

## **Peanut and Mycotoxin Innovation Lab**

**Project Title:** Productivity and Profitability Growth in Peanut Production: A Farm Level Analysis in Malawi, Mozambique and Zambia

**Project Category:** Peanut Economics

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## INTRODUCTION

The overarching objective of this project is to generate and transfer economic knowledge needed to intensify groundnut production, and its subsequent use, so as to significantly increase productivity and farm profits, while reducing the risk of aflatoxin contamination in the harvested crop. The end goal is to boost productivity growth in groundnut farming systems as a way to increase food safety, food security, and farm income in Malawi, Mozambique and Zambia, the Host Countries (HCs) for this project. This work will be done in close collaboration with the Value Chain Project being led by Dr. Rick Brandenburg. Collaboration will also be established with Dr. Mike Deom's Peanut Varietal Development Project, in particular with Dr. Naveen Puppala. Our project will rely fully on the existing partnerships and will extend some of the collaborative agreements already established in the HCs by Dr. Deom and Dr. Brandenburg. This will greatly facilitate the start-up of our activities.

A fundamental underpinning of the project proposed here is that a major constraint to a healthy groundnut value chain in much of Africa is low levels of farm productivity and profits. Productivity and profits can be improved in various ways including gains in marketable yields. Thus, the primary focus of this project is to analyze the farm level costs and benefits of alternative interventions designed to reduce the aflatoxin levels with the goal of increasing peanut quality and prices received by farmers. Such quality improvements also have well documented health benefits. A second area of work proposed is to utilize available data from the World Bank Living Standard Measurement Studies-Integrated Surveys on Agriculture (LSMS-ISA) and variety data generated in Dr. Deom's project to evaluate the farm benefits of improved seed varieties. A third area of work will be to undertake human capacity building through workshops in various topics including production economics, farm management principles and/or impact evaluation techniques.

Farmers benefit from increased productivity and efficiency by having peanuts that are less likely to be contaminated by aflatoxin because contaminated peanuts negatively affect household members' health, animal health when used as feed, and limit the utilization of the product at all levels along the value chain (Florkowski and Kollavali, 2013; Masters et al. 2013). Adoption of varieties that are less susceptible to contamination, the use of proper production and harvesting techniques, and suitable postharvest handling, enhance the likelihood that safe peanuts will move through the value chain. Such peanuts have the potential to increase profits throughout all stages from the farm to the final consumer.

Although increases in yields resulting from adoption of improved technologies have been documented in some countries (ICRISAT 2012), sharp gaps still exist between typical farm yields and those reported from experiment stations and on-farm research trials (ICRISAT 2012). The causes of these productivity gaps are complex and interrelated, including diseases, pests, lack of appropriate technologies (e.g., high yielding varieties), inadequate market linkages, poor post-harvest handling practices, and lack of reliable information to producers and other stakeholders along the value chain (Mutegi 2010; Okello et al. 2010; Masette and Candia 2011). Changing climatological conditions pose further challenges to African farming systems and to all aspects of food security (FAO, 2008).

## OBJECTIVES AND METHODS

### **Objective 1: To examine the costs and benefits of farm level interventions designed to decrease aflatoxin contamination and improve productivity and profits.**

An important dimension in increasing productivity is to provide farmers with timely and relevant research-based information in a usable format that can serve as a basis for improved decision-making and speed up the technology adoption process (Foster and Rosenzweig 2010; Feder, Just and Zilberman 1985). The information required is wide ranging in scope, and thus concerted collaborative efforts are needed among stakeholders throughout the value chain, including researchers, producers, extensionists, policy makers, farmers and other private sector participants.

Under this objective we propose to undertake a research plan for the three countries involved to analyze productivity, cost of production and expected profitability for alternative management strategies. In collaboration with various team members, procedures will be developed to capture and organize the data generated in experiments conducted in other PMIL Projects, as mentioned above, as well as secondary data that might become available from different sources and data generated in in the project led by Dr. Florkowski.

Specific research activities contained in Dr. Brandenburg's project that are expected to generate information for inclusion in the economic analysis are: (i) The evaluation of cultural practices including rotation and harvest dates (maturity) with multiple cultivars in terms of termite infestations, plant pathogens, and aflatoxin levels; (ii) drying and storage techniques, insects and pests in relation to aflatoxin contamination; (iii) the evaluation of the applicability of Malawi (ICRISAT) research based technology in Zambia and Mozambique; (iv) risk indices based on soil characteristics, crop rotations, weather patterns, cultivars, and planting and harvest dates to forecast aflatoxin incidence; and (v) country specific appropriate and affordable drying and storage practices to reduce incidence of mold growth on raw peanuts. We also expect that Dr. Deom's project will generate data appropriate for economic analysis particularly coming from the on-farm trials involving two newly released GRD and leaf spot resistant cultivars from Uganda, namely Serenut 5R and Serenut 6T.

Representative farm models will be constructed for each of the three HCs to examine the productivity and profitability implications of the various practices and interventions to be investigated in the related PMIL projects. The process through which representative farm models are developed often relies on the economic engineering approach (CCRH, 1998). The economic engineering approach relies on a process where inputs and their associated costs are obtained from related production and technical research, consultation of the relevant literature, industry representatives, and general production theory (Cesaro et al., 2008). This methodology was developed in the early 1940s by R. G. Bressler Jr., and his associates at the University of Connecticut and has been continually refined over the years (French, 1977). It is still used frequently in agricultural economics and related fields to

define a model farm that captures typical conditions prevailing in a particular area for a given product (Kay et al., 2008).

Representative farm models will be developed and all the required information assembled from informal surveys, literature review, expert opinions, market based research and data, among others (CCRH, 1998; Cesaro et al., 2008). The result will be a farm model (or models) that is *representative* of the average farm present in each country and region. These models are particularly useful in examining *a priori* the impact of different assumptions, such as alternative technologies, yields, and prices (CCRH, 1998). According to Köbrich et al. (2003), the Representative Farm Model is a very useful tool for prospective investors and producers recognizing that every firm has its own set of unique characteristics and challenges.

The variability or risk associated with the representative farms will also be evaluated with the models. Well-established procedures for calculating production, market, and financial risks from basic estimates of yield and price predictability are readily available (Ahearn and Vasavada, 1992), and will thus be incorporated into the analysis. Expected value, sensitivity, and Monte Carlo simulation techniques will be used to quantify and qualify the distribution of production outcomes. Expected value analysis is used to obtain base results from the models. In this way the representative farm model projections are provided for the most likely outcomes for the given enterprise (Boardman et al., 2006). The sensitivity of these expected values is then evaluated by methodically changing key parameters or variables while holding all others constant (*ceteris paribus*). The estimates are considered to be robust when they are not significantly altered by changes in key assumptions (Boardman et al., 2006).

Monte Carlo simulation is an outgrowth of sensitivity analysis that considers the effect of the simultaneous variability of several assumptions on net benefits. This method of risk analysis relies on the probability distributions of important variables (e.g., yields). Hundreds or thousands of simulated outcomes are generated during Monte Carlo simulations, which are subject to further statistical analysis. Such information is particularly useful when choosing between different opportunities that may have similar mean values but differing levels of variance in the distribution of income (Kwak and Ingall, 2007). It must be noted that such analyses require accurate information in order to generate meaningful results. The accuracy of the information incorporated into the simulations will be confirmed through consultation with expert panels and other reliable sources.

## **Objective 2: Economic analysis of improved groundnut varieties on farm productivity and profits.**

The literature shows that despite well-documented evidence of the positive productivity effects of improved inputs, adoption in many cases remains low (Foster and Rosenzweig, 2010). In groundnut production, there is considerable potential for achieving productivity and income gains through the use of improved varieties that have been developed for

better disease resistance, better yields and good market acceptability (Kassie et al. 2010; Thuo et al., 2014).

Here we propose to utilize data available from the World Bank (WB) Living Standards Measurement Studies-Integrated Surveys on Agriculture (LSMS-ISA) program that focuses on agricultural development in seven African countries including Malawi and Uganda. Malawi is a focus country for the PMIL whereas Uganda is interesting because it has an aggressive peanut-breeding program. Therefore, in this objective we intend to take advantage of the available World Bank data for both Malawi (2a) and Uganda (2b) to study the economic benefits of improved peanut seed varieties. One important aspect of this work is that the two M.Sc. students that will be involved have already taken all their courses and only need partial support to complete their theses. Thus, the work under this objective will be very cost-effective while making it possible to generate useful analysis within a short period of time, which in part will make up for the late start-up date of this project.

### **Objective 2a. Improved Groundnut Varieties in Malawi**

With support from the World Bank, the government of Malawi through its National Statistical Office (NSO) conducted a survey between March 2010 and March 2011 that contains household, agricultural and community information for the 2009-2010 year. This household level data was collected from 27 districts across the country excluding the island district of Likoma since it only represents 0.1% of the population. Overall, there are 12,271 households of which 2,523 cultivated groundnuts. This study will also utilize data for the 2010-2011 year, which the World Bank is planning to release later this summer.

Stochastic frontier analysis will be used to estimate production frontiers for each year separately (Bravo-Ureta et al. 2007). Then, all farms observed in both years will be used to estimate a two-round panel data model. The production frontiers will be used to examine farm level productivity. The analysis will focus on productivity differentials across farmers that use improved seed varieties versus those using conventional varieties. This differential is termed the technology gap. In addition, technical efficiency differentials will be the basis for quantifying managerial gaps. This analysis will then be used to compute the farm income differentials stemming from the technology and the managerial gaps (Bravo-Ureta et al., 2013; Asekenye et al., 2014).

### **Objective 2b. Improved Groundnut Varieties in Uganda**

Uganda presents a unique case study, given its recent history of an approximately 20-year-long civil war, and that this conflict was geographically contained in the northern region, which has been described by many as 'war-torn.' During the 1990s, nearly 2 million people were displaced in Northern Uganda and regional infrastructure was severely damaged. Right of return was allowed in 2006 and by 2012 all settlement camps had been disbanded (UNHCR, 2012). While the importance of developing sound agricultural systems in post-

conflict countries is heralded, the effects of conflict, known to be highly disruptive to education, market institutions, property ownership and social networks, among others are often ignored (Collier et al., 2003; Brauer & Dunne, 2012). This research will consider to what extent displacement and lack of access to land, as a result of the displacement of others, has had on adoption.

Previous examination of adoption constraints identified limited household-level datasets as a barrier to research. This project therefore intends to utilize the LSMS-ISA data, which offers comprehensive survey information with three consecutive years worth of information (2009-2012) and an additional year 2005-2006 that coincides with both the peak and downturn of the war. The LSMS offers a variety of household level information indicative of conflict-induced insecurity ranging from whether one has been an internally displaced person (IDP), to concerns of ownership dispute and whether insecurity affects access to education and transportation. This research can generate important insights concerning farmers' reluctance to adopt improved varieties.

The proposed methodology will make use of Probit and Tobit adoption regression models which allow for a different specification of the adoption variable (Kazianga & Masters, 2002; Anley et al., 2007). Probit models will consider whether or not a farmer has adopted improved seed varieties whereas the Tobit model can accommodate the intensity of adoption such as share of land with improved seeds and share of improved seeds relative to total seeds used. The student that will undertake this work plans to visit Uganda later this summer, using her own resources, to obtain insights into the context of adoption, which will be extremely helpful in the interpretation of the econometric results.

### **Objective 3: Conduct training activities in the three HCs focusing on the economics peanut production.**

The information generated in objectives 1 and 2 above will be the basis for preparing training programs on farm management and production economics focusing on the economic value of intensifying groundnut farming. Training focusing on survey design and impact evaluation concepts and practice is also proposed (Bravo-Ureta et al. 2010; Ravallion 2008). Depending on the topic, the audiences for these programs will include faculty members and graduate students of participating universities, staff from participating institutes, and representatives of the private sector including NGOs and/or farmer associations. The specific topics to be covered in the workshops will be agreed upon with our HC partners based on their needs and interest.

### **SYNERGIES**

Deliberate efforts will be made to maximize the synergies between this Project and Dr. Florkowski's Project as well as the two other projects mentioned above (Dr. Brandenburg and Dr. Deom).

## PROJECT OUTCOMES

- Enhanced knowledge about profitability of groundnuts under different management practices obtained by key stakeholders
- Enhanced productivity of groundnut farming under different management practices obtained

## PROJECT OUTPUTS

- Rigorous econometric evidence on the impact of improved groundnut varieties on farm productivity using alternative approaches and data for Malawi;
- Rigorous econometric evidence concerning the determinants of improved seed varieties in Uganda;
- Farm level economic analysis for groundnut based production systems, for major agro-ecological conditions in the Southern Africa HCs;
- Economic analysis of the benefits of using on-farm postharvest handling, storage and utilization and their link to aflatoxin contamination risk;
- Economic feasibility of interventions reducing aflatoxin contamination of peanuts and peanut products.

The major training outputs of this component include:

- Partial support for degree training of one Ph.D. and two M.Sc. students at UConn, and partial support for a post-doc at UConn during the last 9 months of the project to insure all reports and publications are completed on time. One of the M.S. students will be funded at ½ assistantship (10 hrs.) for the Fall and the second at ½ assistantship for the academic year 2014-2015. The Ph.D. student will be supported as a research assistant during summer 2015 and 2016 and then as a Post-Doc for the academic year 2016-17.

We recognize that significant merits to have HC students undertake the research work. However, given the need to generate results, the short time to do so and the lengthy process required for recruiting students and then to get their visas make it necessary to follow the plan we are presenting. It should be mentioned that the student that will be doing the work with the Malawi LSMS-ISA data is from Ghana.

In addition, funds will be set aside and allocated to the HCs and of course some of this work and funding could go to support local students.

- In-country stakeholders trained through short-term workshops on farm management and production economics, survey design and implementation, and impact evaluation. Participants will include graduate students, government officials and faculty members from the different collaborating institutions.

## **ANNUAL WORK PLAN, MILESTONES AND TIMELINE**

### **Year 1. 2014-2015**

1. Visit the three HCs and complete the elaboration of the research objectives based on actual production and agronomic work completed to date and planned for the future.
2. Design protocols to collect production and agronomic data from other collaborating projects.
3. In cooperation with the HC collaborators prepare plans for in-country workshop for Year 2.
4. Complete productivity analysis of the LSMS-ISA Malawi data. Prepare manuscript for submission.
5. Complete adoption analysis of the Ugandan LSMS-ISA data.
6. Develop economic engineering model to undertake the work under Objective 1.

### **Year 2. 2015-2016**

1. Visit the HCs and conduct short-term workshops.
2. In cooperation with the HC collaborators prepare plans for in-country workshop for Year 3.
3. Prepare manuscripts from the Ugandan LSMS-ISA work.
4. Incorporate production data into the economic engineering model and develop the first round of results and publications.
5. Ph.D. student defends his dissertation and at least one chapter will be directly related to the project.

### **Year 3. 2016-2017**

1. Visit the HCs and conduct short-term workshops.
2. Incorporate additional production data into the economic engineering model and develop the additional results and publications.
3. Present results in professional meetings.
4. Prepare and submit Final Report.



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