Feed the Future Innovation Lab for Collaborative Research on Grain Legumes (Legume Innovation Lab)

FY 2016 WORKPLAN

Project Code and Title: SO2.1 - Farmer Decision Making Strategies for Improved Soil Fertility Management in Maize-Bean Production Systems

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I. Project Problem Statement and Justification

Poor soil fertility is a major factor in low bean yields in Uganda and Mozambique, important Feed the Future focus countries. Both countries have weak and uneven extension systems and rural social and economic institutions, limiting widespread access to improved crop management information, quality inputs and credit, with Mozambique particularly problematic. This research project is based on two premises: (1) sustainable intensification of agricultural production requires improved soil fertility management in which legumes are an integral part of cropping systems; and (2) effectively addressing soil-related constraints will be based on enhancing smallholder farmers' capabilities in diagnosing and finding solutions to important yield constraints, and helping to remove barriers to access various types of soil amendments.

Project research activities focus on key common bean production regions – in Masaka and Rakai districts in south-central Uganda and in Gurue district in northern Mozambique. To understand potentially limiting soil nutrients, the team analyzed physical and chemical properties of soil samples collected from farmers' fields representing the three predominant soil types used to grow beans in the study communities in each country. Results guided nutrient omission studies (NOS), using soils from farmers' fields, which revealed effects of specific nutrients (N, P, K, Mg, Ca, S, and micronutrients) on bean plant growth and development. The NOS in Uganda showed that low P availability limits bean growth on red, black and stony soils. The NOS in Gurue is being repeated due to problems experienced in early 2015. Complementing the NOS is the lime requirement study (addressing low pH, Ca and Mg availability, and Al toxicity). Researcher-managed field trials in Masaka and Rakai districts during the 2014-B and 2015-A seasons demonstrated the importance of seeding for denser stands in all soil types, that addition of P, Ca, and Mg nearly doubled bean yield in black soil, and the effect of adding Rhizobia, seed fungicide, and a foliar fungicide is contingent on rainfall.

With high rainfall levels, one NARO foliar fungal resistant bean variety had the best yield in all management systems while farmers preferred a variety that produced almost no yield in the 'innovative farmer' management system. A third season field trial will be conducted in Rakai during 2015-B. In Gurue, field trials during the 2014-2015 rainy season were adversely affected by farmer activities, compromising results. Field studies during the 2015 dry season in lowland fields will be done to determine which nutrients are most limiting bean yield. Specifically, a nutrient omission study will be conducted at six sites in Mipuagiua, providing results on the influence of soil fertility and nutrient additions on leaf tissue nutrient concentrations and bean yield. Results will guide treatment design of subsequent field trials in Gurue during the 2015-2016 rainy season and 2016 dry season.

Two multistakeholder innovation platforms (IPs) are emerging in Masaka and Rakai districts with assistance of the project team. Members across the value chain share interests, concerns and strategies to address bean productivity and marketing constraints. In 2016, IP members will be engaged in field trials that demonstrate the impact of improved management practices and technologies (MPT) for bean production. In Gurue, farmer research group activities will test site-specific MPT. Both approaches will engage producers and other stakeholders in social learning, stimulate interest among community members in the demonstrations and trials, and contribute to subsequent widespread use of MPT that are proven to be successful in local conditions.

This project team is developing aids (methods and procedures) that will enable smallholder producers with varying levels of education to better diagnose soil and other production constraints, and make improved site-specific crop system management decisions that contribute to higher bean productivity in the short term and improvements in soil fertility in the long term. We are assessing the effectiveness of innovative communication approaches and technologies to engage farmers with diverse characteristics and other key stakeholders in widespread dissemination and adoption of appropriate diagnostic and decision support aids.

II. Project Activities for the Workplan Period (October 1, 2015 – September 30, 2016)

Objective 1: Characterize Smallholder Farmers' Practices, Problem Diagnoses and Solutions

Approaches and Methods

Our interviews and soil surveys document that smallholder farmers recognize the role of a variety of soil-related characteristics that impact bean yield in their production systems: soil color, particle size, soil texture, topsoil depth, rocks, slope, water holding capacity, plant vigor, previous yield results, weeds, etc.

Farmers in Uganda and Mozambique currently use a variety of management practices and technologies (MPT) to maintain or increase bean productivity, with significant variation by location regarding type and extent of use - reflecting awareness, availability, access and affordability. Our baseline farming system and socioeconomic surveys are providing detailed community-wide profiles of farmers' acreage and number of fields, practices of field selection and preparation, crop and variety selection, purchase of good quality seeds, planting methods and spacing, use of various types of inputs (manure, inorganic fertilizers, foliar sprays, pesticides, herbicides), intercropping and rotation patterns, weeding, incorporating crop residues in soil (rather than burning), mounding ridges, mulching, and fallow. Methods and criteria of problem identification and management practices utilized by farmers to date is also important. These analyses guide the research team in its observations and learning how

farmers use existing knowledge to help determine crop system needs and to improve conditions.

Analysis of relevant data from the household baseline survey in Masaka and Rakai is progressing well and is expected to be completed in late 2015. Additional cleaning of household baseline survey data from Gurue occurred in June, permitting the team to proceed with comprehensive analysis during late 2015 and early 2016.

Obj. 1a. Continue collection of primary data in Gurue (lead researcher: R. Maria)

1a.1. Monitor field experiments with selected farmers in Gurue (rainy and dry seasons) (also: R. Yost, A. Lenssen)

1a.2. Document farmers' knowledge, attitudes, and practices (also: R. Yost, A. Lenssen, R. Mazur, V. Salegua)

Milestones

Oct. 2015 – Mar. 2016

1.1 - Reports on farmers' participation in field experiments in Gurue

Apr. 2015 – Sept. 2016

1.2 - Reports on farmers' knowledge, attitudes, and practices in Gurue

Objective 2: Develop and Refine Models about Smallholder Bean Farmers' Decision Making

Collaborators:

Jalia Namakula, GIS specialist, NARL, Uganda

Cassamo Sumila - Institute of Agriculture Research of Mozambique

Approaches and Methods

The institutional support system for selected 'cash crops' plays a significant role in farmers' ability and interest in making investments in crop production and soil fertility enhancement. In Mozambique, an array of cash crops have been introduced or efforts intensified in the past decade by private sector foreign investors, NGOs and international research organizations which provide training, seed and other inputs, and marketing – for soybean, pigeon pea, sunflower, pineapple, cotton, and tobacco. In contrast, common bean production and sales appear to be almost exclusively driven by domestic market actors. Initiatives by Maputo-based 'market women' during the past five years has helped increase market prices for common beans. If/when the support for other crops is reduced or eliminated, or the market prices for other crops decline significantly, common bean production will be viewed as being more lucrative. In Uganda, the two major cash crops are currently affected by disease - banana bacterial wilt and coffee rust; cassava, sweet potatoes, and groundnuts are also widely produced. In both countries, farmers indicated that post-harvest storage is a highly ranked problem. Some farmers try to avoid bruchid damage by using strong chemicals (at least 1 in 10 farmers are using chemicals, some of which are known to be hazardous to human health), while most farmers in Mozambique use nothing.

The existence and strength of farmers' groups varies significantly. In Uganda, some farmer groups formed for projects often don't persist after project support ends (e.g., government extension); others have consolidated and grown into cooperatives. The emergence of two multistakeholder Innovation Platforms in Masaka and Rakai indicates strong interest in coordination across the value chain from inputs to markets. In Mozambique, farmers groups (associations, forums and federations) are the principal mechanisms to access training and other support. Some associations are able to effectively engage in collective marketing, while

others are not. This has significant implications for farmers' decisions to prioritize cultivation of specific crops, including beans, as they take into account the potential for earning needed income.

Building on information obtained during participatory rural appraisals, the baseline household survey is providing a detailed profile of key social, cultural, economic, institutional and contextual factors which shape farmers' decision making – individually and collectively. These include: farmers' sources, credibility, and uses of information about bean crop and soil fertility management; problem diagnoses and solutions adopted; assets and flows of key resources (production materials, labor, money, etc.); gender and other roles (who makes or negotiates which types of decisions, alone or with others); resource constraints (material, labor, financial, etc.); food security; market sales; decision making processes (timing, stages, sequencing); and risk management strategies. Contextual factors analyzed include availability, accessibility and affordability of key resources (natural, physical, financial); value chain development (input and output markets); group and network size and strength; and collective action experience. In Masaka and Rakai, this is complemented by qualitative research using in-depth interviews with farmers to understand how and why they make decisions about production and soil fertility. Together, these analyses can explain current knowledge, attitudes, practices, and subsequent processes of information dissemination, training, utilization, and support to stimulate and sustain widespread change. Characterizing and modeling farmer decision-making processes will provide insight into which households are more able and likely to make fundamental changes and why.

Obj. 2a. Characterize resources and actions to increase bean crop productivity and marketing, and to improve soil fertility (lead researchers: R. Mazur, R. Miiro, V. Salegua, E. Luvaga)

2a.1. Continue analysis of household survey data regarding farmers' resources, management practices and investments, and marketing

2a.2. Document roles and collaboration among members of multistakeholder innovation platforms

Milestones

Oct. 2015 - Mar. 2016

2.1 – Reports on farmers' resources and actions for management practices and investments to increase bean crop productivity and marketing, and improve soil fertility

2.2 – Reports on activities and successes of members of multistakeholder innovation platforms in promoting improved bean crop management practices, investments and marketing

Obj. 2b. Refine models of farmer decision making and identify recommendations for training and support to increase bean crop productivity and marketing, and to improve soil fertility (lead researchers: R. Mazur, R. Miiro, V. Saleguam E. Luvaga)

2b.1. Continue analysis of household survey data to model farmers' decision making

2b.2. Identify specific information and knowledge gaps to be addressed

Milestones

Apr. 2016 – Sept. 2016

2.3 – Models of farmer decision making vis. management practices, investments and marketing

2.4 – Recommendations for training and support for bean production and soil fertility management

Objective 3: Develop and Validate Diagnostic and Decision Support Aids

Collaborators:

Charles Kizza Luswata, soils lab senior technician, Makerere University, Uganda
Jalia Namakula, GIS specialist, NARL, Uganda
Stanley Nkalubo, bean breeder, NaCRRI, Uganda
Clare Mukankusi, bean breeder, CIAT, Uganda
Manuel Amane - Institute of Agriculture Research of Mozambique

Approaches and Methods

To improve soil management decision making, diagnostic criteria and aids will be developed with and for farmers who have varying levels of education. These aids will be based upon field-observable soil classification characteristics in diverse agroecologies in Masaka district, Uganda and Gurue district, Mozambique. Utilizing farmer experience and input from soil scientists and crop systems agronomists, we draw from results obtained during the first two years of our project and the global knowledge base of appropriate practices and technologies, soil and cropping systems management strategies and options appropriate for various smallholder farm systems.

In Uganda, shortened or more typically non-existent fallow periods, lack of fertilizer inputs, reduced soil organic matter concentration, and erosion from water have resulted in stagnant or decreased bean yields. The soil survey conducted in Masaka and Rakai districts in January 2014 documented that Liddugavu (black) soils generally had adequate levels of nutrients and rooting depth generally was not constrained by excessively low pH or Al^{+3} concentrations. Our soil survey results documented that the Limyufumyufu (red) soils were strongly acidic in the 15-30 cm depth, while available P, K, Ca, and Mg likely were limiting bean growth, and this was confirmed with scientist-managed field research in Masaka over two rainy seasons. Additionally, Al^{+3} levels were often significant in red soil, further constraining potential root growth for water and nutrient extraction, and improved systems that included the addition of limestone proved highly effective, doubling bean yields. With reference to results from the lime requirement study, Limyufumyufu soil had this regression equation $y = 0.1285x + 5.5014$. Considering that the recommended pH for beans ranges from 5.8 - 6.5, this equation can be used to calculate the amount of lime required to raise pH from one level to another. For example, raising pH from 5.02 (which is the initial pH of this soil type) to 6 will require 3.88 tons of $CaCO_3$, while raising the pH to 6.5 will require 7.77 tons of $CaCO_3$

A question remaining to be answered is exactly how much lime is required to moderate the effects of low pH, Ca, and Mg on red soil and the profitability of lime addition. Results from the lime requirement study provide good starting points on this for both red and stony soils. Results for the Luyinjayinja (black, stony) soil samples were more similar to those of Limyufumyufu than for Liddugavu soils; both had low pH and concentrations of available nutrients. Additionally, these soils typically had a zone of higher clay concentration that likely limits hydraulic conductivity, increasing water logging of top soil during a wet period. These factors limit root growth in topsoil and subsoil. Results from our January 2014 soil survey and biweekly monitoring of bean fields in Uganda documented that numerous specific soil sites had reasonable nutrient availability and soil quality, yet farmers still experienced low and unsatisfactory bean yields. Scientist-managed research on black soil confirmed that improving stand density by higher seeding rates and timely weeding improved yield when availability of the three most limiting nutrients was increased by fertilization. When rainfall was excessive in April 2015, the single foliar application of a strobilurin fungicide greatly decreased incidence of angular leafspot on leaves and anthracnose lesions on pods, significantly improving yield and quality of yield of NABE14, NABE15, and K132. The farmer preferred variety NABE4, which is

preferred for home food consumption, was highly susceptible to diseases and yields were poor in all systems, even with the application of the foliar fungicide. On the red soil, greater stand density, more timely weeding, addition of limestone to ameliorate excessively low pH, and the application of P and K more than doubled bean yield compared to the management system used by farmers. Analysis of soil samples obtained from farmers in Gurue will yield similarly useful results and provide insights regarding nutrient limitations in bean productivity, particularly when complemented by results from bean harvest.

The nutrient omission studies provided new information on the relative importance of nine nutrients for bean growth and development on Liddugavu, Limyufumyufu, and Luyinjayinja soils from Uganda. Results are being used in scientist-managed field studies comparing different application rates of chicken manure, P, and N. The N addition rates were included because current NARO fertilizer recommendations for bean in Uganda include use of N fertilizer, since N fixation by beans is generally low. Additionally, the previously untested solution strategies of using seed fungicide and a single foliar fungicide application for disease management were highly successful in the recent wetter-than-normal rainy season. Diagnostic aid development is based on results from the nutrient omission studies and scientist-managed studies. Numerous photographs were taken of bean plants shortly after emergence, flowering, and just prior to harvest in scientist-managed studies that show well the key nutrient deficiency symptoms and bean yield potential under greater stand density, improved weed management, with and without application of limiting nutrients, and with and without application of a foliar fungicide. We anticipate including a number of comparative photographs showing the results of management practices that make a difference in bean production and profitability. Development of diagnostic aids requires the inclusion of farmers' input during all developmental phases, not just during testing.

In Gurue, visual observations of the nutrient omission experiment at Tetete and the measured results from Lioma indicate that wet season bean growth on upland soils is responding to both N and P. These are the most costly of the nutrients when added as purchased fertilizer. Therefore, means to provide both N and P to local farmers for the extensive upland soils using low cost systems they can manage is being explored. The inclusion and expansion of the local practice of a pigeon pea rotation in bean production systems may be one way to add biological nitrogen fixation inputs of N into otherwise N limited bean production. Experiments are planned to include a pigeon pea rotation in the bean rotation system to provide increased N input.

Local Mozambique rock phosphate materials are available in Nampula, and this may be an effective way to provide low cost, locally available P. The acid, low Ca soils of Gurue are, in fact, ideal to stimulate rock phosphate dissolution and availability. In addition, rock phosphate applications can provide both P and Ca that can increase soil health and productivity. The residual effects of the rock phosphate would like increase both pigeon pea and bean access to P as soil productivity and health are improved. We will also determine the calcium carbonate equivalent of locally available limestone.

Diagnostic criteria provide implicit comparisons of 'what if' scenarios. Readily observable characteristics will be compared, often in a dichotomous series. These criteria will provide farmers with information on improved practices to achieve particular objectives, and enable farmers to weigh 'trade-offs' between alternative approaches or practices. We have determined for black soil in Masaka that P, Ca, and Mg availability often are inadequate for bean production and that increased stand density, timely weeding in conjunction with addition of these limiting nutrients can more than double bean yield. The development of the diagnostic aid will be done using photographs from the NOS and scientist-managed field studies that documented differences in bean development, bean leaf health, and subsequent bean yields. Photographs taken during the course of the nutrient omission and scientist-managed field studies will

comprise an important component that allows farmers to quickly note important differences between the aforementioned management practices. In subsequent years, images will be available from productive innovative farmer fields where the criteria were used, providing direct comparison of bean growth, development, and yield between management systems used. Additionally, comparisons will be done between innovative farmers and a control (not selected) farmer group where diagnostic criteria were not used as a second level of comparison.

Farmer research groups will be formed and supported to engage producers in field experiments that test and demonstrate the impact of variations in farmer-recommended improved MPT for bean production. Farmer research group activities will generate practical results, engage farmers in social learning, stimulate interest among other community members in the trials and demonstrations, and eventually contribute to widespread adoption of proven management practices and technologies (MPT). Farmer-assisted field research trials will be conducted in each district comparing MPT recommended by productive and innovative farmers with those indicated as relevant based on analyses of soil samples and the nutrient omission studies. These research trials will enable us to confirm nutrient limitations on farmers' fields and improved systems that address the most critical limiting soil nutrients and management practices. Given inherent precipitation, soils, and other differences between Masaka district (beans are planted in both rainy seasons) and Gurue district (beans are planted in the singular rainy season and in the subsequent dry season), we have the opportunity for a robust comparison of our overall methodology. Farmers will be surveyed annually after each cropping cycle to determine impact of using diagnostic criteria on bean productivity, soil quality, and potential for sustainable adoption.

The farmer assisted research will include data collection on initial, annual (pre-planting and post-harvest), and final key soil chemical and physical properties from samples taken at depths of 0-15 cm and 15-30 cm. Initial properties determined typically will be those documented in the nutrient omission and scientist-managed studies that impacted bean growth and development. Bean stand density, yield, yield components (pods/m^2, seed/pod, seed weight), and seed protein will be determined in fields under both management systems and for the non-selected farmer control group. Additionally, timing and intensity of foliar disease development will be assessed, providing relevant results for deployment of newer, more disease resistant varieties as one component of the overall strategy to improve bean production. Statistical analyses used with data from the farmer assisted research will include paired-T tests within selected farmer groups, and analysis of variance with appropriate mixed models, and nonparametric tests, depending on the specific parameter.

The formation and support of farmer research groups will be essential to the success of our efforts to develop and test the effectiveness of diagnostic and decision support methods and aids. Groups and social networks play key roles in experimentation and adoption of new management practices and technologies, involving changes in beliefs, knowledge, and behavior. Researchers and farmers will create a continuous community learning environment - a 'community of practice' in which farmers ask questions and seek answers, and make sense of each other's experiences and knowledge alongside scientific knowledge. This process of *sensemaking* enables people to collectively: devolve new 'mental maps;' set their own goals and outcomes; experiment, evaluate, collectively frame and legitimize the 'way forward;' develop a sense of identity, efficacy and pride; and encourage each other and persuade others to take similar actions.

Based upon insights gained from socioeconomic research on farmer decision making, integrated soil and crop management decision tools appropriate for varying levels of formal education will be developed and tested in various contexts and evaluated for their effectiveness over multiple years. For sustained utilization, we must ensure that the tools are useful and

accessible to diverse populations (low education/literacy, socioeconomic characteristics, etc.). This is accomplished in part by including an array of relevant stakeholders, including smallholder farmers.

Obj. 3a. Determine Solutions to Soil Fertility and Other Bean Production Constraints

(lead researchers: M. Tenywa, O. Semalulu, R. Maria, R. Yost, A. Lenssen)

3a.1. Complete field studies of bean management systems and soil fertility

3a.2. Analyze results and recommended solutions

Milestones

Oct. 2015 – Mar. 2016

3.1 – Completed field studies on bean crop management systems

3.2 – Analyses and recommendations for bean crop management systems

Obj. 3b. Develop Diagnostic Methods and Aids

(lead researchers: M. Tenywa, O. Semalulu, R. Maria, M. Amane, R. Yost, A. Lenssen)

3b.1. Engage farmers in a participatory assessment of the draft initial diagnostic and decision support aid

3b.2. Finalize initial diagnostic and decision support aid

Milestones

Oct. 2015 - Mar. 2016

3.3 - Participatory assessment of preliminary diagnostic and decision support aid

Apr. 2016 – Sept. 2016

3.4 – Refined and field tested diagnostic and decision support aid

Objective 4: Develop and Assess Effectiveness of Innovative Approaches for Dissemination of Information and Decision Support Aids, Training, and Follow-up Technical Support

Collaborators:

Freddie Kabango, Masaka District Agricultural Officer, Uganda
Dorival Freitas, Gurue District Agricultural Extension Officer, Mozambique
Cassamo Sumila - Institute of Agriculture Research of Mozambique

Approaches and Methods

To realize our goals, we are working with existing institutions and organizations to identify and develop messages to provide farmers with appropriate and reliable information to make critical decisions about beans and soil fertility, and pathways that can provide relevant information in an effective, efficient, and sustainable manner. Farmers described strengths and weaknesses of current information providers and existing agricultural information dissemination systems in Uganda and Mozambique. In Uganda, groups are especially important as sources of valued information, along with fellow farmers and NAADS/Extension. Local and national radio programs also are used by some farmers. In Mozambique, fellow farmers are a major source of information, and there is much less access through groups, contact with extension agents, or radio. We are contacting potential information providers to assess their capacity and willingness to develop and deliver messages concerning beans and soil fertility.

The project is engaging producers and other stakeholders, women and men, in testing innovative communications approaches and technologies for learning and sharing information about new management practices and technologies for increasing bean yields and improving soil fertility. Given limited extension system resources in Uganda and Mozambique, methods

that enhance the ability of extension to deliver messages as well as local peer-to-peer dissemination and learning (field days, exchange visits, local community based organizations, farmer associations) will be important. To ensure that those with low literacy skills can benefit, especially women, our communication approaches and technologies utilize visual aids (print materials and animated videos developed through collaboration with Scientific Animations Without Borders - SAWBO), and radio messages in local languages.

To begin engaging local learning and information dissemination systems, we are addressing a widespread problem (weevil damage) by utilizing training materials developed during the previous Pulses CRSP project in Uganda's Kamuli District regarding anaerobic bean grain and seed storage using jerry cans and the triple bag system. The Masaka District Agricultural Officer recently learned and used the triple bag method to verify its effectiveness; he is enthusiastic for the project team to train others. In June 2015, we demonstrated these methods during meetings with 30 members of the two IPs in Uganda using established extension training methods, a live action video, and a newly developed animated video. In Gurue, our communication research is comparing the effectiveness of different combinations and sequences of training media for learning the procedures involved. Beans stored using anaerobic and conventional storage methods will be compared by IP members in Uganda and farmer group members in Gurue in late 2015. Positive results will enhance the perceived value of the project activities and encourage community members to participate in future learning and information dissemination opportunities focused on bean production and soil fertility. Training materials will be refined, further tested, and distributed to a sample of farmers for evaluation of learning processes. This initial engagement will guide subsequent development of messages regarding crop and soil management practices and technologies, and dissemination through information systems effectively and efficiently.

As crop system management diagnostic and decision support aids are being developed by project researchers working in a participatory manner with farmers and other stakeholders, we will identify the most appropriate media and methods for dissemination, pre-test them, revise as appropriate, prepare for initial dissemination, evaluate their effectiveness, and provide recommendations for more widespread dissemination by relevant organizations. Dissemination, training and support will target priority decision-making points for individuals and groups. Optimum levels of training and follow-up support will be determined to identify efficient use of resources (extension personnel, material, financial); this will facilitate development projects being able to utilize our research results for scaling up and achieving widespread impact. Emphasis in each country will be placed on utilizing communication approaches/technologies that maximize available and sustainable resources. Monitoring and evaluating the impacts of project activities will involve collecting and analyzing baseline data and periodic monitoring of indicators.

Obj. 4a. Devise Evidence-Based Information Dissemination System

(lead researchers: E. Abbott, J. Bello-Bravo, B. Pittendrigh, R. Miiro, V. Salegua)

4a.1. Analyze results of field test of prototype message/media

4a.2. Develop new message and align with appropriate media

Milestones

Oct. 2015 - Mar. 2016

4.1 – Analyses of effectiveness of prototype media and training strategies

Apr. 2016 – Sept. 2016

4.2 – Message and media for dissemination of initial diagnostic and decision support aid

Obj. 4b. Refine Content and Information Dissemination System

(lead researchers: E. Abbott, J. Bello-Bravo, B. Pittendrigh, R. Miiro, V. Salegua)

4b.1. Engage farmers and other key stakeholders in a participatory process of assessing the message and media for the initial diagnostic and decision support aid
4b.2. Identify priority issues and strategy for development of new messages

Milestones

Apr. 2016 – Sept. 2016

4.3 – Participatory assessment of message and media for initial diagnostic and decision support aid
4.4 – Foci and strategy for development of messages and media for dissemination of additional diagnostic and decision support aids

Objective 5: Enhance Institutional Research Capacity Relative to Grain Legumes

Approaches and Methods

A key element in building institutional research capacity to increase effectiveness and sustainability of agricultural research institutions that serve the bean sector in Uganda and Mozambique is to provide graduate student training. Our project is training four graduate students in academic programs in U.S. institutions and in research activities in host countries. Specific research foci and affiliations follow:

- one M.S. student from Uganda is studying Sustainable Agriculture and Sociology at Iowa State University and conducting research on farmers' perceptions, knowledge and socioeconomic factors influencing decision making for integrated soil fertility management
- one M.S. student from Mozambique is studying Communication at Iowa State University and conducting research on innovative socio-technical approaches for dissemination of information for diagnosis and decision support
- one Ph.D. student from Mozambique is studying soils/crops at the University of Hawaii and conducting research on alternative management practices for improving bean production

One M.S. student studying Agronomy at Iowa State University has been conducting M.S. thesis field research in Uganda as part of this project, focusing on practical methods to alleviate constraints limiting common bean production in Masaka, Uganda. The student receives stipend and tuition scholarship from ISU, not this project. The student's research is testing the management strategies in replicated, researcher-managed studies.

Three graduate students are receiving training at Makerere University in M.S. programs that contribute directly to project objectives:

- one student is studying soils/crops and conducting research on limiting nutrients and lime requirements for bean production
- one student is studying soils/crops at Makerere University and conducting research on evaluation of bean production under different soil fertility management options in Masaka, Uganda
- one student is studying agricultural extension and innovation at Makerere University and conducting research on gender dimensions of bean farmers' decision making for bean production and soil fertility management in Masaka and Rakai Districts, Uganda

Additionally, short-term training needs are identified as research activities continue. In Uganda, this includes training technicians from Makerere University and from NARL, students, extension workers and some lead farmers in Masaka and Rakai in field soil characterization. One specific area concerns enhancing farmer decision making in soil fertility management through use of the refined indigenous soil classification system. In addition, a Ph.D. student supervised by Richard

Miiro has joined the field research team, under private funding; he is studying how Innovation Platforms may enhance member participation in decision-making. Further, the Bean Program of the National Crops Resources Research Institute (NaCRRI), through its Pre-cooked Beans Project with CIAT, is joining the bean Innovation Platform. They will contribute resources for promoting relevant technologies as our team project addresses soil improvement issues.

Two scientists from IIAM will participate in a training session in Uganda on identifying and characterizing soil 'catenas' in the two countries. This activity is anticipated to assist in the understanding and documentation of the high importance of geomorphology and topography of soils and its importance in the farmer's classification or grouping of soils of the project villages.

A follow up training workshop will be held in Gurue, Mozambique for personnel with IIAM, Instituto Medio Agropecúario de Gurue (IMAPEG), UniZambeze (the new University of Zambézia) to learn and survey local indigenous soil types and classifications that farmers use in their decision-making for bean production. The training will occur at IMAPEG and in two communities where our team is currently working. The objective is to expand and build on the baseline survey previously conducted in the Gurue region by combining indigenous farmer knowledge of soil classification and management with scientist knowledge of soil genesis, classification, and fertility.

Milestones

Oct. 2015 - Mar. 2016 and Apr. 2016 – Sept. 2016

5.1 - Students continue/complete graduate studies programs

5.2 - Short-term training of key technical staff

III. Contribution of Project to USAID Feed the Future Performance Indicators

(*Performance Indicators / Targets Spreadsheet for FY 2015, FY 2016, FY 2017* = attached)

IV. Outputs

Project activities are expected to produce the following outputs:

- Characterization of smallholder bean farmers' agricultural motivations, current knowledge and practices, problem diagnoses, and livelihood and risk management strategies (by end 2015)
- Models of farmer decision making strategies that reflect influences of social, cultural, economic, institutional and contextual factors are developed and refined (by 2016)
- Innovative diagnostic aids using observable characteristics that enable farmers to make site-specific management decisions are developed and validated (by 2016)
- Process for identifying alternative strategies and management practices for improving cropping system productivity and soil fertility is developed (by 2017)
- Effective and efficient methods and media for information dissemination to intermediate and end users are developed and assessed (by 2017)
- Capacity building through applied research-based training is conducted (2013 onwards)
- Research results published in peer-reviewed literature and at the Legume Innovation Lab website hosted by the Management Office at Michigan State University (2015 onwards)

The project's *Impact Pathway Worksheet* provides details of outputs, uses, and steps to achieving our vision of success.

V. Engagement of USAID Field Missions

We will continue to maintain and enhance communication with USAID Mission staff in Uganda and Mozambique. In 2015 in Mozambique, project PIs Russ Yost (University of Hawaii) and Ricardo Maria (IIAM) met with USAID staff members Karelyn Cruz (Agriculture Development Officer), Paula Pimentel (Agricultural Research & Technology Transfer Advisor), and Surendra Bhatta in Maputo on February 17, and Karelyn Cruz and Ryan Fong (GIS Specialist) on June 19. These meetings provided great opportunities to discuss project objectives and activities in the context of recent and current USAID programs in Mozambique. In Uganda, the project Lead PI has met regularly since 2004 with USAID Mission agricultural development staff, and will continue to do so during future travel there to communicate the focus and approach of project activities and explore bases for collaboration. On June 12, 2015, project researchers Rob Mazur, Eric Abbott, Andy Lenssen (all ISU), Moses Tenywa, Richard Miiro (both Makerere University), Onesmus Semalulu (NARL), and two MS students (Makerere University) met with USAID's Andrew McKim (Feed the Future Coordinator) and Simon Byabagambi (Agronomist/ Program Management Specialist) in Kampala. The PI and Co-PIs subsequently met with Martin Fowler (Agriculture and Livelihoods Advisor) and Robert Anyang (Deputy Chief of Party of the USAID Uganda Feed the Future 'Commodity Production and Marketing' project), as recommended. We are also following up on a meeting with William Luyinda (Program Manager) and Mary Arach of AKORION (ICT for Agriculture). Our very enthusiastic discussion with Mark Tamale, General Manager of Buddu Broadcasting Services in Masaka, established the basis for radio broadcasts in Masaka and Rakai concerning project research results and crop system recommendations. We will be pleased to respond when the Missions express interest in an Associate Award that would enable us to provide technical assistance and access to grain legume technologies.

VI. Partnering and Networking Activities

The project team is maintaining and strengthening research collaboration with CIAT scientists. Co-PI Andy Lenssen and Lance Goettsch have coordinated with Steve Beebe (Cali) and Clare Mukankusi (Kampala) on two studies. One involves the determination of biological nitrogen fixation of bean in the three management systems on red and black soils. A non-nodulating bean line (BAT 477) was planted in each of the four replicates, allowing the comparison of N acquired by symbiotic nitrogen fixation (SNF) and through uptake of N from soil. The results ^{15}N:^{14}N from bean leaf samples will allow the calculation of N_{fixed} to N_{soil}. Additionally, Goettsch and Beebe have a separate study on red soil comparing growth, development, and yield of a newly released germplasm from CIAT (ALB91) that is to soluble Aluminum in acid soils with NABE 4, the most preferred bean variety by smallholder farmers in Masaka.

Co-PI Ricardo Maria (IIAM) is following up with Rowland Chirwa (CIAT/PABRA) and Steve Boahen (IITA) to discuss research objectives and activities, and identify potential bases for collaboration. We continue to learn about relevant existing and emerging conservation agriculture approaches and technologies (e.g., how upland farming practices can be improved for reducing erosion and quality of lowlands where rice and bean are grown). We will continue to network with PABRA, the AGRA Soil Health Program and CABI (Ricardo Maria is involved with both programs), McKnight Foundation which has programs with an integrated multi-functional intensification emphasis, Africa RISING which focuses on maize-legume based systems in the Eastern Highland of Africa, the Bill and Melinda Gates Foundation (where PI Rob Mazur met with program officers in February), and IFDC. Project researchers will continue to build collaborative relationships with two African based networks under PABRA (the Pan-African Bean Research Alliance): the Eastern and Central Africa Bean Research Network (ECABREN) and the Southern Africa Bean Research Network (SABRN). The project team, particularly

collaborating research institutions in Uganda and Mozambique, will identify partnering and networking activities to ensure that appropriate public and private sector institutions can engage in follow-up adaptive research and field validation, in addition to technology transfer, in FTF countries and regions so that research outputs are disseminated on a wide scale for quantifiable developmental impact.

VII. Leveraged Resources

The project team will continue to explore opportunities to collaborate and coordinate research efforts with CGIAR scientists, the AGRA Soil Health Program, McKnight Foundation, Africa RISING, the Bill and Melinda Gates Foundation, and IFDC. We will identify how such opportunities would complement and coordinate with planned activities described in this Workplan of the Legume Innovation Lab project.

VIII. Timeline for Achievement of Milestones of Technical Progress

(*Milestones of Progress* = attached)

Appendix 1: Workplan for Training/Capacity Strengthening - FY 2016

Degree Training

Trainee #1
First and Other Given Names: Naboth
Last Name: Bwambale
Citizenship: Uganda
Gender: Male
Training Institution: Iowa State University
Supervising Legume Innovation Lab PI: Robert Mazur
Degree Program for training: M.S.
Program Areas or Discipline: Graduate Program in Sustainable Agriculture *and* Sociology
If enrolled at a US university, will Trainee be a 'Participant Trainee' as defined by USAID? Yes
Host Country Institution to Benefit from Training: Makerere University
Thesis Title/Research Area: Farmers' Perceptions, Knowledge and Socioeconomic Factors Influencing Decision Making for Integrated Soil Fertility Management
Start Date: August 2013
Projected Completion Date: December 2015
Training status: (active, completed, pending, discontinued or delayed): Active
Type of USG Support (full, partial or indirect) for training activity: Full

Trainee #2
First and Other Given Names: Lance
Last Name: Goettsch
Citizenship: United States
Gender: Male
Training institution: Iowa State University
Supervising Legume Innovation Lab PI: Andrew Lenssen
Degree Program for training: M.S.
Program Areas or Discipline: Agronomy

Host Country Institution to Benefit from Training: Makerere University
If enrolled at a US university, will Trainee be a 'Participant Trainee' as defined by USAID? No
Thesis Title/Research Area: Practical Methods to Alleviate Constraints Limiting Common Bean Production in Masaka, Uganda
Start Date: August 2013
Projected Completion Date: May 2016
Training status: (active, completed, pending, discontinued or delayed): Active
Type of USG Support (full, partial or indirect): Partial

Trainee #3
First and Other Given Names: Prossy
Last Name: Kyomuhendo
Citizenship: Uganda
Gender: Female
Training institution: Makerere University
Supervising Legume Innovation Lab PI: Moses Tenywa
Degree Program for training: M.S.
Program Areas or Discipline: Soil Science and Crop Production
If enrolled at a US university, will Trainee be a 'Participant Trainee' as defined by USAID?
Host Country Institution to Benefit from Training: Makerere University
Thesis Title/Research Area: Limiting Nutrients and Lime Requirements for Bean Production
Start Date: January 2014
Projected Completion Date: August 2016
Training status: (active, completed, pending, discontinued or delayed): Active
Type of USG Support (full, partial or indirect) for training activity: Partial

Trainee #4
First and Other Given Names: Sostino
Last Name: Mocumbe
Citizenship: Mozambique
Gender: Male
Training institution: Iowa State University
Supervising Legume Innovation Lab PI: Eric Abbott
Degree Program for training: M.S.
Program Areas or Discipline: Communications
If enrolled at a US university, will Trainee be a 'Participant Trainee' as defined by USAID? Yes
Host Country Institution to Benefit from Training: Institute of Agricultural Research of Mozambique (IIAM)
Thesis Title/Research Area: Socio-technical Approaches for Dissemination of Information and Decision Support Aids
Start Date: July 2014
Projected Completion Date: December 2016
Training status: (active, completed, pending, discontinued or delayed): Delayed
Type of USG Support (full, partial or indirect): Full

Trainee #5
First and Other Given Names: Jafali
Last Name: Matege
Citizenship: Uganda
Gender: Male
University to provide training: Makerere University
Supervising Legume Innovation Lab PI: Richard Miiro

Degree Program for training: M.S.
Program Areas or Discipline: Agricultural Extension Education
If enrolled at a US university, will Trainee be a 'Participant Trainee' as defined by USAID?
Host Country Institution to Benefit from Training: Makerere University
Thesis Title/Research Area: Gender Dimensions of Bean Farmers' Decision Making for Soil Fertility Management in Masaka and Rakai Districts, Uganda
Start Date: July 2014
Projected Completion Date: August 2016
Training status: (active, completed, pending, discontinued or delayed): Active
Type of USG Support (full, partial or indirect): Partial

Trainee #6
First and Other Given Names: Stewart
Last Name: Kyebogola
Citizenship: Uganda
Gender: Male
Training institution: Makerere University
Supervising Legume Innovation Lab PI: Onesimus Semalulu
Degree Program for training: M.S.
Program Areas or Discipline: Soil Science and Crop Production
If enrolled at a US university, will Trainee be a 'Participant Trainee' as defined by USAID?
Host Country Institution to Benefit from Training: National Agricultural Research Laboratories
Thesis Title/Research Area: Effect of integrating organic with inorganic fertilizers on bean yield on three contrasting soils of Masaka district
Start Date: July 2014
Projected Completion Date: August 2017
Training status: (active, completed, pending, discontinued or delayed): Active
Type of USG Support (full, partial or indirect): Partial

Trainee #7
First and Other Given Names: António José
Last Name: Rocha
Citizenship: Mozambique
Gender: Male
Training institution: University of Hawaii - Manoa
Supervising Legume Innovation Lab PI: Russell Yost
Degree Program for training: Ph.D.
Program Areas or Discipline: Agronomy and Tropical Soils
If enrolled at a US university, will Trainee be a 'Participant Trainee' as defined by USAID? Yes
Host Country Institution to Benefit from Training: Institute of Agricultural Research of Mozambique (IIAM)
Thesis Title/Research Area: Alternative Management Practices for Improving Bean Production
Start Date: August 2014
Projected Completion Date: September 2017
Training status: (active, completed, pending, discontinued or delayed): Pending
Type of USG Support (full, partial or indirect) for training activity: Full

Short-term Training:
Type of training: Short-term field based.
Description of training activity: Field soil characterization
Location: Masaka and Rakai Districts

Duration: 3 days
When will it occur? September 2015, February 2016
Participants/Beneficiaries of Training Activity: Soil technicians from Makerere University and from National Agricultural Research Laboratories, MS students, district extension workers and some lead farmers
Anticipated numbers of Beneficiaries (male and female): 10 males, 10 females
PI/Collaborator responsible for this training activity: Professor M. Tenywa and Dr. O. Semalulu
List other funding sources that will be sought (if any):
Training justification: We need to create a community of practice on soil characterization and analysis closer to the farmers.

Type of training: Short-term
Description of training activity: understanding the indigenous soil classification system in a catenary concept
Location: Masaka
Duration: 3 dates
When will it occur? September 2015
Participants/Beneficiaries of Training Activity: Technicians, students and farmers
Anticipated numbers of Beneficiaries (male and female): 10 males, 10 females
PI/Collaborator responsible for this training activity: Prof. M. Tenywa and Dr. O. Semalulu
List other funding sources that will be sought (if any)
Training justification: Farmers describe their soils using the indigenous soil classification system. Early scientific soil classification was based on the catenary concept and more recently, the USDA and FAO World's Soil Reference systems which combine field observations with laboratory analytical data. There is need to develop a system that combines the farmer indigenous with the scientific systems to make better use of both systems at farm level.

Type of training: Short-term
Description of training activity: learn and survey local indigenous soil types and classifications that farmers use in their decision-making for bean production
Location: Gurue
Duration: on a recurrent basis, with field research in October 2015
When will it occur? On a recurrent basis (backstopping and other resources via internet)
Participants/Beneficiaries of Training Activity: staff from government research institutes (IIAM, IMAPEG, UniZambezi and Ministry of Science and Technology)
Anticipated numbers of Beneficiaries (male and female): 24 male, 6 female
PI/Collaborator responsible for this training activity: Ricardo Maria
List other funding sources that will be sought (if any):
Training justification: expand and build on the baseline survey previously conducted in the Gurue region by combining indigenous farmer knowledge of soil classification and management with scientist knowledge of soil genesis, classification, and fertility.

Equipment (costing >$5,000)**:**
Specific Type of Equipment to be purchased:
Justification for equipment to achieve Workplan objectives:
Institution to benefit from equipment:
Institution to purchase equipment:
Amount budgeted for equipment item: