LEGUME INNOVATION LAB FOR COLLABORATIVE RESEARCH ON GRAIN LEGUMES

FY 2015 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 or very uneven extension systems and rural social and economic institutions, limiting widespread access to improved crop technologies, quality inputs and credit. This research project is based on two premises: (1) sustainable intensification of agriculture 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, as well as helping to remove barriers to increased access to various types of soil amendments.

Project research activities are taking place in key common bean production regions in these countries – in Masaka and Rakai districts in south-central Uganda and in Gurué district (Zambézia province) in northern Mozambique. To understand potentially limiting soil nutrients, the team has analyzed the 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. The results of these analyses guided greenhouse 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. Complementing the NOS is the lime requirement study (addressing low pH, Ca and Mg availability, and Al toxicity) which is expected to demonstrate a consistent requirement for pH amelioration for adequate bean root growth on specific soils. Consequently, researcher-managed field trials in the study communities initiated in the second season in 2014 in Uganda and the main (rainy) 2014-2015 season (Oct. – Apr.) and second (dry) season (May – Sept.) in Mozambique are expected to demonstrate the soil-specific nutrient and crop management practices that are necessary to increase bean crop productivity in farmer fields.

The research team has established a base understanding of smallholder farmers' practices of field selection and preparation, crop and variety selection, planting methods and spacing, use of various types of inputs, intercropping and rotation patterns, gender-based division of labor, problem identification and management practices, market sales and storage practices in several communities in Uganda (Mukungwe and Kabonera sub-counties in Masaka District) and (Lwankoni sub-county in Rakai District), and Mozambique (Tetete, Mepuaguía, Ruace and Lioma administrative posts in Gurué District).

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 management practices and technologies (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 MPT.

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

II. Project Activities for the Workplan Period (October 1, 2014 – September 30, 2015)

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

Approaches and Methods

Our initial discussions and interviews with productive and innovative farmers and soil surveys revealed that smallholder farmers recognize the role of a variety of soil-related characteristics that impact bean yield in their production systems: soil color (black soils are generally more suitable for beans than red soils), particle size, soil texture, topsoil depth, rocks, slope, water holding capacity, plant vigor, previous yield results, weeds, etc. In community focus group discussions, they identified factors and ranked the relative importance of each. Farmers identified fields with the predominant soils characteristics for extraction of samples for analysis, and for participation in development and testing of diagnostic aids, presented under Objective 3. In south-central Uganda, these are referred to as Liddugavu (black), Luyinjayinja (black, stony), Limyufumyufu (red); in northern Mozambique, they are called Intethe (black), Cotxoca/Ikochokwa (red), Makande/Etchirokwe (paddy), Ehava (sandy). A significant range of soil types often exists within a given community, and indeed often on specific farms – providing both challenges and opportunities.

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, planting methods and spacing, use of various types of inputs, intercropping and rotation patterns, problem identification and management practices utilized by farmers to date. It guides the research team in its observations and learning how farmers use existing knowledge to help determine crop system needs and to improve conditions. 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. Current MPT that farmers highlighted include:

- Purchase of good quality seeds, where and when available
- Changing the location for planting specific bean varieties, sometimes from season to season
- Minimum tillage – with and without use of herbicides to manage weeds
- Timing of planting - ranging from early to late, depending on rains, pests, market opportunities
- Planting patterns and spacing - some in rows, others broadcast
- Intercropping, with an array of different partner crops and precise timing of bean planting
- High plant density (makes weeding difficult and high risk of rapid pest or disease propagation)
- Crop Rotation – various patterns
- Chemical Fertilizers (relatively uncommon, limited by availability but also price)
- Foliar sprays (purported to be fertilizers, often lacking nutrient value)
- Pesticides (commonly used in Masaka, rarely available and used in Gurué)
- Weeding, from one to three times per season
- Incorporating (burying) crop residues in soil, rather than burning
- Mounding ridges where beans and other crops are planted
- Farmyard manure (very rare, given low density of livestock)
- Mulching – various materials and methods
- Fallowing (very rare, given perceived 'shortage' of land)

Based on information obtained and analyzed to date, women and men often differ in terms of the priority for growing beans, constraints identified, trust in information sources, resource accessibility, decision making roles regarding various aspects of bean production, and solution strategies adopted.

We met with key staff of a non-governmental development organization that focuses on production of certified bean seed. In Uganda's Rakai district, adjacent to Masaka district, Community Enterprises Development Organization (CEDO) works with 80 farmers groups in five adjacent districts, including Masaka. CEDO has been active in Lwankoni sub-county in Rakai since 2005, and almost all farmers interviewed reported getting their bean seed through CEDO. CEDO may be an important source of high quality bean seed for project farmers as our research, demonstrations and dissemination progress.

Obj. 1a. Continue collection of primary data in research communities (lead researchers: M. Tenywa, O. Semalulu, R. Maria)

1a.1. Monitor field experiments with selected farmers in Masaka/Rakai (two rainy seasons) and Gurué (rainy and dry seasons) (also: R. Yost, A. Lenssen)

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

Milestones

Oct. 2014 – Mar. 2015

1.1 - Reports on farmers' participation in field experiments

Apr. 2015 – Sept. 2015

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

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

Collaborators:

Jalia Namakula, GIS specialist, NARL, Uganda

Venâncio Salegua - Institute of Agriculture Research of Mozambique

Approaches and Methods

Participatory Rural Appraisal (PRA) activities (semi-structured key informant interviews, focus group discussions, and situation analysis) initiated the community level research process for understanding smallholder farmers' current knowledge, practices, motivations, experiences and conditions in Uganda and Mozambique. Building on the information obtained through the PRAs, the baseline household survey of practices and conditions is providing a detailed community-wide profile of farmers' sources and uses of information about bean crop and soil fertility management, problem diagnoses and solutions adopted, flows of key resources (information, production materials, labor, food, money, etc.), consumption, market sales, decision making practices and risk management strategies. Contextual factors analyzed include availability, accessibility and affordability of key resources (natural, physical, financial); and value chain development (input and output markets). Baseline data serve as the reference point for monitoring changes in knowledge, attitudes, practices and conditions over time.

Key social, cultural, economic, institutional and contextual factors which shape farmers' decision making – individually and collectively - that are being analyzed include: gender and other roles (who makes or negotiates which types of decisions, alone or with others); goals and priorities; criteria (factors considered and the relative importance of each); information base (nature, sources and credibility); resources required (and the social relationships and economic costs of accessing each); resource constraints (material, labor, financial, etc.); risk assessment/tolerance; decision processes (timing, stages, sequencing); evaluation of experiences; and adjustments over time (responding to changes in both internal and external factors); group and network size and strength; collective action for enhancing access to vital resources; and progress toward livelihood goals. Institutional factors include culturally defined roles, community-based organizations, governance, and socioeconomic status (wealth, gender, ethnicity). These factors may influence current knowledge, attitudes, practices, and subsequently processes of information dissemination, training, utilization, and support to stimulate and sustain widespread implementation. Important outcomes from characterizing farmer decision-making processes in part comes from gaining insight into which households are more prone or able to make fundamental changes and why.

Acreages for all crops combined average 2-8 acres in Uganda and some communities in Mozambique, but also with significant variation (some farmers use 10-25 acres). Beans fields range from 0.25 acres to 5 acres or more. Many farmers in both countries cite 'shortage of land' as a constraint. Ugandan farmers have several months between two rainy seasons, while in Mozambique cultivation of beans and other crops in the dry season almost immediately follows harvest of crops grown during the rainy season.

The support system for cash crops differs significantly between Uganda and Mozambique, as well as among communities. Support involves training, provision of seed and other inputs, and marketing; overall, such support is more directly available in Mozambique, provided by private sector foreign investors, NGOs and international research organizations. In Mozambique, an array of cash crops have been introduced or efforts intensified in the past decade - soybean, pigeon pea, sunflower, pineapple, cotton, tobacco; in contrast, common bean production and sales appear to be almost exclusively driven by domestic market actors. If/when the support is reduced or eliminated, or the market prices declines significantly, common bean production is more lucrative. In Uganda, the two major cash crops are currently affected by disease - banana bacterial wilt and coffee rust; pineapple production is also

widespread. Storage after harvest is rare in both countries, because of income needs at (or before) harvest time and farmers' inability to store bean grain and seed safely; in Uganda, farmers try to avoid bruchid damage by using strong chemicals (unsafe for human consumption), while most farmers in Mozambique use nothing.

To date, we have learned that 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. In Mozambique, farmers groups (associations) are relatively common, being the principal mechanism to access training and other support. A forum is comprised of several associations, and several forums constitute the apex organization, a federation; 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.

Obj. 2a. Characterize access to resources required for bean production (lead researchers: H. Sseguya, C. Sumila)

2a.1. Continue analysis of household survey data to describe resource base variation, characterize how access to key resources is obtained and negotiated, and describe the economic costs involved (also: E. Luvaga, R. Mazur)

2a.2. Continue analysis of household survey data to explain resource constraints (also: E. Luvaga, R. Mazur)

Milestones

Oct. 2014 - Mar. 2015

2.1 – Reports on: resource base, access, costs, resource constraints

Apr. 2015 – Sept. 2015

2.2 - Reports on implications for modeling decision making behavior

Obj. 2b. Characterize farmers' livelihood goals, resources, strategies and success through analysis of household survey data (lead researchers: R. Mazur, E. Luvaga, H. Sseguya, C. Sumila)

2b.1. Continue analysis of farmers' livelihood values, goals, and priorities

2b.2. Continue analysis of social networks, benefits derived, and risk management arrangements

2b.3. Continue analysis of sources, levels, and consistency of household income

2b.4. Continue analysis of variations in household food security

Milestones

Oct. 2014 - Mar. 2015

2.3 - Reports on farmers' livelihood goals, resources, strategies and success

Apr. 2015 – Sept. 2015

2.4 - Reports on implications for modeling decision making behavior

Obj. 2c. Assess influence of institutional factors (lead researchers: M. Tenywa, O. Semalulu, R. Maria)

2c.1. Identify farmer- and other community-based organizations (also: H. Sseguya, C. Sumila)

2c.2. Identify nature of extension services (public and private)

Milestones

Oct. 2014 - Mar. 2015

2.5 - Analysis of local organizations and extension services

Apr. 2015 – Sept. 2015

2.6 - Recommendations for training and support of 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 tools will be developed with and for farmers who have varying levels of education, based upon field-observable soil classification characteristics in diverse agroecologies in two target bean production regions in Uganda and Mozambique. Utilizing farmer experience and input from soil scientists and crop systems agronomists, we will draw from the global knowledge base of appropriate practices and technologies, soil and cropping systems management strategies and options appropriate for various smallholder farm systems.

Shortened fallow periods, lack of fertilizer inputs, reduced soil organic matter concentration, and erosion from water have been purported to result 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 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. Additionally, Al^{+3} levels were significant, further constraining potential root growth for water and nutrient extraction. Results for the Luyinjayinja (black, stony) soil samples were more similar to those of Limyufumyufu than for Liddugavu soils, with low pH and concentrations of available nutrients. Additionally, these soils typically had a zone of higher clay concentration that likely limits hydraulic conductivity and root growth into subsoil. Results from our January 2014 soil survey in Uganda documented that numerous specific soil sites had good soil quality yet farmers still experienced low and unsatisfactory bean yields. Analysis of soil samples recently obtained from farmers in Gurué will yield similarly useful results and provide insights regarding nutrient limitations in bean productivity.

The subsequent monitoring of bean growth, development, and pests in Uganda provided strong evidence that other factors in addition to soil fertility strongly impact bean yield. These factors included low plant density, seeding of older cultivars with low levels of host plant resistance to important pathogens, and early and sustained onset of foliar diseases. Exactly which soil nutrients are inadequate for bean production has not been systematically addressed across a range of important soils; however, nutrient omission studies are currently ongoing in Uganda. Lime requirements for pH management are not yet known. Available aluminum (Al^{+3}) has not been determined for extensive areas. Where data are available, available P concentration usually is low in older, weathered soils typical of Uganda and Mozambique and other areas within SSA. The high concentrations of available Fe and Al in low pH soils rapidly complex available P, making it unavailable for uptake by plants, perhaps explaining in part why phosphorus fertilization does not always improve yield or N fixation by bean and other pulses.

The nutrient omission studies will provide new information on the relative importance of nine nutrients for bean growth and development on Liddugavu, Limyufumyufu, and Luyinjayinja soils from Uganda. Results will be used in designing several potential treatment strategies that are practical for smallholder farmers. Additionally, previously untested solution strategies can be tested on researcher-managed sites to determine validity of identified management practices and technologies (MPT). Diagnostic aid development is in part based on results from the nutrient omission studies. A key element

in diagnostic aid development is the inclusion of farmers' input during all developmental phases, not just during testing.

Diagnostic criteria provide implicit comparisons of 'what if' scenarios. Highly observable characteristics are 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 anticipate that our criteria will rely in part on comparisons of plant growth and development, dry matter accumulation, and color of bean plants grown in the representative soils under different nutrient or management levels. Photographs taken during the course of the nutrient omission studies will comprise an important component that allow farmers to quickly note important differences between or among important management practices. Initially, images will be available from the nutrient omission and lime requirement studies, but in subsequent years, images will be available from productive and innovative farmer fields where the criteria were used, providing direct comparison of bean growth, development, and yield between management systems used. Additionally, comparisons can be done between productive and 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 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 document nutrient limitations on farmers' fields and attempt to address the most critical limiting soil nutrients. Given inherent precipitation, soils, and other differences between Masaka district (beans are planted in both rainy seasons) and Gurué district (beans are planted in the 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, and final key soil chemical and physical properties. Initial properties determined typically will be those documented in the nutrient omission study in impact bean growth and development. Bean stand density, yield, yield components (pods/m^2, seed/pod, seed weight), seed protein and germination percentage are determined in fields under both management systems and for the non-selected farmer control group. Additionally, timing and intensity of foliar disease development are assessed, providing relevant results for deployment of newer, more disease resistant varieties as a potentially viable 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 soil fertility and other bean production constraints (lead researchers: M. Tenywa, O. Semalulu, R. Maria, M. Amane, R. Yost, A. Lenssen)

3a.1. Conduct field studies comparing bean management systems and soil fertility

3a.2. Compare bean varietal responses to crop management systems and soil fertility

Milestones

Oct. 2014 – Mar. 2015 and Apr. 2015 – Sept. 2015

3.1 - Conduct field studies on crop management, soil fertility and bean varieties

3.2 - Analyze soil samples after cropping season

Obj. 3b. Develop Diagnostic Methods and Aids (lead researchers: M. Tenywa, O. Semalulu, R. Maria, M. Amane, R. Yost, A. Lenssen)

3b.1. Identify relevant diagnostic criteria and methods by and for farmers

3b.2. Initiate application of diagnostic criteria and methods by project farmers

Milestones

Oct. 2014 - Mar. 2015

3.3 - Identify relevant diagnostic criteria and methods by and for farmers

Apr. 2015 – Sept. 2015

3.4 - Initiate application of diagnostic criteria and methods by project farmers

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, Gurué District Agricultural Extension Officer, Mozambique
Venâncio Salegua - Institute of Agriculture Research of Mozambique

Approaches and Methods

To realize our goals, we will work with existing institutions and organizations to identify and develop messages that can provide farmers with 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' perspectives revealed some strengths and weaknesses of current information providers and existing agricultural information dissemination systems in Uganda and Mozambique. Current and valued sources include extension services, training workshops, exchange visits, field days, media (community and national radio, TV, newspapers), phones, traders, and input dealers. The perceived accuracy and value of each type of sources varies among study communities.

Some information received through training sessions seems to conflict with information previously disseminated; in addition, some information broadcast on the radio by private sector businesses is viewed as misleading or inaccurate. We have developed an initial list of available and potential information channels and associated organizations. Discussions with providers will enable us to assess their capacity and willingness to develop and deliver messages concerning beans and soil fertility.

The project will engage the core groups of farmers, women and men, in developing and testing innovative communications approaches and technologies for learning and sharing information about new options for sustainable improvement in increased yields and soil fertility. Given limited extension system resources in Uganda and Mozambique, local peer-to-peer dissemination and learning (field days, exchange visits, local community based organizations, farmer associations) will be important methods. To benefit those with low literacy skills – especially women, communication approaches and technologies that may be used include: a variety of visual aids (print materials and animated videos - Scientific Animations Without Borders), and radio campaigns in local languages will be used. Working through project staff and extension, we will provide training to Community Knowledge Workers who can function as intermediaries between extension/NGO communication systems and farmer groups or associations for effectively disseminating agricultural information using participatory methods.

In order to initiate the process of working with local information providers and dissemination systems, we will utilize existing training materials regarding anaerobic bean grain and seed storage using jerry cans and the triple bag system that were developed during the previous Pulses CRSP project in Uganda's Kamuli District. This will enable us to test the information system and providers so that subsequent messages regarding crop and soil management practices and technologies can be launched effectively and efficiently. We will identify the specific type of weevils present in stored grain. The Masaka District Agricultural Officer is currently using those materials to learn about and evaluate the effectiveness of these anaerobic storage methods during a three month period. If successful, a second trial will take place following the second season harvest in late 2014. This will involve participating farmers and local agricultural officials. Training materials will be refined, pre-tested and distributed for this trial on a controlled basis to a sample of farmers. Results will be evaluated by the end of March 2015. In addition, pricing fluctuation data for beans in the local market will be monitored. It is expected that prices are very low at the time of harvest, when most farmers sell, and much higher later. We did note that in Gurué beans produced during the dry season are generally of higher quality and obtain higher prices.

If successful, a full-scale trial would be scheduled following the first season of 2015 (June and July 2015) including participating farmers plus all target farmers in the area. Target farmers are those who produce enough beans and could save them for at least three months before marketing. Extensive publicity would be given to this trial, including radio, extension, and local NGOs plus farmer groups. The messages would be targeted at those who can store beans for at least three months to benefit from increases in market prices later. Data would be collected on: (1) knowledge of the jerry can and triple bagging techniques prior to the experiment (carried out as part of the baseline survey); it is expected that knowledge levels and use would both be very low at this time; (2) knowledge of the jerry can and triple bagging techniques following the publicity campaign, and stated intent to use the techniques after the next two growing seasons; (3) economic analysis of bean price trends over the period to test whether or not bean prices increase as expected in months after the harvest; (4) effectiveness of the jerry can and triple bagging techniques, as measured by the extent of weevil damage to treated jerry cans or a control sample that is stored in the traditional way; and (5) the final project survey would also assess adoption and use of the technique. The assessments would track channel and message effectiveness, and would be used as input for other dissemination activities developed later after soil tests and on-farm trials have been completed.

Following soil nutrient and crop analysis and community communication assessment, we will work with project staff and extension to develop an initial message that can test the communication system with a small number of farmer groups/associations. We will then evaluate the effectiveness of the dissemination system and provide additional training and/or revise methods to prepare for subsequent participatory dissemination activities.

Dissemination, training and support will target priority decision-making points for individuals and groups. Horizontal farmer-to-farmer learning has been found to be preferred by many communities. 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. Test Existing Information Dissemination Systems (lead researchers: E. Abbott, J. Bello-Bravo, B. Pittendrigh, H. Sseguya, C. Sumila)

4a.1. Develop prototype message/media

4a.2. Field test prototype message/media

Milestones

Oct. 2014 - Mar. 2015

4.1 - Develop prototype message/media

Apr. 2015 – Sept. 2015

4.2 - Test prototype message/media

Obj. 4b. Identify and Develop Messages for Decision Making about Bean Production and Soil Fertility, Based on Farmer Identified Management Practices and Technologies (lead researchers: E. Abbott, J. Bello-Bravo, B. Pittendrigh, H. Sseguya, C. Sumila)

4b.1. Identify priority issues

4b.2. Develop messages/media

Milestones

Apr. 2015 – Sept. 2015

4.3 - Identify priority issues

4.4 - Develop first message/media

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 will be training three 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 will study Communication at Iowa State University and conduct research on innovative socio-technical approaches for dissemination of information and decision support aids

- one Ph.D. student from Mozambique will study soils/crops at the University of Hawaii and conduct research on alternative management practices for improving bean production

One M.S. student studying Agronomy at Iowa State University will conduct 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 will test the management strategies developed from Objectives 1, 2, and 3 in replicated, researcher-managed studies, complementing the farmer assisted research.

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

- one student will study soils/crops and conduct research on limiting nutrients and lime requirements for bean production
- one student will study extension and innovation at Makerere University and conduct research on gender dimensions of bean farmers' decision making for soil fertility management in Masaka and Rakai Districts, Uganda
- one student will study soils/crops at Makerere University and conduct research on evaluation of soil fertility management options for beans in Masaka, Uganda

Each country has one research technician who is gaining experience in multidisciplinary research activities and specific skills in preparing and analyzing soil and crop samples. Additionally, short-term training needs are identified as research activities continue. Training of agricultural technicians in methods of acquiring, verifying, and recording information is especially important in Mozambique.

Milestones

Oct. 2014 - Mar. 2015 and Apr. 2015 – Sept. 2015

5.1 - Students continue 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 and 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 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

In Mozambique, project PIs from U.S. and Ugandan universities and from IIAM met with the USAID Mission Director and Feed the Future staff on May 29, 2013 in Maputo. This provided a tremendous opportunity for sharing information about USAID programs in Mozambique and the Legume Innovation Lab program. In-depth discussion of our project and the expertise of research team members revealed several key points of significant interest for Mission staff. These included soil test kits, animated videos about management practices, and use of agricultural technologies. 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. Project researchers met with key staff in the Mission in Kampala on June 6, 2014. The PI and Co-PIs will establish ties with Mission development partners, as recommended. 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 continues to learn about relevant existing and emerging conservation agriculture approaches and technologies (e.g., how upland farming practices in Gurué can be improved for reducing erosion and quality of low land where rice and bean are grown), and explore opportunities to collaborate and coordinate research efforts with CIAT scientists (Steve Beebe, Cali; Clare Mukankusi, Kampala; and others currently being contacted in the PABRA network), 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 (with which Haroon Sseguya and Robert Mazur are in discussions), Africa RISING which focuses on maize-legume based systems in the Eastern Highland of Africa, the Bill and Melinda Gates Foundation, 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 2015

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: August 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: Haroon Sseguya
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: Evaluation of Soil Fertility Management Options for Beans in Masaka
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
Description of training activity
Location
Duration
When will it occur?
Participants/Beneficiaries of Training Activity
Anticipated numbers of Beneficiaries (male and female)
PI/Collaborator responsible for this training activity
List other funding sources that will be sought (if any)
Training justification

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: