important to meet global food security. The use of proper storage conditions such as temperature and humidity, and the type of structures used are critical in determining the storage life of agricultural produce. Many small farmers in India use traditional storage structures that have been in practice for hundreds of years. These structures have not been updated to accommodate the latest findings from storage research so as to minimize losses. For example, in India potatoes are often stored in heaps in traditional structures called “thumboo or daddi” in the production fields. Poor aeration and respiration by the potato lead to hot spots within the pile of tubers that result in rot due to mold and loss of crop. We have improved upon the traditional structure by incorporating PVC pipes with perforations in the heaps that facilitate aeration inside the piles. Such intervention has resulted in the reduction of losses and has increased the storage life from 45 to 120 days.

One of the other major issues in developing countries such as India is the lack of cold-chain storage capacity in the distribution of horticultural produce. Transport of tomatoes in an unrefrigerated truck for several hours in a tropical weather can lead to rapid decay. We have implemented the use of mobile refrigerated truck in southern India that has led to 10-15% reduction of losses. Similarly, adaptation of ventilation and evaporative cooling storage of potatoes in southern India has resulted in reducing post-harvest losses from 53% to 3.2%. Thus implementing modern post-harvest and storage technologies can help save more food to safely reach our plate.

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ENGINEERING SOLUTIONS IN GRAIN STORAGE FOR GLOBAL FOOD SECURITY

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ABSTRACT

Poor storage systems lead to losses of up to 50% of stored grain. Grains are stored by various systems in the value chain, which include piles on the ground, bag storage in ware houses, on the cob storage in cribs

and bulk storage in silos and bankers. This paper discusses the technical and economic merits of the various grain storage systems and provides proposals for development of storage systems which will enhance food security in developing counties.

APPLICATION OF CFD SIMULATION IN THE DESIGN OF IMPROVED SOLAR FRUIT DRYER

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ABSTRACT

Several solar drying technologies exist in Uganda, but marred with multiple deficiencies such as inefficient conversion of trapped solar radiations into thermal energy, low throughput, prolonged drying times and inherent difficulty in maintenance of hygiene. The present study focused on development of a solar dryer design, from materials that are locally available, that overcomes such difficulties. The dryer design consisted a concrete base of 7 m × 5 m ×10 cm, with a parabolic frame made of painted mild steel and covered with a 198 µm transparent UV-stabilized visqueen. Simulations built on Computational Fluid Dynamics (CFD) were made to predict air flow and temperature distribution inside the drying chamber using ANSYS FLUENT V14.0. Simulation results were validated by experimental investigation of temperature, air flow, and relative humidity inside the drying chamber followed by statistical comparison of simulation and the observed results. Further the dryer was tested with three full batches (120±7 kg) of fresh sliced pineapple pulp pineapple slices of 2-3 mm thickness and diameter 10±1.5 cm for the sunshine period of 8:00 am to 6:00 pm, continued to the following day until the desired moisture content of 15% wb was reached. CFD simulations predicted air flow and temperature to be 0.68±0.07 ms^{-1} and 51±3°C, respectively. These results were validated experimentally and were found to be 0.47±0.02 ms^{-1} and 57.8±10°C for inside air flow and temperature respectively. There was no significant statistical difference ($p>0.05$) between predicted values and the observed. Further, temperature and relative humidity inside the drying chamber did not significantly vary from row to row or column to column ($p>0.05$). Due to the uniform distribution of temperature, relative humidity and flow fields of drying air inside the drying chamber, the dryer effectively dehydrated a 120 kg batch of fresh pineapple pulp from 87±4% to 15±2% moisture content in 16±1.5 h which usually takes 2 to 3 days with the current solar dryers that farmers use. Short time drying eliminates potential of produce loss due to decay during drying, yields quality dried products, and enables the farmer to dry more batches thus translating into better incomes.

MULTIPURPOSE SOLAR DRYER CONCEPT FOR SMALL AND MEDIUM FARMHOLDERS

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ABSTRACT

Drying crops is one of the most feasible low-cost means of reducing post-harvest losses and aflatoxin contamination. The lack of available drying technologies cause huge losses to smallholders' crop production that amount to billions of dollars in loss of income from agricultural production annually. Open sun-drying is still the most common means of drying crops for small-holder and medium farmers. However, this method is not efficient and results in poor product quality & phytosanitary condition, and handling losses. While there have been a number of solar dryer designs and prototypes developed for small and medium holders, their adoption has been relatively low. We will present a multipurpose solar dryer developed as part of a project through Purdue's USAID funded Post-harvest Handling and Food

Processing Innovation Lab. The multipurpose crop dryer is applicable to drying cereal grains, oilseeds, tubers, vegetables and cash crops like cocoa and coffee. It is also reconfigurable as an energy source for other household purposes. We highlight its engineering features, drying performance tested with maize, carrots and mangoes, and other attributes that facilitate market linkages of the farmer to large processors, improve the welfare and income earning potential of the small & medium holder farming household.

BIOTECHNOLOGY BLOCKS THE PRODUCTION OF GOSSYPOL IN COTTONSEED, CAPTURING THE VALUE-ADDED POTENTIAL OF THIS TECHNOLOGY WILL REQUIRE A REEVALUATION AND MODERNIZATION OF COTTONSEED PROCESSING

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ABSTRACT

Modern plant biotechnology (utilizing RNAi and a seed specific promoter) has produced a genetically superior cotton plant that has gossypol production silenced in the seed while retaining normal levels in all other plant tissues, allowing the plant to retain its innate chemical defense mechanism. It is referred to as Ultra-Low Gossypol Cottonseed (ULGCS). This technology has the potential to greatly improve the value of this massive, underutilized protein resource. This breakthrough will make a substantial contribution to global food security, while also improving the sustainability of cotton.

Gossypol, a naturally occurring noxious compound found in pigment glands located throughout the cotton plant, is an effective insect deterrent, but it is also a cumulative toxin in animals with simple stomachs. The end result is that almost all of the protein produced by the cotton plant is relegated to ruminant feed. Ruminant species do not utilize protein as efficiently as monogastric or aquaculture species. Elimination of gossypol allows cottonseed protein to be used much more efficiently by using it in food products for direct consumption by humans. More than 10 million metric tons of cottonseed protein is produced worldwide each year. This is not a trivial amount of protein. Without gossypol, this is enough protein to satisfy the daily, basic protein needs (50 grams/person) of more than 600 million people for one year. Food scientists have created a wide range of food products from ULGCS cottonseed, including humus, plant-based dairy substitutes, chopped nuts, a peanut butter alternative, protein fortified beverages, protein bars and many others. Since the cotton plant is drought and heat tolerant, it is uniquely suited to serve as a source of both food and fiber for an ever increasing world population. Coincidentally, in some geographical regions, cotton is grown in close proximity to malnutrition and hunger. In addition using ULGCS for direct consumption by humans, recent research demonstrates 100% replacement of fish meal in feeds for shrimp, black sea bass, hybrid striped bass, and pompano, without a decrease in performance. These species are very efficient at converting plant-based protein to high-quality animal protein. As both the population and the standard of living increases, the need for increasing the supply of protein becomes critical. ULGCS offers the potential to drastically improve the utilization of a massive protein resource that is already being produced, but is grossly underutilized.

For more than 100 years cottonseed has been processed for the oil. All the other cottonseed products, except linters, are fed to cattle. Cottonseed oil mills are in the business of making edible oil and cattle feed. ULGCS is a complete game changer for the cotton industry. First, it will allow existing cottonseed processors to produce better quality edible oil while also reducing processing costs, due to the fact that physical refining can be used to refine the oil, instead of caustic refining. Physical refining has never been done with cottonseed oil, due to the presence of gossypol. A virgin, cold pressed, physically refined cottonseed oil will now be possible. Mechanical oil extraction and physical refining can be done with simple equipment at the local level, rather than transporting the seed to large solvent extraction plants. Edible, whole cottonseed kernels can be produced using cryogenic dehulling and other simple

dehulling equipment. Protein concentrates, protein isolates and high protein meals and flours will now be possible, whereas cottonseed protein containing gossypol cannot enter any of these food ingredient markets. Since cotton is a perennial, woody plant, the nutrition and taste profile of cottonseed is similar to a tree nut. A lot of cottonseed processing research was done in the 1970's after the discovery of edible glandless cotton. Much of that research needs to be revisited, updated and documented with modern processing technology. An innovative new processing technology, the" Brush Delinter "is a direct result of efforts to find new, more efficient and environmentally friendly processing techniques, for both planting seed and edible ULGCS.

This biotechnology-based proof of concept provides strong evidence that it is now possible to produce cottonseed on a large scale that is safe for human consumption. The improvement in the use of this high quality, valuable, massive, underutilized protein resource has the potential to make a rather large positive contribution to global food security. However, realizing the potential of this exciting biotechnology breakthrough will require that considerable time and resources be devoted to processing technology, product development and product utilization research.

OPEN FORUMS

Open Forums will address questions related to the way forward and opportunities for global partnership.

Group 4 **Agricultural Engineering in Africa - Past, Present and Future**

Facilitator: Umezuruike Linus Opara, Stellenbosch University - South Africa

Panelists: Jeff Smithers, University of KwaZulu Natal – South Africa
Noble Banadda, Makerere University – Uganda
Michael Faborode, Obafemi Awolowo University – Nigeria
Margaret W. Gitau, Purdue University – USA
Gajendra Singh, Indian Agricultural Research Institute – India

Location: Auditorium

It is now widely recognised among African leadership, governments, development experts and the international community that the poor state of African agriculture remains the major Achille's heel of the Continent's economic transformation and industrialisation. The majority of Africans still live in rural areas, remain poor, and depend on subsistence agriculture for livelihood. Put plainly, Africa and the majority of its people will remain poor and under-developed unless we radically and sufficiently change the way we practice agriculture to increase the production of food, feed and fibre, and process these raw materials into value-added products and services that are demanded and traded locally, regionally and globally. Rather than the current predominance of subsistence agriculture, the factors of agricultural production (land, labour, capital) must be transformed into Wealth through agribusiness, a process which creates gainful employment (waged labour) opportunities, on and off the farm. Success in this new agriculture for wealth creation requires significant improvements in factor productivity as well as total production, and reduction of pre- and postharvest losses. These improvements will be underpinned by the development and deployment of new skills (labour) and technological innovations across the value chain, including the protection of our increasingly fragile environment and eco-systems. More than ever before and exceeding the challenges faced by the rest of the world during their periods of agricultural revolution, the new African agriculture of the 21st century and beyond must be climate smart. The agricultural engineering discipline and related professions have key roles to play in realising successful transformation of African agriculture. But questions and doubts remain. (1) What is the state of agricultural engineering technologies and their application in African agriculture? (2) How well are current academic and research institutions and programmes aligned to meet the present and future needs of industry in terms of graduate attributes, skills, experiential learning, work readiness, and production of new knowledge and technological innovations? (3) What is the status of agricultural engineering professional societies and networks at country, regional and continental levels – what roles and impacts have they made and/or could potentially make towards Agenda 2063: the Africa We Want (and more directly, the African Agriculture We Want) and how could these bodies be strengthened for relevance and impact? Recently, the Pan African Society for Agricultural Engineering – AfroAgEng, was formed (www.pasae.org.za) as the continental umbrella of professionals interested in the promotion and advancement of agricultural engineering discipline, profession and practice in Africa. What lessons can we learn from the experiences and operation of similar continental and regional professional associations?

Group 5 **Capacity Building for Mitigation of Climate Change by Use of Precision Agriculture in Developing Countries**

Facilitator: Ganesh Bora, Mississippi State University - USA
Panelists: Gajendra Singh, Indian Agricultural Research Institute - India
Dharmendra Saraswat, Purdue University - USA
Phong Nguyen, Vietnam Academy of Water Resources - Vietnam
Koffi Djaman, Africa Rice Center - Senegal
Location: Simons

Policy makers along with scientist, academicians and progressive farmers in South and South-East Asia have substantial influence on development of modern agricultural methodologies. Precision Agriculture in the USA has greatly optimized the use and contributed in the reduction of use of chemicals and fertilizer with positive economic and environmental impact and increase in crop yield. This has resulted in reduction of GHG emissions and aided in mitigating climate change impacts. Similar technology with adaptive modifications/customization can be used in developing countries and the policy makers and professionals of these countries could be trained to influence the farmers for such adoption.

Group 6 **The Potentials of Biogas Technology in Enhancing Energy and Food Security**

Facilitator(s): Taisha Venort, Purdue University - USA
Panelists: Isa Kabenge, Makerere University – Uganda
Nicholas Kiggundu, Makerere University – Uganda
Ji-Qin Ni, Purdue University - USA
Location: Helder

The integration of biogas technology into rural livestock farming systems is becoming more common in Kenya, as the National Domestic Biogas Programme has facilitated the installation of over 10,000 biogas plants in the country since 2009. Historically, rural biogas plants installed in similar contexts in developing countries have had a short practical life span. A comprehensive understanding of the role of biogas technology in Integrated Food–Energy Systems (type II IFES) can assist actors and stakeholders in improving its applications for energy and agronomic use. This study sought to conduct a follow-up assessment on the operation of biogas plants in Nandi County, Kenya, towards gaining new understandings of success factors for type II IFES. A preliminary analysis was performed on a database obtained through the Netherlands Development Organization (SNV), to assess the operational status of 200 biogas plants. About 110 farm households with either operational (OP) or non-operational (NOP) biogas plants were randomly selected and visited. Data on farming systems and technology application were collected using a checklist questionnaire. Descriptive statistics and principle components analysis were used to investigate correlations between variables of application, and the operational status of the biogas plants. The preliminary results revealed a 1.2 ratio of OP/NOP. The most common 8 m^3 and 10 m^3 size fixed-dome plants are often unable to meet daily cooking requirements for traditional energy intensive meals (i.e., Ugali, Githeri) of most households. Though full substitution to biogas is a rare occurrence, partial substitution still contributes to reducing workload associated to cooking for women and elders, and retaining few small local forests. Farmers' experiences integrating the use of bio-slurry into farming practices show specific patterns of fertilizer application: Bio-slurry is mostly preferred for African indigenous vegetables and grass feeds, dried manure for fruits, and chemical fertilizers for common cash crops (i.e., tea: *Camellia sinensis*, and maize: *Zea mays*). Users' experiences also reveal that poor farm structure and management, high cost of installation and repair, and the lack of skilled and reliable technicians, affect the viability of most biogas plants, which limit application and dissemination. This study suggests that higher OP/NOP ratio could be an indicator for longer practical life span of biogas plants in a region, a key factor for ensuring local energy security and long term food security. Experiences of long-lasting biogas and bio-slurry use can help better understand and guide future research avenues for biogas technology application in agriculture.

Group 7 **Sustainable Agricultural Intensification for Improved Food and Nutritional Security**

Faciilitator: Ajit Srivastava, Michigan State University – USA
Panelists: P.V.V. Prasad, Kansas State University – USA
Johann Strauss, Plant Sciences Western Cape Department of Agriculture
Alan Hansen, University of Illinois – USA
Manny Reyes, Kansas State University – USA
Mark Musumba, University of Florida and Columbia University - USA
Location: Stenneberg

The grand challenge of increasing production of nutritious food to meet growing population requires a systems approach towards agriculture. Sustainable Intensification (SI) uses the farming systems approach and focuses on increasing food production on existing farmland per unit area per unit time. The concepts of SI improve resource use efficiency to enhance productivity of farms without any environmental or social impacts and assures provision of all the ecosystem services of a healthy environment. It is based on the philosophy that in order to grow, agriculture must learn to save ('Save and Grow' concept of FAO). SI will require efficient use of labour and access to appropriate scale mechanization tools for efficient management of land, soil, water, crops, weeds, nutrients and planting, harvesting and threshing equipment to minimise crop losses and human drudgery. SI not only takes into consideration components of biophysical sciences but also social sciences to measure impacts on multiple domains (productivity, economic, environment, human condition and social). Obtaining measureable impacts on farmers' fields will require participatory approaches, effective collaboration and knowledge sharing, enhanced human and institutional capacity and creation of an enabling environment by engaging all stakeholder and partners. Thus, SI is necessary for achieving food and nutritional security and improving resiliency of smallholder farmers.

THEME 4 FOOD DISTRIBUTION AND LOGISTICS FOR ACCESSIBILITY

EFFECTIVE FOOD DISTRIBUTION AND LOGISTICS FROM SMALLHOLDER FARMS FOR INCREASED FOOD SECURITY

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General Director of the Social Sciences Group, Wageningen University and Research

ABSTRACT

Food logistics concerns all activities in the supply chain to match product supply from the (smallholder) farm with local, regional or even international market demand for those products. It aims at getting the right food product, at the right place, at the right time, according to the right specifications (including quality and sustainability requirements) at the lowest cost. However, this is challenging as markets have diverse requirements, production and supply are influenced by weather conditions and actors in these types of chains experience that original good quality products are subject to quality deterioration due to physiological processes potentially resulting in significant food losses (Hodges et al., 2010; Gustavsson et al., 2011).

Postharvest losses (PHL) are a major obstacle in achieving sustainable fresh produce chains and have repercussions for food security, poverty, and economic growth, especially in developing countries (Hodges et al., 2010). Major causes of high PHL in fresh produce chains can be attributed to inadequacies in logistics and quality management. Typical examples of inappropriate logistics management contributing to PHL are poor demand forecasting (Van Gogh et al., 2013), inefficient inventory control systems (Kaipia et al., 2011), and lack of supply chain coordination (Gustavsson et al., 2011). Insufficient temperature, humidity, and atmospheric conditions control (Kader & Rolle, 2004; HLPE, 2014), inadequate packaging (Gustavsson et al., 2011; Kitinoja, 2013), poor product quality control (Kitinoja et al., 2011; Prusky, 2011; Kereth et al., 2013) are examples of inappropriate quality management contributing to PHL. Obviously, interventions to reduce PHL are needed to improve sustainability of fresh produce chains and improve global food security.

In this talk I will give an overview of (i) logistics performance requirements in agrifood supply chains, (ii) key activities and decisions of food distribution and logistics, (iii) social, economic and technology trends and developments in agrifood supply chains that impact food security, (iv) main bottlenecks in food distribution and logistics based upon a number of case studies in developing countries, and (v) main interventions to improve food distribution and logistics.

MEASURING LOSSES IN SUGAR SUPPLY CHAIN: A BRAZILIAN CASE STUDY

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ABSTRACT

When one delivers the sugar in bulk from an origin to a certain destination, a series of physical losses (quantitative and qualitative) can be observed. Such physical losses imply, directly and indirectly, monetary losses. This article aims at measuring physical losses (quantitative and qualitative) in the supply chain of bulk sugar, from the moment the product output leaves the production units to the exporting vessel. Different loss indicators (real losses, breaking technical and contractual retention), related to the different stages of sugar logistics (road and rail transport, transshipment and port operations in the terminals), were accounted. From field research, interviews and database obtained with representative agents of the sector, it was possible to characterize the logistic processes in handling flows with selected export destinations and also to identify differences in infrastructures according to the agents involved. It was also possible to understand the procedures and particularities involving the weighing of vehicles in each logistics step and to visually identify the various types of physical losses in logistics operations, as well as the existing handling care in cases involving loss minimization. In the case of sugar originated in the State of São Paulo, the percentage of total export losses, which ranged from 0.233% to 0.533%, with an average of 0.283%. Specifically for the multimodal corridor, the range of total losses varied from 0.583% to 1.179%, with an average of 0.752%. For flows of Minas Gerais, through the road mode, the levels of total losses ranged from 0.255% to 0.555%, with an average of 0.305%. In the case of multimodal options, intervals ranging from 0.576% to 1.173% were observed, with an average of 0.745%. It was thus demonstrated that it is not possible to establish a single indicator to "loss", beginning with the difference in the concepts involved (if it is an actual physical loss or if it concerns to technical breaks or deductions, negotiated between agents over the logistic operations). Anyway, it is certain that the losses in export logistics chain significantly affect the sugar sector, as they fall on a number of economic indicators involving the opportunity cost of lost sales, additional logistical costs and possible effects on extra taxation.

FRUIT SUPPLY MANAGEMENT CHAIN PRACTICES AND THEIR EFFECT ON FOOD AVAILABILITY AND QUALITY IN BOGOTA CITY

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ABSTRACT

The objective of this study, was to evaluate the availability of seven fruits in Bogotá City. The fruits were considered as a priority by the Colombian Nutritional and Food Safety Plan for 2012-2019.In addition, this project evaluates the influence of the fruit supply chain management on the fruit's availability and their nutritional quality in Bogotá City. This study was performed at the facilities of Bogotá-Abastos Corporation (CORABASTOS), Bogota's main food supply management and agricultural business platform. Fruit commercialization process, availability, handling, storage, and quality were identified by visiting and surveying the main wholesale fruit businesses at CORABASTOS. Preliminary results, showed that 5% of the seven fruits are not available for consume due to bad supply management practices. As a result of our

study, the design of a pulp processing plant was proposed in order to consume the 5% of fruits that are currently wasted.

THE RELATIONSHIP BETWEEN THE TRANSPORT INFRASTRUCTURE AND THE DEGREE OF ACCESSIBILITY TO MARKETS: THE CASE OF CORN IN BRAZIL

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ABSTRACT

In Brazil, the maize supply chain have regional particularities, which evidence the relationship between logistics infrastructure and the degree of accessibility to domestic and foreign markets. This study aimed to (a) characterize the corn logistics chains in two Brazilian states with different features of flow: Tocantins, with flows mainly destined for the exports; and Bahia, with corn mainly transported into Brazilian market; (b) Identify risks and limitations related to those maize chains studied which imply logistics costs for the producer. It was conducted a field research to application of questionnaire to 16 representatives of different corn chain stakeholders in Bahia and Tocantins. The results allowed the characterization and identification of logistics risks and limitations most evidenced by the agents.

Results

Tocantins exports about 70% of its production (the national average is about 34%). The areas of greatest production are close to major transport infrastructure, enabling higher logistics competitiveness for these producers. In general, the transport infrastructure in Tocantins has: a railway and three recently opened rail-road terminals, enabling a significant reduction in freight for export through the port of São Luís (MA); a road network that allows transport of grain from the production areas and warehouses directly to the São Luis port or to rail transhipment terminals

For the other hand, about 94% of corn produced in Bahia are distributed in the domestic consumer market. The poor level of logistics infrastructure connecting the production areas to the ports and the dependence on road transport explain the predominance of flows directed to the domestic consumption.

The main logistical risks and limitations identified in both states were: (1) Poor quality of the secondary roads (that connect producing regions to the main roads) increases the freight paid in the producing regions up to R$ 30.00/ton. In some cases, producers directly invest in new transport routes or in the maintenance of existing ones; (2) Lack of storages in the farm exposes the producer to logistical and marketing risks (such as higher freight and lower price paid for the grain, respectively); (3) Abundant rainfall in the region hamper or even suspend harvesting and transport operations of corn in secondary roads (4) Large lines and high waiting times at rail-road transhipment terminals increase the freight up to R$ 10/ton. (5) Transport fleet displacement to other relevant producing areas of corn (such as Mato Grosso) also increase the freight paid by the states of Tocantins and Bahia.

ASSESSMENT OF SILO MATERIALS HANDLING EQUIPMENT: A CASE STUDY OF SOME ESTABLISHMENTS IN OYO AND OGUN STATES, NIGERIA

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ABSTRACT

The use of silo has enabled the bulk storage of grains in large quantity. The beginning of the utilization of modern silo in Nigeria was dated to the late 1950s when pre-fabricated galvanized and aluminum silo units were installed in Ilero (Oyo state) and Ilaro (Ogun State) in 1957 and 1958 respectively. The acceptance/ utilization of silo storage is therefore high in Ogun and Oyo States of Nigeria. Earlier research findings indicated that most silos in Nigeria are used for short-term storage due to the poor state of existing facilities and inadequate silo materials handling equipment (MHE). This study identified the types of MHE and accessories used with silo and their effectiveness; the problems associated with their uses; and proffered solutions to the problems identified.

This study therefore conducted an assessment of silo MHE and other accessories in Oyo and Ogun States of Nigeria. Nine (9) and seven (7) various establishments (including brewery, feed mill, cement factory, flour mill and farms); where silos are utilized in Oyo and Ogun States respectively were identified and visited. Questionnaires were administered to technical and administrative personnel in the establishments. The results show that 40% of the sites use their silo for grains storage with the view to process it into livestock feeds. Approximately 10% of the sites use their silo to store cement and tobacco; while 20% use theirs to store raw materials for flour production. The study showed that no silo can survive without MHE; because movement of materials within the silo will almost be impossible. This is implying on those investing on silo to also invest on MHE and accessories.

The types of MHE and accessories identified include inlet hopper, bucket elevator, belt conveyor, screw conveyor and aspirator. Some of the problems associated with loading and unloading of material in and out of the silo include: congestion, dust pollution, noise pollution, slacking of conveyor chain and belt, technical problem, belt slippage and material blockage. Problems associated with silo MHE include: corrosion, water seepage, wear of sprocket and gear teeth, power failure, loosening of elevator cups, burnt electric motor, wear or tear of belts, and over stretching of conveyor chain and belt. The solutions proffered for the identified problems are also reported.

IMPROVING FOOD SECURITY AND FOOD SAFETY OF SMALLHOLDER FARMERS IN THE WESTERN HIGHLANDS OF GUATEMALA THROUGH REDUCTION OF POST-HARVEST LOSSES IN MAIZE

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ABSTRACT

Traditional post-harvest practices used for maize by smallholders in Guatemala are the result of a long process of empirical experimentation and adaptation. These practices have been applied in an economy essentially oriented towards subsistence. Previous research has shown that many of these practices may not guarantee grain integrity and protection against major storage pests, thus impacting food safety, along with food and income security of the smallholder farmers. This project aims to improve food safety and food security of smallholder farmers through the implementation of affordable post-harvest technologies geared towards reducing post-harvest losses, mitigating mycotoxin contamination, and improving storability of corn. In the first phase of the project, a post-harvest assessment study was conducted through farmer interviews in the region of Huehuetenango, Guatemala, in order to identify

factors contributing to post-harvest losses and to better understand how traditional storage structures, pest control and storage management may affect quality and shelf-life of the stored maize. Also samples are been periodically collected throughout the duration of storage to quantify actual losses, moisture content, and mycotoxin contamination. The second phase evaluated the effects of improved post-harvest and storage practices/technologies on post-harvest losses and mycotoxin levels in stored corn compared with traditional practices. In this phase, a group of smallholder farmers were given access to improved corn drying and storage equipment (i.e. solar dryers, metal silos, plastic barrels, and hermetic storage bags). Moreover, as a third phase of the project smallholder farmers and their families will receive intensive training regarding the hazards of mycotoxin consumption, the importance of appropriate drying, storage and post-harvest practices to maintain grain integrity, and how to improve their traditional post-harvest practices. The use of improved post-harvest management systems by smallholder farmers will enhance farmers' capacity to intensify production activities and improve food safety and security.

A QUALITATIVE DISCUSSION ABOUT THE UTILITY OF STAPLE GRAIN LOGISTICAL PLATFORMS IN GHANA, WEST AFRICA

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ABSTRACT

It is hard to understand why the spread of sms texting, commodity exchanges, microfinance, mechanization, improved seed, fertilizer, pest management and increased gross yields in the world's poorest places has been heralded as breakthroughs with the potential to "double the agricultural productivity and incomes of small-scale food producers." When the reality is, significant Postharvest and related input loss (PHL) needlessly limits higher yields from increasing the well being not just of smallholders but of entire developing countries.

Staple grain, pulse and oilseed storage programs have been proven by farmers, agronomists and stored grain researchers to guarantee Food security against PHL. However, Sub-Saharan African (SSA) institutional sack storage and "warehouse receipt systems will likely fail when support is withdrawn. These are typically multimillion projects that do not work, as the marketing environment is not sufficiently developed to support them. Even if they did work, they would not help smallholders, which they are often claimed to do"(World Bank/Ferris, 2013).

Background

Let's try to imagine the plight of a woman farmer in SSA, growing grain to feed her family without staple grain utility storage. She will suffer "significant Postharvest loss" (Lipinski, 2013), because practically she does not have the right to benefit from her harvest. If she sells for a low price during peak harvest, her labor and other production inputs (that are often micro-financed) will be wasted. If she attempts to own the right to the value of assets like Land tenure, she may "increase the risk of violence in the short run, by challenging traditional gender roles and increasing conflict in the household" (Bott, 2005). The combined result is she may experience "market failure" (Jones, 2011) after selling low, and then buying back at a higher price. In this sense, the PHL risk undermines a mother's ability to feed her children quality, high calorie grain or improve farm income.

Objectives

Simplify PHL into "after the plate" and "before the plate" topics and by setting aside wet, low calorie fruit/vegetable PHL, because for example, "Encouragingly, though, tackling [grain] post-harvest loss is not rocket science. It does not require technological breakthroughs or years of high level scientific research as do some of the other challenges we face" (Cousins, 2015) (1.) To evaluate the utility of various

Ghana grain grower storage options by organizing and reviewing literature including lifecycle assessments, popular press examples and personal observation of adaptive learning in low investment, tenure-less SSA agriculture. (2) To implement mobile utility storage at 4 locations to demonstrate this approach. (3) Identify any potential institutional roadblocks with adoption of mobile storage systems.
Approach / Design / Methods

Approach Ghana growers with assessments of: sack, metal cans, hermetic or ZeroFly®bag, field and farm house, silo and mobile utility (See Image 1.) storage. Perform due diligence by inspecting storage systems. Design, test and refine mobile utility storage at 4

POSTER SESSION

1 FACILITATING AGRICULTURAL DECISION MAKING THROUGH ICT APPLICATIONS

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ABSTRACT

Absence of desirable impact of investments in three sectors of agriculture, namely research, education and extension, in Sub-Sahara Africa (SSA) is attributed to lack of weak linkages among the three sectors. Overcoming the weakness through use of Information and Communication Technology (ICT) is likely to facilitate decision-making by timely dissemination of research-based information to the intended stakeholders. This presentation is about the design of an innovative weed management system that uses smartphone and crowdsourcing in a hierarchical manner. The smartphone application (in short "app") is used for capturing weed images that is submitted to a crowd server for generating image processing-based solutions. Two levels of crowdsourcing processes have been developed to identify weed images. The first of the two-crowdsourcing levels consist of a non-expert crowd contributed by Amazon Mechanical Turk (AMT) and the second level consists of a crowd composed of experts such as field-level workers (county extension agents in the US). The developed system was assessed for its suitability for accurate identification of weeds using a probabilistic decision engine. Test results showed that 80% of weeds were identified accurately using the low cost AMT crowd with a maximum latency of 3 hours. The system also had the ability to communicate remedial control practices for containing identified weed infestation. Thus, the designed system could become an integrated part of a crop management program that minimizes yield losses through timely and accurate identification of weeds and adoption of proper control practices in areas served by wi-fi connectivity.

2 DESIGN AND TESTING OF LOCALLY MANUFACTURED MOBILE MULTIPURPOSE AGRICULTURAL UTILITY SYSTEMS IN SUB-SAHARAN AFRICA

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ABSTRACT

Agriculture is one of Sub-Saharan Africa's (SSA) largest contributors to GDP and has the potential for significant growth in food production, yet it falls far behind the productivity of most other continents. Many rural communities have few affordable options for transportation and power. This limits the use of labor-saving technologies and access to markets. Significant amounts of time and energy are spent tilling, weeding, planting, harvesting, and hauling produce and crops, all by hand or foot. Even when surplus food is available at harvest, a lack of transport and storage technologies leads to high post-harvest losses. For smallholder farmers the transportation of grain is often still done manually.

The Purdue Utility Project is a co-creation partnership between Purdue students, NGOs, and communities in SSA working on the development of the Purdue Utility Platform (PUP) and labor-saving attachments. The PUP is a multipurpose utility vehicle that can transport up to 900 kg on unimproved roads or off-road and can also power attachments such as water pumps, maize grinders, generators, and threshers. Its design uses a common angle iron size for the frame, along with driveline and suspension car parts from recycled vehicles. All the parts and materials for the vehicle can be obtained in-country and assembled locally, keeping the material cost low. The purpose of the project is to address the challenge of affordable transportation and farm mechanization in SSA through international partnerships. Students on the project learn teamwork, critical thinking, cross-cultural communication, global awareness, and problem solving, while the partners also contribute to the design, build, testing, implementation, and marketing.

Locally manufactured PUPs are currently operating in Cameroon, Guinea, and Uganda. The PUP has been built, tested and iteratively refined since 2010 in Cameroon, primarily as a means of transporting water, construction materials, agricultural produce, and technologies implemented by the African Centre for Renewable Energy and Sustainable Technologies (ACREST), such as water filters, cook stoves, biomass briquettes, and tree seedlings for a reforestation project. In Uganda tests were done with tillage and powering a thresher. In Guinea the PUP has been connected to a rice reaper head. Efforts are ongoing to commercialize and scale-up the technologies.

3 MILLETS AND PULSES: TOWARDS IMPROVED NUTRITION, SUSTAINABILITY AND FOOD SECURITY

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ABSTRACT

Pulses are an important source of macronutrients, containing almost twice the amount of protein compared to cereal grains, and rich in complex carbohydrates (e.g., resistant starch and oligosaccharides). In addition to being a source of macronutrients and minerals, pulses also contain plant secondary metabolites that are increasingly being recognised for their potential benefits for human health.

Pulses are a rich source of the amino acid lysine, hence when combined with a good source of the amino acid methionine, present in cereals or pseudo-cereals such as millets, they provide a balanced protein source to consumers. Millets are highly tolerant to extreme weather conditions and have been successfully cultivated in marginal lands, providing resilience in a world experiencing climate change challenges.

Reducing the environmental impact of protein consumption is of critical importance to meet the growing needs of a growing world population. In fact, the livestock sector generates more greenhouse gas emissions as measured in CO_2 equivalent — 18 percent — than the transport sector. Indeed, 40% of the produced dietary protein needs is supplied by nitrogen fertilizers which are required in modern agricultural production. Since pulses require little to no nitrogen fertilizer, eating foods that contain

pulses can improve the 'fuel mileage' of what we are consuming. Pulse crops bring an advantage to cropping systems by leaving nitrogen behind for the following crop. Indeed to feed a growing population, farmers have to provide their crops with the right nutrients. Nitrogen is the nutrient most needed in crop production, and the main input to manufacture nitrogen fertilizer is natural gas, a fossil fuel. Pulses are among the small group of food crops that source their nitrogen from the surrounding air. Pulses are able to do this through a relationship maintained with nitrogen fixing soil bacteria that live inside their root systems.

A staple of many traditional diets around the globe, high-protein, low-fat, high-fiber pulse grains have been shown to fight diet-related diseases and malnutrition. Many pulse varieties tolerate drought and break pest cycles that afflict cereal crops. In recognition of the tremendous advantages to be gained by eating more pulses in a growing world, the United Nations General Assembly has declared 2016 the International Year of Pulses (IYP). In synergy with pulses, it is also important to integrate other whole grains such as millets to provide complete amino acids profile to consumers.

4 MODERNIZATION OF AGRICULTURAL PRODUCTION THROUGH SHARED AND MULTI-USER PIVOTS FOR SMALL LANDHOLDERS IN AFRICA

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ABSTRACT

In much of the world, agriculture is dominated by small landholders and subsistent food production. Due to the increasing competition for limited water supply and the need for food security, it's important to modernize agriculture in these countries. However, this has proven to be difficult, as small land holder farming lacks sufficient scale and economic return to pay for the investment needed.

Multi-user and shared center pivots are increasing being promoted to address the "economics of scale" problem. In addition, with the right selection of water applicator technology, pivots can have irrigation efficiencies similar to drip with significant less maintenance requirements and on-going costs.

While the first multi-user center pivot known to exist was introduced in 2002 in Burkina Faso, in recent years, new projects have been implemented in several countries including Rwanda, Kenya and Ghana. The largest existing shared pivot development in Africa was installed just two years ago, the Kagitumba Irrigation Project in Rwanda consisting of 41 pivots. An even larger project was scheduled to be completed by September 2016 in the Nasho area of Rwanda consisting of 63 pivots. Former dryland farmers are being organized and assigned to pivots. This is also the first multi-user pivot project known in Africa employing pumps with variable frequency drives

In this paper, the concept of shared and multi-user concept is discussed, including observations and lessons learn from the few existing projects. Definitions for multi-user and shared pivots are proposed, technical considerations for land division under pivots are given, as well as considerations in farmer organization and equipment specifications. Keys to success are likely the way farmers are organized, the degree of directive farming and technical assistance made available to farmers, as well as the design, operation and management of the pivots. This paper will evaluate these projects using these success keys.

5 DESIGN AND TESTING OF MULTIGRAIN THRESHING MACHINE FOR SUB-SAHARAN AFRICA

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ABSTRACT

One of the biggest barriers to food security in Sub-Saharan Africa is the lack of mechanization in agriculture. The majority of farmers are smallholder farmers who cannot afford or utilize large agricultural machinery common in developed countries. Threshing is the energy-intensive process of separating grain from material other than grain (MOG). Traditional methods of threshing or shelling include beating the grain stalks with sticks, trampling the material by people or animals, or shelling maize cobs individually by hand. Grain is easily lost and contaminated during these processes, decreasing the quantity and quality of available food.

In an effort to address this challenge, a multigrain threshing machine was designed, built, and tested at Purdue University. The thresher uses only parts and materials commonly available in Sub-Saharan Africa. Crop material was fed tangentially into the threshing drum and flowed axially along the threshing drum. An oscillating sieve and a fan were used to separate the grain from the MOG. Testing was done with maize cobs with husks and whole soybean stalks. Batch tests were performed with a 6.5 hp gasoline engine running at 3000 rpm, driving the drum at 12 m/s peripheral speed, the oscillating sieve at 10 Hz and air from the fan at 8.9 m/s. Preliminary results showed that 96% of the corn and 94% of the soybeans landed in the grain bin with only 1.3% and 6.6% MOG respectively. The feed rates of 200 kg/h for corn and 20 kg/h for soybeans were not limited by the power of the engine but by the narrowness of the input chute and clogging at the entrance gap between the drum and concave. Modifications for improved stability, cleaning, and feeding have been made and additional tests will be performed to measure improvements.

6 SMART AUTOMATED IRRIGATION SYSTEMS

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ABSTRACT

An integrated program of research is being undertaken in Australia which aims to achieve a 10-20 percent improvement in water productivity, efficiency and farmer profitability through the adoption of new irrigation technologies, together with science application by farmers and irrigation professionals. The program consists of three components.

1. Practical, reliable irrigation scheduling technologies,
2. Precise, low cost automated control systems for a range of irrigation systems,
3. A network of farmer managed learning sites located in major regions referred to as “optimised irrigation” farms.

The project is a partnership between the major irrigation industries of cotton, dairy, rice and sugar.

This paper summarises work being undertaken to develop smart automated precision irrigation systems for whole of farm scale use. The systems are being tested and validated at the field scale, and demonstrated to growers and potential commercial providers to encourage future industry adoption.

The project involves significant development, evaluation, field testing and engagement of potential commercial partners. Field level testing is being implemented at one centre pivot irrigated pasture site in Tasmania, one furrow irrigated cotton field near Moree, NSW, one lateral move cotton site in Dalby, Queensland and one furrow irrigated sugar site in the Burdekin, Queensland. Sites are being

monitored to assess both the volumetric irrigation performance and crop yields as well as technical challenges and economic cost benefit. This will assist growers and commercial providers assess the merits of adopting smart automated irrigation systems.

7 CLIMATE CHANGE AND FOOD PRODUCTION IN US MIDWESTERN WATERSHEDS

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ABSTRACT

Long-term shifts in annual and seasonal precipitation and temperature, increased flooding, longer drought periods, extreme precipitation and saturated soils may potentially enhance projected soil erosion and water quality degradation, and reduce crop yield and consequently threaten food security. According to survey of Midwestern corn producers by USDA-NIFA, there is a strong agreement on additional steps needed to help farmers protect farmland from increased weather variability. There is also a strong agreement on using conservation tillage, cover crops, and other conservation practices on vulnerable lands including investments on agricultural drainage systems to prepare for expected increased precipitation. Two river basins located in the US Midwestern corn belt, White River and Wabash River Basins, with a drainage area of 29,000 and 42,700 km^2, respectively, were selected to understand how hydrological and water quality processes and crop yield respond to climate change by incorporating six climate change scenarios (three General Circulation Models (GCMs) outputs under two Climate Change scenarios 4.5 and 8.5) for mid- (1920-1949) and late-century (1971-2100) to Soil and Water Assessment Tool (SWAT). These two river basins represent the significant portion of the agricultural land of Indiana. The model successfully simulated the annual corn and soybean yields from 1995 to 2014 in comparison with the NASS county level yield measurements with mean PBIAS of +4% and +2.5% for simulated corn and soybean yield of Wabash River Basin and mean PBIAS of -0.89% and -7.3% for simulated corn and soybean yield of White River Basin, respectively. Based on GCMs ensemble outputs, under RCP4.5, projected change in precipitation (temperature) is 4% (1.2°C) for mid-century and 6% (2°C) for late-century. Similarly, under RCP8.5 projected change in precipitation (temperature) is 11% (1.3°C) for mid-century and 14% (4.5°C) for late-century. The preliminary results show that during midcentury, corn yield is projected to be reduced by 3-8% and soybean yield reduced by 8-10%. For late-century, corn yield is expected to be reduced by 10-20% and soybean yield by 30-45%. Projected water quality and soil erosion is more critical in White River Basins with 39% (94%) increase in sediment load while it is only 15% (40%) for Wabash River Basin under RCP4.5 (RCP8.5) during mid-century, respectively. There is a need to identify vulnerable area and river segment to climate change across the river basins for implementing the management practices to mitigate potential negative impacts.

8 SIMULATED CROP WATER USE RESPONSE TO NUTRIENT MANAGEMENT IN AQUACROP FOR COMMERCIAL DRYLAND MAIZE PRODUCTION WITHIN KWAZULU-NATAL, SOUTH AFRICA

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ABSTRACT

When considering water management alternatives for dryland agriculture, mineral nutrition is a key factor in the overall adaptation, survival, and resulting yield response of the crop during drought stress. Nutrient transport and uptake are influenced by soil moisture and net transpiration rates in addition to soil-specific characteristics, creating an intersection of optimizing factors for plant use: nutrient availability and crop water use. To investigate optimal thresholds for crop water use in response to nutrient rate application on yield during drought stress, a yield and transpiration gap analysis of a commercial dryland maize production was done in KwaZulu-Natal. Scenarios for varying rates of N, P, and K management were developed using the United Nations Food and Agriculture Organization AQUACROP model, which simulates growth, yield, and transpiration on the basis of crop water productivity. Crop growth was simulated for 30-years using long-term precipitation and temperature records from the South African Agricultural Research Service weather station network; daily wind speed was estimated using global NCAP-DOE Surface Reanalysis u- and v-wind variables, and solar radiation estimates were based on coupled outputs from the Variable Infiltration Capacity model weather generator. Crop growth parameters and site characteristics were established during the 2014-2015 growing season, when regular crop growth analysis measures of leaf area and aboveground dry matter were collected every 10-14 days. Model outputs were calibrated and validated using long-term yield data from rate application studies provided by Cedara scientists with the KwaZulu-Natal Department of Agriculture and Rural Development. Validated outputs were analyzed using a mixed effects statistical model to conduct pairwise comparison of yield and transpiration across nutrient management and water availability scenarios. Differences in management strategies will be presented and discussed, as well as the performance of AQUACROP nutrient stress algorithms across scenarios tested.

9 THE COST OF IRRIGATING RICE IN THE SAHEL: ENERGY AND WATER PRODUCTIVITY IN SENEGAL RIVER VALLEY IRRIGATION SCHEMES

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ABSTRACT

The rice sector is significant to the economies of the Sahel region. In Senegal, consumption of rice is by far the largest among all cereals. Total rice consumption in the country exceeds local production by more than 50%, requiring the country to rely on costly rice imports to satisfy domestic rice demand. The Senegalese government has a history of investing in the rice sector, with a large number of government constructed irrigation schemes used by smallholder farmers with plots ranging in size from about 0,25 to 1 hectare. These schemes are expected to contribute to the national goal of rice self-sufficiency through increased productivity in the domestic rice sector and to mitigate rice importation costs. The Senegal River valley schemes are dependent on pumping water from the Senegal River into irrigation scheme canal systems. There is a significant dependency of rice irrigation on electrical energy. The cost of electrical energy for supplying irrigation water ranges from 20 to 25% of total rice production costs. It is a major constraint for smallholder rice producers. This study focused on water and electricity use, productivity of irrigation water, energy productivity, and the electricity cost of irrigating rice at four irrigation schemes in the Senegal River Valley in Senegal. As contribution to performance assessment of these irrigation schemes, we compared (1) depth of ponded water and ponded flood volumes in the rice schemes under farmer practices and that under the good agricultural practices where the recommended flood depth is 5

– 10cm, (2) productivity of irrigation water, and (3) productivity of electrical energy used to supply irrigation water. The schemes in this study were characterized by low water productivity. Depth of ponded water and ponded flood volume under farmer practices was consistently higher than that under recommended good agricultural practices. In 2015 the productivity of supplied irrigation water ranged between 0.3 and 0.6kgm^{-3}. Energy productivity for electricity used to lift water onto the schemes ranged from 24 to 62kg of rice paddy per kWh consumed in irrigation water supply. The energy cost of supplying irrigation water ranged from $39/ha to $49/ha. Efficient water use in line with recommended good agricultural practices and improved water management at scheme level will result in lower production costs and increased profitability for smallholder farmers.

10 DEVELOPMENT OF A MIXED MODE PASSIVE SOLAR DRYER

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ABSTRACT

A mixed mode passive solar dryer was designed, constructed and tested. The dryer is composed of solar collector (air heater) and a solar drying chamber constraining rack of two wire mesh trays both being evenly spaced. The heated air from a separate solar collector is passed to the cabinet, and at the same time, the drying cabinet absorbs solar energy directly through the transparent glass. Locally available material were used for the construction, chiefly comprising of wood (plywood), glass, aluminium metal sheet, projection hanger, a compass, lagging material (leather blanket with foam) and wire mesh for the trays. The dryer test was carried out in University of Uyo, Uyo. Akwa Ibom State. Nigeria. The maximum attainable temperature of the dryer is 61.3℃ with a corresponding ambient temperature of 35.0. The final moisture content of 12.0℃ was achieved using the solar dryer from an initial moisture content of 64.0%. The solar dryer has a drying rate of $0.11\frac{kg}{hr}$. The rapid rate of drying in the dryer reveals its ability to dry food items to reasonable safe moisture.

11 DRYING CHARACTERISTICS AND ENERGY REQUIREMENT OF DRYING COWPEA LEAVES AND JUTE MALLOW VEGETABLES

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ABSTRACT

Thin layer drying of cowpea leaves (*Vigna unguiculata*) and jute mallow (*Corchurus olitorious L*) (African leafy vegetables) was studied at different temperatures (40°C -100°C) in a convective laboratory dryer. The study determined the drying characteristics of the vegetables, the maximum drying temperature and the drying energy requirements. Moisture content of the African leafy vegetables was determined on dry basis and the data were used to calculate moisture ratios and drying curves were plotted. The drying occurred in the falling rate period. The experimental data were fitted to fourteen thin layer drying models and the most appropriate drying model determined using correlation coefficient, mean square error and standard error of estimate. The model developed by Page showed good agreement with the data obtained

from the experiments of this study because it consistently returned the required attributes from statistical analysis and its simplicity. The energy requirement of drying vegetables at the different temperatures was calculated. Cowpea leaves had a longer drying time of 304 min and a higher specific energy requirement of between 168 J/g at 100^{o}C and 11.2 J/g at 40^{o}C while jute mallow had a drying time of 256 min and an energy requirement of 155.3 J/g at 100^{o}C and 10.6 J/g at 40^{o}C respectively.

12 VALUE-ADDED PRODUCTS FROM MAIZE WASTES FOR ENHANCING REVENUE OF SMALL HOLDER FARMERS

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ABSTRACT
Currently all the revenue that the 86% of agricultural households growing maize on 20% of total crop area in Uganda is derived from grains with zero income from stover. This research was carried out to find out potential products that can be developed for value addition to local maize stover for enhancement of farmers' income in environmentally friendly way. A batch pyrolysis reactor 0.0376 m^3 was run at temperatures 350-550 ^{o}C to investigate slow pyrolysis of maize stover. The main pyrolysis products of bio-oil (vinegar), tar and biochar were obtained. Chemical composition of the pyrolysis oil and tar was analyzed using Gas Chromatography – Flame Ionization Detector (GC-FID). The results showed that the vinegar and tar contain 15 and 14 notable components respectively. Vinegar and tar components were the same with one additional component, ethanol, found in vinegar. The principle components (retention time; weight fraction) of the maize stover vinegar were: acetaldehyde (5.931 min; 3.795 %), acetic acid (11.352 min; 45.679 %), methyl-propyl-ketone (MPK) (12.841 min; 11.620 %), hydroxyl acetone (acetol) (13.582 min; 4.267 %), 3-hexanone (15.410 min; 4.826 %), and furfural (17.501; 6.822 %). The retention time and weight fraction for the components existing in both vinegar and tar were not significantly different ($p < 0.05$).

13 PYROLYSIS OF BLENDED AND NON-BLENDED RESIDUES OF PINE AND EUCALYPTUS FORESTRY WOODS

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ABSTRACT
Over 11% of the 241551 sq. km of total land in Uganda is under forestry and woodland producing over 34.4 million tons of wood resource. However, about 65% of this resource remains as wood waste in form of saw dust, chips and offcuts of which 90% is unutilized that is to say; left to rot or burnt in the open at the saw mills posing environmental and health issues. The objective of this research was to examine the potential of pine and eucalyptus forestry wood wastes in the production of bio-fuels, that is, vinegar, bio-ethanol, bio-char and tar by pyrolysis that can be used as alternative sources of energy. Pine, eucalyptus and a blended mixture of pine and eucalyptus wood wastes each 2kgs were fed in a 0.0376m^3 batch reactor initially at 27^{0}C and ran at a heating rate of 10^{0}C/min. to 400^{0}C and held for 45 minutes. Chemical analysis of the obtained wood vinegar and tar samples was conducted using a gas chromatograph (GC)

model 7820A equipped with a flame ionization detector (FID). The results showed that pine, eucalyptus, and blended mixture of pine and eucalyptus wood vinegar contained 15, 9 and 11 notable components respectively. The principle components of wood vinegar were determined to be: acetic acid, acetaldehyde, furfural, methyl-propyl-ketone (MPK), propanoic acid, acetone, and 3-hexanone. The tar made from pine, eucalyptus, and blended mixture of pine and eucalyptus contained 12, 9 and 11 notable components respectively. The presence of the oxygenated aliphatic and aromatic hydrocarbons make the bio-oils a potential source of transportation fuels.

14 CONVERSION OF PINEAPPLE WASTE INTO VERMI-COMPOST TO ENHANCE AGRICULTURAL PRODUCTION

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ABSTRACT
The ever-increasing world population and consequent increase in food production has resulted in the production of large amounts of agricultural wastes. In many areas, agricultural residues are either left in the field to decompose,burned in open-air to clear the lands or openly dumped. These practices are not only associated with negative effects on the environment through uncontrolled emissions but also lead to loss of vital plant and energy resource. At the same time, soil degradation is a widespread phenomenon in Sub Saharan Africa partly due to loss of crop nutrients from the field each season through crop harvests with no nutrient replenishment. This problem could be alleviated by treating biodegradable waste using suitable methods and then applying it to crop fields as soil conditioner. The agro waste if properly managed could be considered a big bio-resource for enhancing food security in the communities that would not afford use of expensive inorganic fertilizers. One of these methods is vermicomposting, which involves use of earth worms to convert organic wastes into a humus-like substance called vermi-compost. Vermi-compost, the end product of vermicomposting, is a finely divided soil conditioner with high porosity and water-holding capacity and a low C:N ratio that contains high amounts of nutrients in forms that are readily taken up by plants. This vermicompost can be used as a soil conditioner to address the continual fertility loss of soils. It should be noted that vermi-composting offers an opportunity for effective use of agricultural waste.

15 UTILIZATION OF BANANA WASTES FOR SLOW PYROLYSIS TO YIELD BIO-INFRASTRUCTURE PRODUCTS IN UGANDA

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ABSTRACT
The current relapse in the amount of fossil fuel yields worldwide highlights the need for adoption of renewable energies to supplement the current natural fossil fuels. For developing countries, harnessing renewable energies like bio-oil and biochar is a particularly feasible idea from the economic and environmental points of view. This research therefore, investigated the possibility of using the banana

biomass wastes in Uganda as a feedstock for fast pyrolysis to yield bio-oil and biochar. Slow pyrolysis carried out at temperatures of 350-5500oC with a moderate hot vapour residence time of about 45-900 minutes yield up to 26%, 24%, 30% and 20%% of direct vinegar, tar, biochar and flammable non-condensable gases respectively. In addition, Uganda being the second world's producer and consumer of banana generates up to 17.5 million tonnes of banana wastes annually which can be converted to bio-oil and biochar thus boosting the energy level and agriculture substantially. Therefore, this research seeks to pyrolyse banana wastes to yield bio-oil (vinegar and tar), biochar and consequently test the possibility of biochar use as bio-cement, soil conditioner and as a fuel source consequently increasing bananas' usefulness in Uganda.

16 POTENTIAL OF ORGANIC WASTE FOR BIOGAS GENERATION FROM SMALL-SCALE FOOD PROCESSING UNITS

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ABSTRACT

Small-scale food processing is characteristic of many enterprises in Uganda. The organic waste from the processing units is a menace and a source of vectors. However, organic waste can be degraded to generate high quality and quantity biogas if mixed in appropriate ratios. The main goal of this study was to determine ratios of organic wastes for production of biogas from such units, a case study of FTBIC. The samples of organic waste were quantified and characterized for their potential to generate biogas. Nine treatments in duplicate without inoculum were selected for production of biogas in the ratios: pineapples and other waste 3:1 (A1), 1:1 (A2), and 1:3 (A3); Mangoes and other wastes 3:1 (B1), 1:1 (B2), and 1:3 (B3); and orange and other wastes 3:1 (C1), 1:1 (C2) and 1:3 (C3). Other waste types included: Irish potatoes, bananas, vegetables, passion fruits, water melon, pumpkins, pawpaw, mixed food leftovers, and jackfruit waste mixed in equal mass ratios. A 6 m^3 fixed dome digester was sized with 2.48 m diameter and 1.24 m height. The food/microorganism (F/M) ratio was 0.5 i.e. 1.5 gVS of the substrate was digested with 3 gVS of inoculum. The obtained results show that on average, 213.7 kg of organic waste was produced daily from the processing unit. The moisture content (MC), total solids (TS), and volatile solids (VS) for the individual organic wastes ranged from 45 to 97.3% wet basis, 54.4 to 6.3% and 60 to 97.3% respectively. The MC, TS and VS of the treatments ranged from 80.8 to 89.2% wet basis, 10.8 to 19.2 gTS/kg and 923.2 to 952.7 gVS/kg respectively. Orange waste with other waste in the ratio of 3:1 yielded the best performance for biogas production (0.7 L/gVS) with 64.3% methane content. Thus more percentage of orange waste in a mixture of organic waste yielded the highest quantity and quality of biogas. Generally, organic waste mixed in appropriate ratios (3:1, 1:1 and 1:3) produces high quality and quantity biogas in adddition to reduction of waste volumes. Conversion of organic waste to biogas through anaerobic digestion had many benefits such as: source of energy and minimized environmental impact due to reduced waste volumes and pollution.

17 SOLAR DRYING TECHNOLOGY FOR PRESERVATION OF FRUIT BY SOUTH AFRICAN FARMERS

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ABSTRACT

Post-harvest losses remain a persistent problem phased by farmers in developing countries, including South Africa. This requires intervention to improve the livelihood of the subsistence and emerging farmers of the country. Drying is a preservation technology, which is rated second to cooling with performance. Solar drying technology has been used throughout the world, including African countries like Nigeria and Ghana. The use of solar thermal energy for an energy-intensive process such as drying is considered an attractive solution considering the availability of abundant solar energy, specifically in South Africa. Preservation of fruit by drying can be done by a solar dryer, open-sun drying and conventional dryers. The limitation of open-sun drying is that the produce quality varies, as for conventional dryers they are a more efficient technology which requires electrical energy. Most of the farmers cannot afford to operate these dryers and therefore, opt for open-sun dryers. This is mainly because the electricity tariff increases, which have rendered several operations like drying unsustainable. This study investigates the production levels of mango, banana, apricot, date, grape, tomato and apple and the post-harvest losses of these commodities in South Africa. Also, the common preservation technologies used in South Africa. The study is based mainly on a desktop study, interviews with key stakeholders including owners of farms producing the commodities and field visits to the respective farms and preservation facilities. Subsistence and emerging farmers in South Africa are experiencing an average of 50% of post-harvest losses mainly due to a lack of efficient and affordable preservation technology. Open sun-drying is the commonly used preservation method, which does not produce high quality produce. Solar dryers of an average of 200 kg capacity are required to curb these losses and avoid limitations of open-sun solar dryers. Literature review studies indicated that solar cabinet and greenhouse dryers are applicable. In addition, naturally ventilated solar dryers are more feasible due to low operational cost.

18 THERMOSTABILITY OF CASSAVA LINAMARASE

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ABSTRACT

Cassava (*Manihot esculenta*) is a major staple crop for an estimated 700 million people worldwide. It has high amount of carbohydrates, as well as some anti-nutrients such as cyanogenic glycosides (linamarin 95% and lotasutralin 5%). The cell wall enzyme, linamarase, catalyzes hydrolysis of linamarin into acetone cyanohydrin and free cyanide. However, linamarase is quickly inactivated at high temperatures. The objective of this study was to investigate thermal stability of linamarase over the temperature range of 35-75°C. Linamarase was extracted from the root cortex of cassava tuber and partially purified by ammonium sulphate precipitation. The enzyme extracts were heated at 35, 45, 55, 65 and 75°C for 10, 20, 30, and 40 minutes before activity assays were performed. Experimental data was fitted by the Arrhenius equation. The results show that two distinct thermal stabilities were present in the Arrhenius plot. Temperature had a statistically significant effect on enzyme activity. The enzyme exhibited highest activity at 45°C whereas activity steadily decreased as temperature increased up to 75°C after which the enzyme was completely inactivated**.** Treatment time had no significant effect on activity of the enzyme. Two distinct thermal stabilities were present in the Arrhenius plot. The Arrhenius plot exhibited a break after 55°C with a sharp increase in the activation energy (E_a) at this critical point. These findings suggest that linamarase is relatively thermostable below 55°C. The estimated activation energy (E_a) at 35-55°C and 55-75°C was 1.87 and 115.9 kJ mol^{-1}, respectively.

19 NUTRIENT COMPOSITION OF SIX POTATO CULTIVARS BEFORE AND AFTER FRENCH FRY PROCESSING

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20 AN OVERVIEW OF THE BRAZILIAN AGRO-LOGISTICS: CHALLENGES AND OPPORTUNITIES

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ABSTRACT

One of the most striking phenomena observed in the Brazilian agricultural economics in the past decades, and in an accelerated way in recent years, is the transformation in its spatial arrangement. The agricultural businesses have occupied new frontier areas such as the North and Center-North, in addition to large areas in the Northeast, usually through activities combining modern production technologies. Similarly, input suppliers, storage and processing industries have clustered around production zones, focusing especially on minimizing the transportation costs involved. The basic motivation for the search of such optimization is the need for augmenting the competitiveness of national products. This has already implied a clear reduction of costs in exporting operations. The highway transportation modality has accounted for approximately 60% of the cargo transportation in Brazil, *versus* 20% of the railway system and 15% of the waterway system. Such predominance of the highway mode can be explained by the larger extension of highways installed (increasing 200,000 km of paved roads *versus* decreasing 30,000 km of railways), as well as by the difficulties that the other transport categories face in order to efficiently meet increasing demands in farther areas in the country. These remote areas are not necessarily provided with rail or waterways. Nevertheless, while analyzing the branching of the Brazilian highway system, the density coefficients are noticed to be very conservative, with a Brazilian average of 19 km of highways per 1,000 km^2 *versus* an average of 397 km of highways per 1,000 km^2 in the U.S.A. (a continental dimension country such as Brazil). The State of São Paulo presents the highest density of highways in the country: 106 km of paved roads per 1,000 km^2. According to data from SIFRECA (Information System for Agricultural Freights, of ESALQ/USP), the highway distances traveled by agricultural bulk solids can be relatively high. Especially for grains, they have to nearly cross the country in view of the long distances separating the concentrated areas of production from the various consumption markets. A great deal of new projects on transport infrastructure is based on projections of movement of soybeans and byproducts, both in traditional regions and in the new agricultural frontier regions. To a certain extent, there is a dependency relationship of the viability/success of such new undertaking towards a typically monocultural business. On the other hand, the concerns and actions of the soybean complex companies are clearly regarding logistic issues.

21 POST-HARVEST LOSSES IN WHEAT SUPPLY CHAIN: A BRAZILIAN CASE STUDY

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ABSTRACT
About 25% of every calorie grown are not consumed by humans because of food losses across all stages of the food value chain. About 24% of total food loss occur at production or harvest, 24% at handling and storage, 4% at processing and packaging, 12% at distribution and marketing, and 35% at consumption. Specifically at the transportation stage, food loss occurs due to many factors, but the majority is related to failure in infrastructure as, for example, poor road conditions and old heavy-duty vehicles. In this context, food loss in transport and storage in Brazil is a relevant issue to be studied, once the country is an important player in global food production. This article aims at measuring quantitative losses across wheat grain logistics chain in Rio Grande do Sul (RS), a Brazilian state responsible for about 50% of national production of wheat. The study was divided in two phases. In the first phase, it was done a literature review to characterize the wheat logistics chain in Brazil and, specially, in RS State. The second one was related to field trips and primary data collection. Two different questionnaires were built and applied to agents involved in the wheat logistics chain in RS State: (a) cooperatives and wheat mills; and (b) trucking companies. From field research and questionnaires, the wheat supply chain in the state of RS was characterized and loss rates for each stage of the chain were quantified. For the main transport flows in the internal market, the losses represent 11.41% of the total amount of wheat grain from farms, with the losses in harvesting and storage with cooperatives accounting for 93.55% of total losses. Transport operations represented 6.45% of the total losses of the reporting flow. Monetization of physical losses totaled an amount of R$ 119.4 million. According to the results obtained in this study, strategies are suggested to mitigate losses of food in different arrangements of logistic chains.

22 THE DETERMINATION OF ROAD FREIGHT PRICES IN THE BRAZILIAN AGRO-LOGISTICS

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ABSTRACT
Brazil has gained prominence in the international context of global food supply, with increasing rates of production and productivity. In this way, the agro-logistics is one of the main factors affecting the competitiveness of the country, representing a significant share of the costs of the supply chain of agricultural products, which has a high dependence on highways for the distribution of products, covering large distances with large volumes. The purpose of this article is to present the major factors affecting the road freight price in Brazil for different agricultural loads into a transport corridor of great economic importance for the exports of the country. The road freight market of agricultural cargo in Brazil is highly competitive (large number of agents: shippers and carriers) and low barriers to entry and exit (particularly, the prices of freight come from the structure of supply markets and product demand, from which the demand for transportation can be derived). The method used to assess the determinants of road freight prices of agricultural cargo consisted of an econometric analysis using cross-section techniques to a database built in 2012. The evaluated products were sugar, soybeans and corn. In this analysis, it became clear that different products used the same set of equipment and transport infrastructure (same road), having a different pricing for freight. In this sense, it appears that the distance, number and values of tolls and port destination positively impact freight rates, with the track quality and the existence of the railway alternative causing reductions in freight rates. The results show significant differences in the price for freight product reviews, with sugar related to the highest

pricing and corn with the less expensive value of freight. About the behavior of destinations, it became evident that transport flows to foreign markets have higher freight prices in relation to freight prices observed at local markets. These results illustrate a factor which is charged on the "Brazil cost", once the commodities studied lose their competitiveness in foreign markets due to increased transportation costs for export (and, consequently reducing the margin of the producer). Therefore, this study contributes to the process of knowledge of the determinants of road freight in agricultural cargo prices, providing also inputs in the decision making for the public sector regarding infrastructure investments as well as proposing public policies for the country.

23 ADVANCES AND CHALLENGES IN GRAIN STORAGE SYSTEMS

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ABSTRACT

Agricultural grains are handled as bulk materials and are typically stored in thin-walled, stiffened cylindrical steel bins (silos) with conical roof systems in order to maintain the quality of grains after harvest. The roof and walls of grain bins are fabricated from cold-formed corrugated steel panels. These panels are bolted together. The cylindrical shell is usually stiffened by vertical and circumferential stiffeners. The conical roof is usually supported by purlins and rafters, especially in large diameter bins. The proper design and construction of an adequate, efficient storage system requires a large investment and should not be undertaken without thorough planning. Modern industry's demands storage for larger size bins, coupled with the need of higher rates of loading and discharge, advances in grain yields, and ever changing grain storage conditions have complicated the task of engineers. A failure in grain storage system results in risk to life and causes catastrophic economic losses. Future grain storage systems will require advanced controls for grain conditioning, handling, and storage.

24 NON-INVASIVE METHOD FOR THE ESTIMATION OF THE CONCENTRATION *IN VITRO* OF TACHYZOITES OF *TOXOPLASMA GONDII* USING RADIOFREQUENCY

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ABSTRACT

Toxoplasma gondii one of the world´s most common parasite, which is the causative agent of Toxoplasmosis disease. *T. gondii* is a protozoon with the capacity to infect different host species, including humans and animals, through different transmission routes. One of the transmission routes may involve three life-cycle stages: oocysts ingestion, tissue cysts ingestion, and tachizoyte ingestion. The first route involves infection from the environment, the next two routes involve contaminated meat or primary offal from a number of animals. Differences in culture and eating habits may affect the differences in transmission routes around the world. In Colombia, 25% of the reported cases of toxoplasmosis in pregnant women is caused by contaminated meat with *T. gondii.* In addition, 52.7 % of meat samples from three animal species were positive with *T. gondii* in a study[1] from several Colombia cities. In order to develop diagnostic tools and treatments for toxoplasmosis, accurate enumeration methods of the parasites are needed. In this research, we developed a non-invasive method for the enumeration *T. gondii* parasite in their tachizoyte stage using a capacitive sensor. The capacitive sensor consist of two electronic oscillators and one heterodyne circuit that generates an electromagnetic field around an antenna, which is affected by the concentration of parasite, suspended in solution inside a plastic test tube located close to the antenna. The frequency generated by the sensor is proportional to

the concentration of *T. gondii* cells. A proof-of-concept experiment was performed on samples of Tachizoytes of virulent RH strain of *T. gondii* cultivated in cell culture, this samples were provided from Research Group in Molecular Biology and Biochemistry of parasites, Andes University, Colombia. This study performed two sets of serial dilutions of Tachizoytes in PBS 1X. As a control, frequency signals were recorded for no presence of test tube, test tube with PBS 1X solvent only, and diluted samples 1:15 and 1:30 for the first set and 1:30, 1:40, 1:50, and 1:60 for the second set. Preliminary test results, showed that the capacitive sensor differentiated both control samples and parasite samples with different generated frequency signals. The more diluted the sample, the higher the frequency signal was generated. The actual count for each sample tube was determined by using Neubauer Counting Chamber to generate a table cellular count vs. frequency. More studies are needed to improve electric field stability and other standardized enumeration methods should be used for validation and comparison purposes.

25 *WHEN IS IT CLOSE ENOUGH?* AN EVALUATION OF COMPLEXITY TRADE-OFFS FOR MODELING PESTICIDE RUN-OFF RISK WITH VFSMOD

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ABSTRACT

A main issue when building models that represent the "real" behavior of a system is the complexity dilemma: *how much complexity is required to get a close enough approximation of the system´s behavior? When is it close enough?* While these questions may look rather philosophical, they cascade into major practical, economical and regulatory consequences. We will present a frameworks: Global Sensitivity and Uncertainty Analysis (GSA/UA) as pragmatic set of tools to deal with these questions. GSA/UA a global understanding of model sensitivity and uncertainty, and to rank model input factor´s relative importance when all factors varied together. One potential applications of GSA/UA is to guide the reduction of model complexity without losing model explanatory power. We will illustrate the usefulness of both frameworks with a series of case studies focused on the analysis of factor importance determining the efficacy of vegetative filter strips (VFSs) for reducing pesticide run-off risk to the aquatic compartment as represented by the process-based model VFSMOD (Vegetative Filter Strip Modeling System). Since the efficacy of VFSs depends on site-specific input factors, relationships of filter efficiency with filter length and other input factors may result in rather complex and non-linear relationships. We will illustrate how some model parameters assumed to be critical in endless discussions in different regulatory frameworks, may reveal themselves as non-relevant when measured in a common scale metric with all the other input factors present.

26 ENERGY ASPECTS OF THE LIQUIDATION OF THE WILLOW PLANTATION

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ABSTRACT

Willow plantations are used 20-25 years for the biomass production as raw material for solid biofuel. After this period the soil has to be reclaimed. The biggest problem is to damage root system of the willow stopping possibility of the regrowth of the plants.

Mulchers are used for reclamation of the soil. Fuel consumption of the tractors powered mulches is relatively high: 440-1400 L/ha. Reduction of the fuel consumption means reduction of the energy for liquidation of the willow plantation.

New constructed machine which reduce fuel consumption will be presented.

27 FUMIGATION IN SEALED SILOS TO CONTROL STORED GRAIN INSECT PESTS

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28 UPGRADING THE NUTRITIONAL QUALITY OF *ELEKUTE* (TOASTED MAIZE MEAL) THROUGH ENRICHMENT WITH AFRICAN YAM BEAN (*SPHENOSTYLIS STENOCARPA*) USING RESPONSE SURFACE METHODOLOGY

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ABSTRACT

Low nutritional value and inconsistent sensory quality arising from crude, non-standardised processing operations characterise some Nigerian maize-based snacks including *elekute* (toasted maize meal). *Elekute* is widely consumed as snack in South Western part of Nigeria. African yam bean seed (AYBS) is an underutilised crop with high nutritional value, but there is limited information on its use to enrich maize snack. This study was designed to optimise the production of toasted maize meal and to improve its nutritional value by incorporation of AYBS.

AYBS (Tss-30) was dehulled manually after soaking in water (1:5w/v) for 4h at 29±2^{o}C, boiled for about 20 min, dried at 60^{o}C and toasted at 100^{o}C, and milled into flour (500 µm). Using Box-Behnken design of Response Surface Methodology (RSM), maize (BR-9928-DMR-SY) was toasted at varied temperatures (120, 130 and 140^{o}C) and time (8, 10 and 12 min) according to seventeen combination associated with three independent variables and milled into flour (500 µm). Toasted AYBS flour was substituted in the toasted maize flour at ratio 100:0, 80:20, 70:30 and 60:40 according to the experimental design. Each blend was mixed properly to obtain a homogenous blend. Proximate composition and sensory attributes of the blends were determined. Samples with the best products' qualities were obtained from RSM as optimum processing conditions. Data were analysed statistically ($p=0.05$).

Protein (9.50-18.71%), ash (1.89-2.62%), sugar (4.24-6.22%) increased, fat (5.77-2.57%), starch (58.71-51.15%) and moisture contents (8.59-7.98%) decreased with increase in percentage of AYBS of the flour blend. Sensory perception varied significantly ($p<0.05$) among the products especially for appearance and taste (5.1-7.9). Toasting temperature (135^{o}C), toasting time (11.5min), and 30% AYBS were the optimum conditions obtained. The result of the validation showed a standard deviation ranging between 0.11 and 0.23.

The study showed that toasted maize meal (*elekute*) blended with toasted AYBS flour exhibited improved nutritional content over toasted maize meal without AYBS, creating a novel use for African yam bean seed. Standard processing conditions for producing toasted meal of consistent sensory qualities from blends of maize and African yam bean seed was established. Creating novel uses for underutilised crops could be a step towards achieving food security.

THEME 5 CAPACITY BUILDING FOR FOOD SYSTEM STABILITY

ROLE OF CAPACITY BUILDING IN FOOD SYSTEM STABILITY IN CONTEXT OF SMALL HOLDER FARMS

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ABSTRACT

Traditionally agricultural and food production and post-production operations on small holder farms in developing countries have been labor intensive. Due to rising labor scarcity and cost, aging farmer populations, dependence on females and the change in value chains, many operations are being mechanized using labor saving technologies. Mechanization contributes to increase in inputs efficiency, improvement in timeliness and quality of operations, reduction in post-harvest losses and reduction in drudgery. Through custom-hiring services provided by entrepreneurs, both farmers and non-farmers, small holder farms are integrated into mechanized systems. Trained human resources are necessary for the success of the uptake and use of sustainable mechanization for food system stability. For capacity building training must take place at all levels and involve a broad range of stakeholders including Ministries of Agriculture, Trade and Industries as well as farmer organizations, people working in agriculture-food supply chain and those involved in manufacture, testing and standards, supply and distribution, selection, operation, maintenance and repair and management of machinery. The curriculum of higher education institutions should be revised to meet the research and development needs of changing trends in mechanization of agricultural and food production and post-production operations. Targeted training programs, including vocational training and short courses should be offered to meet immediate needs of skilled manpower.

SURVIVING TO THRIVING: EMPOWERING POOR SMALLHOLDER FARMERS THROUGH TECHNOLOGY-BASED SOLUTIONS

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ABSTRACT

A well-recognized problem in development is not lack of good ideas, but turning these ideas into sustainable and scalable solutions or innovations. One of the reasons behind the high field failure rate is a poor understanding of context and limited collaboration with the users as equal partners during solution ideation, development, testing, and transition from a project to a business. Lessons from over 12 projects conducted in the past 20 years with sub-Saharan Africa women users of technology-based solutions will form the corpus of this address, in the form of a six-item practical survival guide. Successful projects will be used to illustrate the items. Sample projects either transitioned or in the process of transitioning to business will include, but not limited to: Solar energy-powered avian incubator for Sahelian countries (e.g., Burkina Faso); biogas-powered evening milk cooling for entry into the cold chain the next day; and labor-reducing or income-increasing hand-operated churner for ghee-making.

OPPORTUNITIES AND CHALLENGES FOR THE ADOPTION OF PRECISION FARMING TECHNOLOGIES IN SWINE PRODUCTION

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ABSTRACT

Relative to other sectors of agriculture, the livestock industry in general and the swine sector in particular has been slow to adopt precision farming approaches that could dramatically improve the efficiency and sustainability of producing pork. This is despite the fact that there are an increasing range of new technologies available that could be deployed on commercial swine operations that would, in theory at least, revolutionize the management of swine production and reduce production costs.

Currently available technologies allow detailed monitoring of the pig and its environment in "real time", from the farm through to the point of slaughter, potentially providing a wide range of information on the physiological and metabolic status of the animal and its effective environment. This should allow relatively precise fine tuning of production practices in a timely manner leading to enhanced productivity and welfare of the pigs and improved profitability.

For example, monitoring auditory parameters such as vocalization or coughing can indicate the stress levels and respiratory disease status, respectively, of a population. Capturing and processing of images and/or video of the pigs can be used to predict the weight of the animal, identify abnormal situations, and monitor human-animal interactions. Measuring the level of and diurnal patterns in feed and water consumption combined with estimates of live weight changes together with monitoring of metabolic parameters and the climatic environment can indicate the adequacy of the nutritional program. This would allow for frequent changes in diet formulations on the basis of current performance levels, environmental conditions, and economics. Monitoring body temperature and environmental conditions in the facility can determine when situations of either heat or cold stress occur and automatic adjustment of the environmental controls could quickly alleviate any problems. There is also technology available for use in the breeding herd that can predict the time of onset of estrus and of farrowing.

So why has the industry been slow to adopt these promising technologies? In general, producers have concerns over the reliability, accuracy, costs, and return on investment of any new technology. The swine barn is a relatively dirty environment and any equipment needs to be robust enough to operate for long periods in such an environment. In addition, there are numerous examples of technologies with great potential not working when adopted commercially. A good example relates to approaches to predicting the live weight of individual and groups of pigs on commercial operations, essential fundamental information for the integrated management of growing-finishing animals. This is simple enough to achieve in concept and there have been a number of attempts to accomplish this based on different approaches. However, there is still no proven technology that has been demonstrated to function on large-scale facilities with the required degree of accuracy and reliability, and/or without negatively impacting pig performance.

In addition, the relationship between the automatic measurement and the biological responses of the animal are not always fully established which results in problems with data interpretation, particularly when deciding the break point between acceptable/unacceptable levels. For example, there is lack of understanding of the link between relatively small changes in the animals' behavior and the underlying biological cause(s).

Also, the "center" for any integrated management system is likely to be a computer model that will assimilate and analyze all of the different data streams that can be collected relating to the animal and its environment. Although a wide variety of models have been developed, most notably for predicting

the pigs growth responses, there is a dearth of models with proven accuracy for predicting biological and economic responses for use in commercial situations.

The goal of having a wide range of measurements relating to animal and its environment being collected, analyzed, and interpreted real time leading to timely changes in management is conceptually realizable. However, considerable challenges still remain to develop technologies and data integration systems that are proven to be effective and reliable under commercial conditions

TOWARDS BIOSYSTEMS ENGINEERING IN KENYA

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ABSTRACT

In the past years, Kenyan Universities offered courses in Agricultural Engineering, from which, Biosystems Engineering was later developed. The objectives of this paper are; analyze the history and evolution of Agricultural Engineering to Biosystems Engineering, evaluate the current accreditation status of Biosystems Engineering in various Universities in the country, compare the different names given to the degree program in the different institutions. Eventually, the paper will do an analysis of the way forward for Biosystems Engineering in Kenya.

The transformation of Biosystems Engineering from Agricultural Engineering in the University of Nairobi began in a Faculty of Engineering curriculum committee meeting, on l5 May 1996, the Faculty wanted to do a review of the curricula offered to students. This was preceded by a series of meetings and workshops to discuss and finalize the change. Faculty members in the curriculum review committee studied various curriculums of Biosystems Engineering programs offered in leading world Universities. Stakeholders were actively involved in the development of the Biosystems Engineering curriculum for the University of Nairobi.

Through this process, it was found that the course offered in Agricultural Engineering had some deficit, especially regarding environmental protection and sustainable land use, (UNESCO, 2004). Changes in history and new technologies demanded graduates with broad modern skills and competence, in which Agricultural Engineering was slightly lacking. Most of the graduates suffered in securing employment. With the evolution to Biosystems Engineering, it was found that the new graduates were able to pursue careers in more areas such as industry, research, and education.

As Biosystems Engineering exposes the students to the in-depth scientific exposition of engineering principles and to practical work, the graduates are able to become hands-on Engineers. Biosystems Engineering has very many ways in which it can be applied to benefit humankind. Some of these areas include; Power and Machinery Engineering, areas related to Irrigation and Water Resources Engineering, Environmental Engineering, Food and Process Engineering and Structures Engineering.

EMERGING INNOVATIONS FOR THE SMALL SCALE BEVERAGE PROCESSING INDUSTRY IN UGANDA

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ABSTRACT

The main problems faced by small-scale liquid foods processors in developing countries and Uganda in particular include; high business start-up costs and lack of appropriately sized equipment. Locally

manufactured equipment are advantageous in that they not only do the job but allow for after sales support, readily available spare parts, ease of knowledge transfer and creation of jobs. In particular equipment has been fabricated to meet the needs of incubatees graduating from the Food Technology and Business Incubation Centre (FTBIC), Makerere University. The FTBIC was created with one of its core objectives to incubate processors for a limited period of time and allow them to have access to good processing facilities. However, sharing equipment limits their outputs and therefore the necessity to graduate to their own premises. To reduce on startup costs, the incubatees need affordable and appropriately sized equipment. To meet this need, equipment has been designed and fabricated including; 150L/hr capacity batch pasteurizer, 103L/hr capacity soy milk machine and 105 kg/hr capacity Fruit pulper. This research further focuses on the performance of the Batch pasteurizer in Samalina Beverage International Ltd pioneered by a graduate incubate of FTBIC, a company processing a mixed fruit juice. Use of the batch pasteurizer enables the processor to process up to 300L/day. The processor has been able to increase the production capacity from 1000L/month to 4000-6000L/month since it offers more process control as regards time and hygiene.

THE CAMEROON AGRIBUSINESS PROJECT: A PROJECT TO IMPROVE FOOD SECURITY IN AFRICA WITH LARGE SCALE SUSTAINABLE AGRICULTURAL PRODUCTION

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ABSTRACT

The Cameroon Agribusiness Project (CAP) is a multi-phase, efficient scale project designed to address endemic food insecurity in Cameroon and neighboring countries. The envisioned CAP includes:
i) Irrigation/cultivation of 165,000 hectares of under-utilized arable lands for the production of rice, maize, soybeans, and sorghum; ii) planting 55,000 hectares of eucalyptus plantation for bio-energy production; iii) cultivation of mango, citrus, guava and dacryodes edulis fruit trees; iv) aquaculture; v) cattle production; vi) poultry production; vii) construction of industrial facilities for grain drying, storage and processing; biodiesel production, livestock feed production; fish, poultry, fruit, and beef processing; bulk fertilizer blending plant; equipment maintenance and service buildings; facilities for management personnel; and viii) power production from biomass; water supply development, treatment, and distribution (potable, and irrigation); improvements in transportation infrastructure; and administrative & residential infrastructure.

The CAP will be located in the Central Region of Cameroon and owned by COMAGRI SA, a Yaoundé based company formed expressly for this project. Project goals are to produce per year, 1,800,000 tons of paddy rice, 750,000 tons of soybeans, 450,000 tons of maize and sorghum grain, 300,000 market weight cattle, 240,000 tons of fish, 15 million broilers, and 600,000 tons of fruit.

The market products will include: white & parboiled rice; soybean meal; refined soybean oil; soy lecithin; glycerin; fresh and frozen fish; primal cuts of beef and chicken; sausages, luncheon meat and pate; and juice/nectars of fruit.

The CAP will utilize technical agricultural production innovations such as: i) No-Till Cropping Systems; ii) Growing rice with sprinkler irrigation; iii) Precision farming; iv) Large scale cultivation of a fruit tree named dacryodes edulis to produce biodiesel.

The CAP will be implemented with the technical assistance of agricultural technology professionals from various countries. *Agricultural Engineering Associates, Inc,* an American consulting firm with over four decades of international development experience, has been selected as the technical services coordinator. The initial feasibility study and business plan concludes the project will cost 5.3

billion USD and will generate more than 400,000 direct, and indirect sustainable jobs. The State of Cameroon will fund 72% of the Cameroon Agribusiness Project's first phase of production.

BUSINESS INCUBATOR CONCEPT IN THE REDUCTION OF LOSSES AND PRODUCT DEVELOPMENT FOR SCALING-UP PURPOSES

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ABSTRACT

The business incubator of the Postharvest Technology Centre at Tamil Nadu Agricultural University was established under the auspices of a Canadian International Development Agency (CIDA) Tier 1 Project on "Consolidation of Food Security in South India". The centre has necessary infrastructure for pilot plant operation and for training on the postharvest aspects of fruit and vegetables, and of grains and cereals. A modern bakery facility located in the complex is also part of the incubator. With these infrastructures the incubator accomplishes the following: i) Product development, ii) Research, iii) Educate and train students in multi-disciplinary context, iv) Capacity building for entrepreneurs, and v) Standardization. Recently the capacity of the facility has been expanded to be able to also provide testing and certification services for food safety. The facility has also served and contributed to many international projects including the current Phase II Scaling Up on millets project supported by Global Affairs Canada (GAC) through the CIFSRF program of International Development and Research Center (IDRC).

The business incubator provides training in postharvest technologies and access to the necessary infrastructure to self-help groups, entrepreneurs, farmer associations and organizations, and baking groups to foster the start-up and growth of enterprises by these groups. The accomplishments of the business incubator through these activities have been outstanding. The incubator also trains and informs media personnel, staff of NGOs, and government staff, provides support to student projects, and showcases new technologies.

The business incubator concept has been extremely successful and has had long term sustainability beyond the active period of the CIDA Tier 1 project which was from 2002 to 2007. The activities and success of the incubator has had great impact in the region, and the multiplication of this kind of facility has been a main consideration of the government of Tamil Nadu State and other states in India.

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THEME 6 SYSTEMS LEVEL PERFORMANCE FOR FOOD SYSTEM STABILITY

ROLE OF SYSTEMS LEVEL THINKING IN FOOD SYSTEM STABILITY IN THE CONTEXT OF SMALLHOLDER FARMS

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ABSTRACT

Global farming systems incorporate a wide spectrum of elements defined by the constraints within each system and the options available to producers to address the challenges they face. Farming systems can be defined by: climate, crop and livestock choices, management strategies, resource availability and marketing options amongst many other components. The first stage of agricultural research sought "simple problem" definitions to achieve the goal of increased crop yield by identifying single factors which could be changed within the system. Significant yield improvements were achieved through single-factor research on improved genetics, fertility management and pest control solutions. As research identified the interrelationships between management strategies and ecosystems the next stage of research framed "complex problems" with the target of sustainable intensification of productivity. New methodologies evolved to understand the connectivity of farming systems with their impact on soil, water and biodiversity along with economic sustainability.

Rittel and Weber (1973) introduced the concept of "wicked problems" to describe issues which are perceived to be impossible to solve due to contradictory, incomplete or evolving aspects. Addressing one aspect of a wicked problem may uncover or create other difficulties. The complexity of cropping systems which have expected economic, environmental and social outcomes need to be considered within a larger boundary of potential impacts and solutions.

The United Nations has designated 2016 as the International Year of Pulses. This paper explores the progression of problem definition for grain legume research in both the developing and developed world. Examples from across the globe using the grain legume experience will identify principles which need to be considered if the wicked problems of cropping system productivity are to be overcome.

AGRICULTURE, ENERGY AND GLOBAL FOOD SECURITY

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ABSTRACT

Technologies, climate, and markets for agriculture are changing rapidly. Global food and feed demand is predicted to increase significantly in the next 30-50 years.

Food security requires energy and water security. The efficient uses and management of energy and water resources and associated environmental effects are becoming one of the major challenges facing agriculture in the world.

The last decade has seen significant efforts to decrease the environmental impact from agriculture. Much of these efforts have been focusing on carbon-footprints, energy efficiency and adoption of renewable energy, which includes solar, wind, and bioenergy.

Currently, many agricultural industries are not only facing with rising energy costs, but also struggle to dispose of waste products in an environmentally and fiscally responsible manner.

This paper will look at some of the research programs conducted in Australia regarding 1) Energy input in different agricultural processes and industries; 2) Adoption of renewable energy in agriculture; 3) Value-adding opportunities and production of bioenergy from the waste streams; and 4) Potential of self-supply of energy in agriculture.

It is found that rational and efficient use of energy resources is essential for sustainable development in agriculture. Renewable energy is also an important direction for the future. An acceleration of bioenergy production from waste would be an important goal of agriculture. Biomass has the potential to turn unwanted waste-streams into energy and other useful resources for agronomic and industrial purposes. The future food supply is intrinsically linked with energy, water and climate issues and must be managed in an integrated way.

IRRIGATION AND WATER SAVING STRATEGIES TO INCREASE WATER PRODUCTIVITY AND NITROGEN USE EFFICIENCY IN THE PADDY FIELD

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INTEGRATING AGRICULTURAL BIOGAS SYSTEMS IN UGANDA

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ABSTRACT

The anaerobic digestion sector in East Africa has sustained consistent growth in recent years, transforming wastes to energy in the form of biogas. Systems provide biogas for cooking and nutrient rich effluent for crop production. This project team has assessed the nutrient value of effluent using numerous field trials in Uganda, assessed effluent quality on numerous systems, and determined biogas production and air quality impacts from its use as a cooking fuel. The team has had significant experience, including successes and failures, in developing and implementing new technical designs as well as social and economic issues associated with the installations. Although small scale digestion systems provide valuable biogas for cooking, it has been found that system limitations can reduce installation potential or the associated environmental benefit. Current GCFSI-funded efforts are in progress to evaluate low-cost slurry separation technology to reduce system water demands and increase effluent application to agricultural lands, evaluate a new dual fuel stove design, evaluate the use of absorption chillers for refrigeration from biogas, and assess the theoretical potential of heat applications to increase biogas production. The team is field testing these innovations at existing biogas systems operated in and around Kampala, Uganda. Working directly with stakeholders to test the innovations enables the research team to translate three years of primary research into sustainable, scalable, commercial outcomes for the agricultural sector in East Africa to increase profitability and reduce environmental impacts.

ADAPTING LINKED LIVESTOCK, HOUSEHOLD AND SECTOR MODELS TO EXPLORE POLICY IMPACTS TOWARDS CLIMATE RESILIENCE IN FUTURE SCENARIOS

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ABSTRACT

Future population growth and unequal development will require a significant effort in providing nutritious, available and affordable food to increasingly vulnerable populations including women and children. Currently over 200 million children are chronically malnourished with elevated risk of physical

stunting and cognitive impairment. The recently-established USAID Feed the Future Innovation Lab for Livestock Systems at the University of Florida is a 5 year effort to improve livestock productivity and the incomes and nutrition of livestock holders through appropriate improved technologies, capacity building and enabling policies in Ethiopia, Rwanda, Burkina Faso, Nepal and Cambodia. Within the Innovation Lab, the Future Livestock Systems area of interest focuses on the computational and narrative scenarios required for envisioning household to national dynamics for animal sourced foods. Our primary methodology focuses on adapting an established Livestock Sector model that links herd dynamics, household vulnerability and national policies to project potential impacts of micro-, meso- and macro-scale drivers. Initial simulations of livestock sector policies show variable impacts on different households and regions within a nation, highlighting significant challenges in crafting climate-adaptive policies to increase overall sector resilience. Increased analysis with systematic uncertainty and sensitivity analysis will also aid in the resilience testing of potential policies to mitigate unfavorable climate or market conditions.

INVESTING IN LOCAL CONTENT DEVELOPMENT: A SOLUTION TO FOOD INSECURITY IN NIGERIA

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ABSTRACT

Nigeria is a country with spectacular biodiversity, large arable land and vibrant cultural diversity. The food and agriculture sector was the most important in terms of contributions to domestic production, employment and foreign exchange earnings. It has since the 1960s, remained stagnant because of negative impact of oil boom and the neglect of the sector resulting in reduced productivity efficiency and lack of investments. Success in agriculture and food processing cannot be determined by a few individuals making massive profits while the rest of the farmers wallow in poverty because they lack the land, technology or finances to produce. It can only be when majority of Nigerians are able to produce enough to feed the country and export the surplus. Availability of physical infrastructure, conducive political and economic environment, investments in management and technical skills, continuous stream of new agro-technology and systematic development and enhancement of rural institutions are identified as factors of change. Improvement in capacity productivity and promotion of more investment in primary agriculture, storage and processing sectors to curb the food security problems can be achieved when effective transformations are launched to improve the food and agricultural system. In other to achieve this transformations, investment in Nigerian agri-food content, a cohesive strategy that strengthens the whole food and agricultural system, was proposed. Policy wise, Nigeria will have to think holistically about sustainable food and agriculture systems and innovative ways to balance scarce and financial resources. The government should maximise their role as motivator and funder for projects which build local content friendly environment, for both small and medium enterprises (SMEs) as well as multinational companies in Nigeria. Friendly legislative impetus is also required.

ADAPTATION OF PRECISION AGRICULTURE TO INCREASE CROP YIELD AND MITIGATING CLIMATE CHANGE IN DEVELOPING COUNTRIES

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ABSTRACT

Developed countries has greatly optimized the use of chemicals and fertilizer by adapting precision agriculture (PA), with positive economic and environmental impact and increasing the productivity. PA Technology such as auto-guidance systems in farm vehicles increased the field capacity and efficiency and also resulted in reduction of GHG emissions, aiding in mitigating climate change impacts. Similar technology with adaptive modifications/customization can be used in developing countries. Policy makers along with scientist, academicians and progressive farmers in South and South-East Asia have substantial influence on development of modern agricultural methodologies. PA is in nascent stage in these countries. It may be noted that the technology is there and some of the large farmers have started to use it for economic benefits.

The adaptation of analytic techniques with importance of Q certificate, carbon balance, livelihood adjustment due to change in climate is being studied. The impact of global change research by practicing PA technology with advanced mechanization is assessed by reducing agricultural inputs and its effect on CHG emission in these countries. The impact is substantial in Bangladesh, India, Thailand and Vietnam.

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