Enhancing Nutritional Value and Marketability of Beans through Research and Strengthening Key Value Chain Stakeholders in Uganda and Rwanda

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Abstract of Research Achievements and Impacts
Significant progress in addressing research and development objectives has been made by the project team. Activities to improve bean yields and quality (first objective) involve refresher trainings on improved management practices for production, harvesting, drying, and sorting; experiments with hermetic storage; a farmer led field day to demonstrate and explain practices and technologies; and sharing knowledge gained with other farmers. Field experiment data for three cropping seasons have been quantified and analyzed in relation to seed variety and methods and techniques of soil fertility enhancement (manure and phosphorus). This includes assessing some new early maturing (60-65 days), drought tolerant and anthracnose resistant NaCRRI bean lines. Extension training materials have been updated to reflect research results. Experiments at ISU focused on physiological bases for accretion and partitioning of iron and zinc in bean seed, and drought tolerance. We increased seed quantities at ISU for processing and nutritional studies.

Regarding the second objective, enhancing the nutritional value and appeal of beans through appropriate handling and processing, there are several important research accomplishments. We analyzed effects of soaking, malting and steaming on protein and starch digestibility, and polyphenol and phytate content. Optimizing the bean flour processing protocol for production of porridges and sauces was followed by sensory evaluation for consumer acceptance. Optimization involves Nutreal, a private company collaboration with Makerere University's Technology Business Incubation Centre which provides technical support to refine, brand and market bean-based composite flour. Given the focus in Rwanda on processing methods designed for application in rural communities, research focused on development and organoleptic evaluation of composite flour for cold extruded snacks. Extrusion demonstrated in two rural communities was enthusiastically received. Additional experiments on processed bean flour examined oil absorption, wettability, emulsion capacity, and foaming capacity – characteristics useful in community-based and commercial applications. In Uganda's Kamuli district, recipe competition and the 'bean cook day' identified popular new methods of bean preparation that can promote increased consumption. A rapid market survey of diverse market channels in Kampala focused on nutrient enhanced flours for porridges, weaning foods, supplementary feeding for children, ready-to-eat snacks and foods, and bread. This identified market opportunities for bean products.

Collaborative work to increase marketing and consumption of beans and bean products (third objective) involved weekly updating of public market price boards in all VEDCO operation areas in Kamuli and disseminating market prices for crops via cell phone messages. VEDCO organized the first value chain stakeholder workshop in Kamuli that identified marketing constraints in the bean value chain and strategies for collaboration to overcome them.

Project Problem Statement and Justification

Agriculture in East Africa is characterized by women and men working in small scale, rainfed production, averaging 2 hectares per household. Erratic bimodal rainfall patterns in recent years further challenge cropping results. Farmers have limited access to extension, training for improved agronomic practices, inputs, new technologies, and credit. Producers are not well linked with profitable markets, especially to emerging sectors of domestic and regional markets. Private traders operate on a small scale with limited investment capability. Availability and use of processed products at present remain very modest. As a result of low production levels, hunger is widespread and the vast majority of the rural population lives in absolute poverty.

Our recent efforts to introduce new agronomic practices and technologies demonstrate encouraging progress. Ongoing collaboration since 2004 of Iowa State University (ISU), Makerere University (MAK), and Volunteer Efforts for Development Concerns (VEDCO) in Uganda's Kamuli District using a sustainable livelihoods approach increased food security and market readiness from 9% to 77% among 800+ farm households. The main crops are maize, beans, sweet potatoes, cassava, bananas, rice and coffee. Most (90%) of participating households produce beans, but few (20%) sell some. The SL approach focuses on understanding and supporting individual and community capabilities, assets (natural, physical, human, financial, social, cultural and political capital), goals, strategies and activities. Diversification of livelihood opportunities and activities is crucial to sustainability. In combination with SL approaches, scientific knowledge, improved technologies, financial assistance, and changes in government policies can have significant positive local impacts. Participatory research methods can generate knowledge that people can apply to improve their individual and collective well-being.

Beans provide a strategic opportunity to help meet the Millennium Development Goal targets of reducing hunger and poverty. Improved beans production in Uganda and Rwanda offers unique opportunities to address the deteriorating food security situation there and elsewhere in sub-Saharan Africa. The short growth period and two growing seasons offer great opportunities to contribute to rural poverty alleviation - playing an essential role in sustainable livelihoods of small scale farmers and their families, providing food security and income to the most vulnerable group, the women and children. Testing whether yield improving technologies result in beans with better nutritive value (Objective 1) or processing characteristics (Objective 2) is an important under-researched issue in this region. Improved linkages to emerging markets are also essential (Objective 3).

Central problems limiting production of quality beans and higher yields

- Declining soil fertility and inefficient cropping systems unable to utilize available resources effectively and efficiently

- Limited accessibility and affordability of quality seeds, non-seed inputs and other yield improving technologies
- Effects of drought and other weather related factors compromise productivity and quality
- Diseases (root rot, anthracnose, angular leaf spot, common bacterial blight, viruses, rust, ascochyta blight) and insect pests (bean stem maggots, aphids, bruchids)

Central problems relating to nutritional value and processing of beans

Pre- and post-harvest losses for beans are very high throughout the value chain, mostly due to poor harvest and post-harvest practices and poor on-farm storage facilities. Poor pre- and post-harvest handling also results in the majority of beans on the market being characterized by mixed varieties and poor quality with high levels of foreign matter, rotten or shriveled beans, and infestation. The lack of value-added bean products having reduced preparation times makes bean preparation laborious with high fuel requirements; consumers also tire of monotonous flavor, which may be improved by processing and creation of value-added bean-based food products. As a result, an increasing number of people are abandoning or reducing their bean consumption despite its documented high nutrient content and health benefits.

The nutritional value of beans may be affected by phytates, trypsin inhibitors, polyphenols, lectins, saponins, oligosaccharides and hemaglutinins. Phytates and polyphenols limit iron uptake, and optimizing bean processing to improve iron bioavailability is a key need. Treatments such as de-hulling, soaking, milling, fermentation and germination (malting) and cooking enhance the digestibility and nutritional value by lessening some of the above constituents, but optimizing bean processing for nutritional value is needed.

Central problems inhibiting increased marketing of beans and derived food products

Prospects of marketing increased quantities of beans and new agro-processed bean products within the Ugandan and regional markets require carefully examining production and marketing constraints (increased farm productivity, producer incentives, and access to better markets). Equally important is examining prospects for increasing demand for beans and agro-processed products (understanding consumers' tastes and preferences, increased consumer awareness of benefits of consuming beans and other value-added products, increasing consumer choices of value-added products, etc.).

Planned Project Activities for April 1, 2009 - September 30, 2010

<u>Objective 1</u>: To Improve Harvested Bean Quality and Yields

Approaches and Methods:

Obj. 1a. Determine and Prioritize Key Production Constraints of Six Priority Bean Varieties

Quantify the effects of abiotic stresses on physiology and yield formation of priority bean varieties

- Meta-analysis of the effect of the biotic and abiotic factors on the yield of common beans. The methodology will involve collecting data on yield from all published papers and subjecting them to meta-analysis to determine major constraints and trends in bean yields.
- Controlled environment (greenhouse) experiments conducted to compare the physiological responses of five priority varieties to limited water supply during grain filling.
- Controlled environment (growth chamber) experiments to compare the physiological responses of five priority varieties to high temperature stress during grain filling.
- Document impacts on seed number, seed size, and seed nutrient composition.

Benchmarks

Oct. 2009 – Mar. 2010

- Meta-analysis report on the effect of water stress.
- Relative sensitivity of varieties to water stress documented
- Impact of stress on seed nutrient composition documented

Apr. 2010 – Sept. 2010

- Relative sensitivity of varieties to high temperature stress documented
- Impact of stress on seed nutrient composition documented

Obj. 1b. Improve Quality and Yields of Beans through Evaluation of Better Production Practices

- Repeat season 1 in 2009 replicated field trials with 6 cooperating farmer groups (30 locations) to compare the yield of (NABE 6 [white dry bean, small seeded] and K 131 [carioca dry bean] and K 132 and NABE 4 [red mottled beans] in Kamuli district)
- Repeat season 1 in 2009 assessment of benefits of improved soil fertility by comparing the yield of manure fertilized vs. non-fertilized treatments on K 132 [red mottled bean] in Kamuli district in Uganda.
- Establish irrigation/fertization demonstration at VEDCO office garden in Kamuli. Document benefits for production, nutrient value, and economic returns on beans.
- Document and analyze location x genotype effects on yield, yield components, and seed nutrient composition.
- Compare impact of timely harvesting on initial seed quality (germination, fungal and insect infestation, physical damage) and maintenance during storage.
- Compare storage techniques and their impact on germination.

Benchmarks

Oct. 2009 – Mar. 2010

- 2009 yield data collected and analyzed
- 2009 seed composition analyzed
- Impacts on bean quality from improved harvest and storage techniques documented
- Irrigation/fertigation demonstration established

Apr. 2010 – Sept. 2010

- 2010 trials conducted using improved production practices
- Yield and nutritional profile of priority varieties confirmed
- Optimum response and economic return on irrigation determined

Obj. 1c. Strengthen Farmers' Collective Capabilities to Learn and Share Innovative Practices

- Promote adoption of recommended practices to increase yield of quality beans through RDE and farmer training, and facilitating access to superior varieties and priority inputs
- Train cooperating farmers in bean production practices, including pre- and post-harvest handling, and marketing, and the importance of careful record keeping for research and demonstration activities using the production manual prepared for this project.
- Conduct field days at research/demonstration sites for farmers outside of VEDCO cooperator groups.

Benchmarks

Oct. 2009 – Mar. 2010

- All cooperating farmers and farmer group members trained in research methods
- Open field days conducted at selected variety trial and fertilizer trial sites
- Irrigation/fertigation techniques demonstrated to RDEs and CNHWs

Apr. 2010 – Sept. 2010

- Farmer knowledge on participatory research methodologies/designs put into practice for improved field trial implementation
- Trainee follow-up conducted to reinforce implementation of recommended practices
- Recommended research results incorporated into training procedures and promotion protocols RDEs in other VEDCO operational areas and beyond (NaCRRI can use the 'lessons learned' to apply to their other areas of operation)
- Field days conducted for other NGOs, international agencies, and foundation representatives interested in the farmer-to-farmer approach to achieve sustainable food security – include other researchers from NARO institutes and other relevant organizations
- Results from objectives 1a and 1b (above) to be applied to other bean producing districts by NaCRRI and other research units or institutions

Results, Achievements and Outputs of Research:

Determine and Prioritize Key Production Constraints of Five Priority Bean Varieties

Meta-analysis of the effects of water and temperature stress on yields is underway. The literature review is completed, and analysis is focusing on yield and its components. Previous research provided limited information on seed composition. Preliminary experiments on sensitivity of

varieties to water stress have been completed. There was difficulty is controlling the level of stress due to aggressive plant growth with adequate fertility. Morphological plasticity and varietal differences to stress were determined. Two varieties (K131 and NABE2) were more tolerant to stress, while NABE4 was the most prone to water stress, probably due to its luscious growth under the adequately fertilized greenhouse soil mix. Initial research to documented impact of stress on seed nutrient composition has involved assessing commercial varieties from Uganda (K131, K132, NABE2, NABE4 and NABE6) in the greenhouse.

At present, results are inconclusive because we could not sufficiently control the stress due to the wide plasticity in plant growth. Varieties from NaCRRI selected as stress tolerant currently in our studies include K131 and NABE2. These have undergone preliminary trials for drought tolerance in the greenhouse at ISU. Water stress studies at ISU will be completed this winter following replication in the greenhouse. Nitrogen free soil has been obtained for studies which will enable better management of vegetative germination**.**

Collaboration has been initiated and a Material Transfer Agreement (MTA) signed between CIAT-Colombia and Iowa State University. With this agreement, we shall receive germplasm from breeders that reflects variation in drought and seed nutritive composition. Recombinant Inbred Lines and their parents will be very useful in understanding the physiology of seed nutrient composition. Use of RILs will enable us to compare lines with the same growth habit.

We are also working to increase the quantities of seed for processing and nutritional studies. A total of 60 kg of clean bean seed was produced at ISU (NABE6 - 40 kg, NABE2 - 10 kg and K131 – 10 kg). Other varieties (NABE4, K132 and Kanyebwa) planted at ISU were destroyed by flooding and residual herbicides. Land has been secured for multiplication of more seed on organically managed land at the ISU horticulture farm in 2011.

The National Crops Resources Research Resource Institute (NaCRRI) at Namulonge has developed early maturing varieties of lines that are drought tolerant and resistant to anthracnose. These lines are being evaluated in Kamuli. In the coming season, they will be included in physiology studies at ISU. NaCRRI recently received over 200 nutri-bean lines (lines high in iron, zinc and protein) from the University of Nairobi through our CIAT partners for multiplication this season. The seeds planted at NaCRRI for multiplication will facilitate evaluation next season. ISU will use some of the seeds for physiological studies once the multiplication increases the quantity of seeds available.

Improve Quality and Yields through Evaluation of Better Production Practices

In 2009, 30 trial sites were established for both season 1 and season 2. Data were collected from planting through harvest. After harvesting, samples were taken to NaCRRI where measurements of seed total weight, clean seed weight, 100 seed weight and moisture contents were taken.

These results represent combined data of two seasons carried out in 2009. Four improved varieties (K132, NABE4, K131, NABE6) developed at NaCRRI, and a popular local variety (Kanyebwa) were evaluated at each site. The fertility trial involved application of 10 T/ha organic manure applied at planting. Plots were 5m x 5m, arranged in a randomized complete block design with two replications. Seed yield per plot was quantified on 'cleaned seed' (shriveled seed removed) and adjusted to kg/ha.

Only K131 yielded significantly more than the local variety - Kanyebwa (Figure 1). The yield of all varieties was far below the potential yield of 1500-2000 kg/ha [meaning 600-800 kg/acre] observed on NaCRRI research station fields. Manure application increased seed yield of all varieties except NABE4. Yield increases up to 34% for K131, 53% for K132, and 70% for Kanyebwa were observed (Figure 2). Yield increases were due to corresponding increases in the number of pods and seeds per plant (data not shown). However, even the best yields with manure were less than 50% of the yield potential. This could be due to insufficient and unbalanced nutrient supply as well as diseases and pests.

Based on these results, other sets of experiments have been initiated to assess on farm the effect of phosphorous, manure and the interaction between manure and phosphorous on the yield of common beans. Further, pest and disease incidence and severity, as affected by soil fertility treatments and intercropping, will be assessed. Intercropping beans with maize and other crops is a common practice in Uganda. Performance in terms of yield and ease of management in a crop mix is one of the criteria that farmers use in selection of varieties. On farm trials will assess the yield advantages that accrue from a bean-maize intercrop on farm. Important pests and diseases will be assessed during pod filling to determine how the incidence and severity relates to the fertility treatments and its relationship to yield.

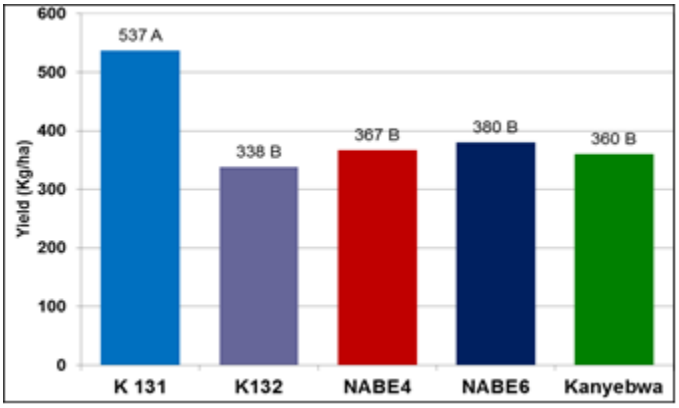

Figure 1: Genotypic variation in yield of common beans under farmers' conditions. Data are the mean for two growing seasons. Means with the same letters are not significantly different at $p < 0.10$.

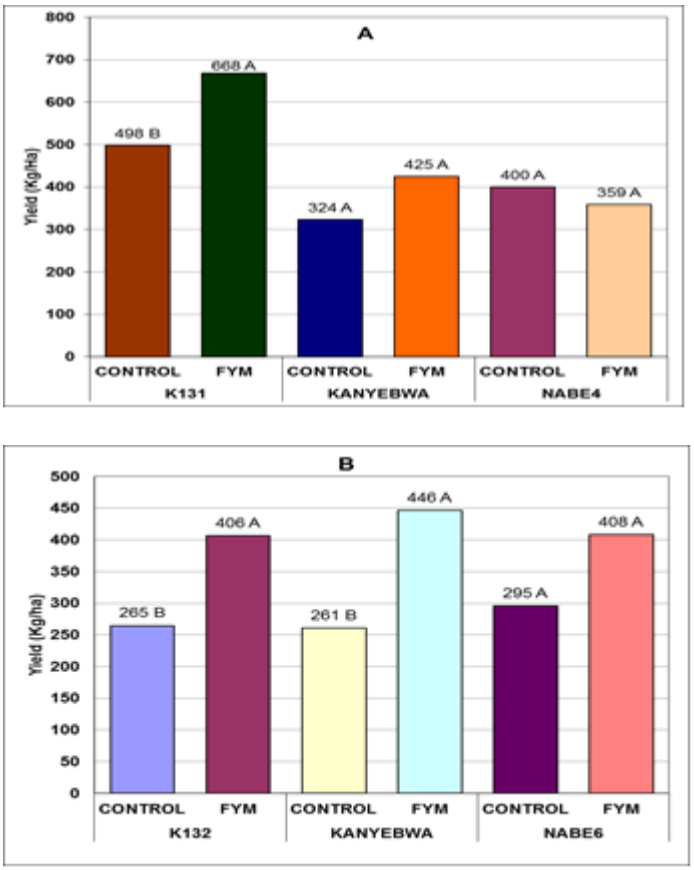

Figure 2: Response of common bean yields to 10T/ha manure application
Part A: Comparisons between K131, Kanyebwa and NABE4
Part B: Comparisons between K132, Kanyebwa and NABE6
Data are the mean for two seasons. Means with the same letters are not significantly different at $p < 0.10$.

Seed samples were obtained from each of the harvested trial plots during the first season of 2010. The seeds were fumigated to prevent them from becoming infested with weevils. Once the phytosanitary certificate papers were obtained for export to the U.S., seed samples were sent to ISU for analysis.

To determine the effect of soil fertility on seed composition, seed samples from Kamuli were analyzed for mineral composition, total carbon and percentage protein content. Mineral analysis was done using inductively coupled plasma (ICP) mass spectrometry. The percentage total carbon and percentage total nitrogen were determined by combustion technique (TruSpec CN, LECO). Seed protein concentration was estimated by nitrogen concentration x 6.25. Nitrogen content was determined by combustion.

There were no significant effects of manure application on seed composition for Phosphorous (P), Potassium (K), Zinc (Zn), Copper (Cu), Iron (Fe), Manganese (Mn), Aluminum (Al), Calcium (Ca), Magnesium (Mg), % total carbon (TC) and protein content. Significant manure effects were only documented for Sodium (Na). Significant variety differences in composition were only present for K, Fe, Mg and protein content. In all cases, the Variety x Manure interaction was not significant. Correlation analysis showed that Fe content was positively correlated with Mn (0.58, $p<0.001$), Ca (0.82, $p<0.001$), Na (0.71, $p<0.001$), TC (0.37, $p<0.05$) and protein concentration (0.40, $p<0.05$). Protein concentration was also positively correlated with Mg (0.50, $p<0.001$). Zinc had no significant correlation with all the other seed components analyzed.

The first season 2010 trials were established April 7-25. A total of 30 sites were established. Three out of the five sites for each group were for variety trials, and the remaining two were for fertility trials. However, the fertility trials this time consisted of 24 plots compared to 18 during the last season. Before planting the trial plots, soil samples were collected and taken to Kawanda Agricultural Research Institute for analysis. The amount of phosphorous applied depended on the soil test results. Phosphorous levels used were 60, 40 and 20 kg/ha. In plots where Phosphorous x Manure interaction was used, half of the corresponding levels of phosphorous were added. Both farm yard manure and phosphate were applied to the different plots this time. For this report, results from plots where 60 kg/ha of Phosphorous was applied are reported. For the other Phosphorous levels, the number of farms was insufficient for statistical comparisons.

Farmers conducted germination tests before planting of the trials, as learned during project training. Planting was done with spacing of 50 cm between rows and 10 cm between plants within each row. Each plot was 5m x 5m. Weeding of the trials varied from group to group, depending on the planting dates. Overall, weeding was carried out two to three weeks after planting. Harvesting occurred before mid-day, as recommended, to avoid shattering and losses.

Results showed that the there was a significant effect of Location x Variety interaction for total seed yield, clean seed yield and seed size (100 seed weight inherently varies among the varieties due to differences in seed size, though soil fertility treatments could have some effect). However, there were no significant differences in the total yield among varieties (see Table 1). K131 had the highest clean yield, while NABE4 had the lowest clean yield, with 48% of the seed classified bad seed (poorly filled, diseased). Drought and heavy rain affected growth and yield in some locations.

Table 1: Variety Differences in the Mean Yields of Five Common Bean Genotypes

Variety	**Total Yield (kg/ha)**		**Variety**	**Clean Yield (kg/ha)**		**Variety**	**Seed Wt. (g)**
K132	567A		K131	372A		K132	46.4A
Kanyebwa	527A		K132	351A		NABE4	39.7B
K131	526A		Kanyebwa	341AB		Kanyebwa	35.8C
NABE6	522A		NABE6	319AB		NABE6	17.8D
NABE4	517A		NABE4	270B		K131	17.0D

Means values with the same letter are not significantly different ($p \leq 0.10$)

In this trial, three varieties, K131, NABE4 and Kanyebwa were compared in 3m x 3m plots. The on-farm trials were arranged in Randomized Complete Design with two replicates per treatment. Soil fertility treatments included: (1) Farm Yard Manure (10T/ha), (2) Single Super Phosphorous (60 kg/ha), (3) Farm Yard Manure (10T/ha) and Super Single Phosphorous (30 kg/ha), and (4) Control. For seed collection, boundary rows were excluded and the equivalent to 6 m^2 was harvested. Yields per plot were then standardized to 13% moisture content and to kg/ha.

There were significant differences in yields among farmers, but no significant effect of soil fertility treatments, variety and soil fertility x variety interaction on the total and clean seed yields. The limited response could be due to insufficient soil fertility amendment levels or

unbalanced nutrients during the flowering and seed filling. The climate in Uganda is warm, such that any applied organic manure quickly decomposes and therefore nitrogen (N) becomes available early in growth, while the excess is leached or volatilized. The beans may therefore have had insufficient levels of N during the critical stages of flowering and seed filling. Further, in Phosphorous (P) deficient soils, P applied as fertilizer is quickly fixed by the Iron and Aluminum oxides prevalent in Kamuli soils. Thus, only a small amount is left in the available form for plant uptake. These factors could partly explain the lack of significant effects of N and P on the yield of common beans.

Despite the overall lack of significant differences, the fertility treatments generally yielded higher than the control, with higher yields where phosphorous was part of the treatment (see Table 2). Application of phosphorous alone led to a 32% increase in clean yield compared to the control. The response to phosphorous shows that it is needed for higher bean yields. Analysis of the 100 seed weight showed significant differences among varieties, as expected, and a significant soil fertility treatment effect on seed weight. However, the variety by soil fertility interaction was not significant. Farm yard manure application seemed to lead to a bigger seed size. Other experiments should compare increasing rates of phosphorous to determine the most appropriate range for the soils in Kamuli.

Table 2: Effect of Manure (M), Phosphorous (P), and Manure by Phosphorous (M x P) by interaction on the yield of common beans

Treatment	**Total Yield (kg/ha)**		**Treatment**	**Clean Yield (kg/ha)**		**Treatment**	**Seed Wt. (g)**
Control	633B		Control	415B		Control	31.0B
Manure	747A		Manure	509A		Manure	33.7A
Phosphorous	787A		Phosphorous	552A		Phosphorus	31.0B
M x P	752A		M x P	516A		M x P	32.3B

Means values with the same letter are not significantly different ($p \leq 0.1$).

Seed samples for all three seasons completed in Kamuli have been received at ISU for processing and nutritional studies. The following quantities of seeds have been received: K131 = 20.4 kg, K132 = 18.15 kg, NABE4 = 20.55 kg, NABE6 = 17.65 kg, and Kanyebwa = 14.8 kg.

Drought is becoming increasingly common in Uganda, including Kamuli district. Farmers are in no position to time planting as they used to as weather has become unpredictable. Farmers noted that they used to plant in June and July to take advantage of the second, albeit shorter, rainy season; now, however, the reliability of efforts to successfully 'time' planning has become very difficult or impossible. NaCRRI has identified eight early maturing lines, with two already released for farmer use. These varieties/lines mature in 60-65 days, which can help farmers to produce beans in the context of unpredictable variation in the timing and duration of the rainy season. These lines are currently being evaluated in Kamuli for their performance. Data from those trials will soon be sent to ISU for analysis.

Evaluate and Reduce Post-Harvest Losses

Members of the six farmers groups were mobilized in their respective sub-counties for this training. NaCRRI research technicians Richard Sekabembe and John Sulume trained 70 farmers

(59 women and 11 men) on proper methods of harvesting seeds as soon as they reach physiological maturity. To avoid losses, farmers were shown how to use string or banana fibers to tie bunches of harvested beans and to use sacks for transport to their homes. Using tarpaulins for a clean drying environment was emphasized, as were sorting and re-drying of seeds to achieve and maintain the recommended moisture content. Farmers were shown that using less violent methods of threshing avoids splitting the seeds. They were also trained on proper storage, with sacks on a raised platform and not touching the wall of the house. For seeds, proper use of fungicides and pesticides was demonstrated to minimize losses during storage and maintain seed quality. For consumption, regular drying and use of preservatives from the neem tree and ash can be used. Farmers indicated that adoption of recommended post-harvest management practices (harvesting, transporting, drying, threshing, sorting and storage) resulted in loss reductions.

Materials for post-harvest training materials for use by extension agents and farmers have been developed with input from a consultant from Mango Tree, a non-governmental organization specializing in education and communication. These materials cover crop production (land selection, land preparation, planting, weeding, and soil fertility management), pest and disease management, and pre- and post-harvest handling. The training materials were pre-tested in the field, followed by workshops with farmers to incorporate suggestions into the process of revision. Each group was subsequently given one set of charts for use during their training sessions.

An experiment was conducted in rural Kamuli during July-August, 2010, to determine the effectiveness of hermetic storage in controlling insects in beans and corn. Heavily infested beans (bruchids) and corn (weevils) were purchased in the local market and stored in used but clean edible oil 10L plastic containers under two conditions: (1) hermetically sealed (airtight) and (2) open to air infiltration but closed to insect migration in or out of the container. The containers were stored at ambient conditions (approximately 22˚C) for four weeks. The weight, quality characteristics and degree of infestation (live and dead insects) were determined before and after storage. After four weeks of storage, the total number of insects approximately doubled in the hermetically sealed containers and tripled in the open containers. However, the hermetically sealed containers resulted in 100% insect mortality. In the open containers, approximately 50% of the insects were alive and actively feeding on the beans and corn beans which resulted in significant quality deterioration compared to hermetic storage. The CRSP project team is currently investigating the feasibility of replicating this experiment using larger containers, such as 200L plastic barrels typically used for water storage.

Strengthen Farmers' Collective Capabilities to Learn and Share Innovative Practices

Continuing training on research methods and procedures to be used for the 2010 field trials involved all six farmer groups. NaCRRI research technicians conducted this training in March prior to the onset of the first season trials. The topics covered included farmers roles and

benefits, site selection, plot layout, treatments and randomization. It helps farmers understand why and how treatments and activities are involved, the outputs that are expected, and how they can internalize and institutionalize these actions. This enhances farmers' confidence in trial management and their sense of ownerships of the process and the results.

Improved and non-improved seeds were planted near each other for comparison purposes. During the field trials, farmers observed that their local variety has a shorter maturity period compared to the other varieties, though it can be significantly affected by diseases and attacked by pests. In response to this, the NaCRRI technical team introduced a new variety, similar to the farmers' own Kanyebwa. Farmers observed the crop performance. When the four original improved varieties did not perform as expected, farmers identified a local variety that is similar to NABE6 (white in color) and planted it near the established trials. When harvested, it yielded better than NABE6. NaCRRI researchers are examining these results and determining appropriate action for future field trials. Research results have been incorporated in subsequent trainings sessions.

Trainee follow-up was conducted by VEDCO and NaCRRI staff immediately after the training and thereafter VEDCO follow-up the trainees on a regular basis. Through these follow-ups, VEDCO has been able to note that the adoption rate was high. Farmers practice what they have learned on their own fields share with their neighbors. Project recommended practices are already being informally disseminated to non-project households and areas, Project team members are also incorporating other innovative practices, such as improved bean recipes, to help farmers increase consumption and improve nutrition.

The first CRSP field day was held on July 2, 2010, in Butansi sub-county. CRSP and non-CRSP farmers were mobilized and all the partners in the CRSP project took part. Approximately 150 farmers (two-thirds of them women) and other stakeholders participated. The objectives of this field day were to enable farmers to share with others the knowledge that they have acquired through research, demonstrate and explain new management practices and technologies (germination testing, site selection, land preparation, row planting and spacing, timely weeding, pest management, harvesting methods, post-harvest handling, moisture content, seed preservation), storage technologies and methods (triple bagging, airtight plastic containers), and community-based seed production. In addition to demonstrations and discussions both in-field and at 'stations' regarding management practices and technologies, CRSP farmers used 'peoples theatre' to communicate – often with greatly appreciated humor – to field day attendees.

The field day enabled the project team and participating farmers to obtain suggestions from other farmers and stakeholders to improve practices or approaches which will be useful in dissemination and scaling up. Agronomic management practices (soil fertility enhancement, planting, management of diseases and pests, etc.) are being applied on other crops, by non-project households, and in other communities. We have been exploring approaches informally disseminating for hope when recommended practices and technologies within the next year to non-CRSP households in Kamuli and subsequently beyond, once ongoing experimentation and application are completed.

<u>Objective 2</u>: To Enhance Nutritional Value and Appeal of Beans through Appropriate Handling and Processing

Approaches and Methods:

Obj. 2a. Evaluate and Reduce Post-Harvest Losses

- Development of post-harvest training materials and adoption of existing ones
- Training of farmers in pre and post-harvest handling of beans for minimal deterioration
- Evaluation for extent of adoption of innovations from training
- Evaluation of influence of farmer innovation uptake on post-harvest losses

Benchmarks

Oct. 2009 – Mar. 2010

- Materials for post-harvest training developed
- Farmers training in pre- and post harvest handling completed

Apr. 2010 – Sept. 2010

- Evaluation of extent of adoption completed
- Influence of innovations on post-harvest losses evaluated

Obj. 2b. Analyze Influences of Agronomic Conditions and Processing on Nutritional Qualities of Beans

- Five bean varieties (NABE 2, NABE 4, NABE 6, K 131 and K 132) harvested from experimental farms in Wakiso district in central Uganda have been obtained. These varieties will be subjected to various processing techniques, performed according to procedures developed by Dr. Nakimbugwe at MAK and Drs. Hendrich and Murphy at ISU. They will be assessed for nutrition quality. Nutritional quality analysis will focus on nutrient and mineral content (done in collaboration with Dr. Westgate's laboratory in Agronomy at ISU), protein and starch digestibility, iron bioavailability, bean ferritin and anti-nutritional factor (phytate, polyphenols) contents as key determinants of iron bioavailability.
- Iron bioavailability will be determined according to methods proposed by Garcia *et* al. (1996) and Au and Reddy (2000), with bean ferritin done by ELISA according to methods in Dr. Reddy's laboratory at ISU. Starch digestibility will be determined using official AACC method 32-40 (AACC, 2000), Protein digestibility, phytate content according to AOAC Official Method 986.11 and polyphenolic compounds according to AOAC Official Method 965.31, as well as by HPLC methods to be developed in Dr. Murphy's laboratory.

Benchmarks

Oct. 2009 – Mar. 2010

- Nutritional analysis of harvested beans from Season 1 in 2009 will be completed
- Nutritional analysis of effects of processing (first round of improvements) will be completed

Apr. 2010 – Sept. 2010

- Nutritional analysis of harvested beans from Season 2 in 2009 will be completed
- Nutritional analysis of effects of processing (second round of improvements) will be completed

Obj. 2c. Develop Processing Techniques with Improved Efficiency, Feasibility and Consumer Acceptance of Bean-Based Food Products

- Based on the results of Mar.-Sept. 2009 bean flour protocol development research, the best approach (combination of processing methods) for developing the bean flour will be refined and later promoted for uptake. Nutritional analysis of the bean flour will be done to determine the shelf-stability of the bean flour with time.
- Members of a Kamuli community will be involved in developing acceptable protocols that utilize the developed bean flour and the most acceptable recipes using the bean flour will be promoted within the community. The potential of the bean flour to contribute to improved nutrition will be assessed based on existing dietary patterns and intake data that CSRL affiliates have been collecting since 2006.
- The protocol for processing products based on the bean flour will be promoted for uptake.

Benchmarks

Oct. 2009 – Mar. 2010

- Protocols for products utilizing bean flour developed
- Potential contributions of developed bean-based products to nutrition assessed

Apr. 2010 – Sept. 2010

- Assessment of the shelf-stability of the developed bean flour-based products completed
- Processing protocols for bean flour-based products promoted
- Assessment of consumer acceptability of products utilizing bean flour determined
- Follow-up on community adoption of promoted practices undertaken

Results, Achievements and Outputs of Research:

Determine the Influence of Agronomic Conditions on Nutritional Quality of Beans

We tested the hypothesis that implementation of improved farming practices would increase yield and the nutritional value of the beans. It also sought to determine the most effective processing parameters to maximize nutritional value of beans with respect to decreasing anti-nutritional factors and increasing protein and starch digestibility. Application of farm yard manure over two growing seasons had no significant effect ($p<0.05$) on anti-nutritional factors (phytate and polyphenols), though significant differences existed between varieties and between harvests. Difference between harvests could have been due to locations and soil conditions since paired data were received from different farmers. Total polyphenol content ranged from 0.31 to 1.58 and from 0.33 to 1.37 mg/100g in the control and farm yard manure treatment, respectively. The total polyphenol content was lowest in NABE 6 (small white) and highest in Kanyebwa (medium sized, mottled) (see Table 3). Phytate content varied from 0.49 to 0.81 and from 0.31 to 1.38 in the control and farm yard manure treatment, respectively. The phytate content was lowest in NABE 4 and highest in the K131 variety. Studies on the effect of agronomical practices on iron bioavailability using a Caco-2 cell culture model are ongoing.

Table 3: Total polyphenol and phytate content of bean varieties over the two growing seasons

	Total Polyphenols (mg/100g)		Phytate (g/100g)	
Variety	Control	FYM*	Control	FYM*

K131	1.08	1.37	0.65	1.38
K132	0.84	0.85	0.65	0.58
Kanyebwa	1.58	1.37	0.75	1.09
NABE4	1.49	1.01	0.49	0.31
NABE6	0.31	0.33	0.81	1.23

*FYM=Farm yard manure

Determine the Influence of Processing on the Nutritional and Sensory Quality of Beans

The effect of soaking, malting and steaming on protein and starch digestibility, as well as on polyphenols and phytic acid, were determined using K131 and NABE6 varieties. Individual processing techniques had significant effect on total polyphenol and phytate content. However, the magnitude of these effects was variety and factor specific, ranging from 15-38% reduction (both polyphenol and phytate) in K131 to 22-39% (polyphenol) and 73-83% (phytate) reduction in NABE6. The combined effects of these processing techniques were evaluated using K131, and optimized for minimizing polyphenol and phytate contents and maximizing starch and protein digestibility.

In Uganda, the protocol initially developed for processing bean-flour, using K131 as the model variety, involved the following steps:
Soaking (12 hours) → malting (48 hours) → de-hulling → steaming (15 minutes) → roasting (15minutes). It was then refined to: soaking (12 hours) → malting (24 hours) → steaming under pressure (20 minutes) → oven drying (at 65°C for 8 hours) → fine milling. The malting time was reduced from 48 to 24 hours because the beans were sufficiently sprouted after that time. Steaming replaced roasting, followed by oven drying; the reason for this is that when the flour was used for porridge, it tasted burnt.

Since soaking, malting and steaming times have greater influence on nutritional quality and sensory acceptability of the processed bean flour, they were selected for optimization. Three levels of each of the three processes were tested as shown in Table 5 below.

Table 5: Criteria used for optimizing bean flour processing protocol

	Processes and Duration		
Level	**Soaking (hours)**	**Malting (hours)**	**Steaming (minutes)**
Low	6	0	0
Middle	15	24	10
High	24	48	20

The influence of different levels of the independent variables on starch digestion, protein digestion and polyphenol/phytate contents were optimized using Statease software. Optimal levels of the three sets of variables were 24 hours soaking, 48 hours malting, and 18.7 minutes steaming. These processes resulted in optimal starch and protein digestibility values of 91.16 and 87.73, respectively, and phytate and total polyphenol levels of 0.22% and 0.58 mg/100g, respectively. Processing also lowered the viscosity of the porridge prepared from the bean-based flour to 3.4 times (70%) less than that maize flour and 5 times (80%) less than the viscosity of millet flour, based on same proportions of the flours in the porridge, on dry matter basis. The

sensory acceptability of the product made with bean based flour was also improved by processing, particularly by steaming compared to non-steamed beans. Based on the sensory evaluation studies for consumer acceptance using a nine point hedonic scale, the overall acceptability was found to be of 7.67. Studies are ongoing to validate this protocol for all the other varieties covered by the project and to correlate reduction in anti-nutritional factor content to iron bioavailability.

While the bean flour can be consumed solely as a sauce to accompany staple dishes, it has also been incorporated into a composite flour that can be consumed either as porridge or sauce. The composite flour was developed with 40% bean, 30% grain amaranth, and 30% rice flours. Grain amaranth was oven roasted at 220°C for 8-10 minutes followed by fine milling, while the rice flour is just fine milled. The combination was adopted after several combinations were tested consumer acceptability. The potential contribution of bean-based products to nutrient intake for children will be determined based on serving size and the nutrient requirements for that specific age group. Similar estimations will be made for other vulnerable groups that are at risk for nutritional deficiencies.

Studies on development of extruded flour as well as an extruded snack were scheduled to be carried out at ISU. However, this depended on the ability to multiply seed material in quantities necessary for product development experiments at the pilot plant. The harvest from the Summer 2009 multiplication trials did not produce enough material, so a larger area was planted in Summer of 2010. The latter harvest has generated sufficient raw material for use in developing extruded products, and the trials are scheduled for late Fall 2010.

Once the extruded snack and flour have been developed, their nutritional and sensory characteristics will be evaluated. Plans to assess the effect of bean consumption on nutritional status in humans were eliminated due to logistical constraints and cost. Implementation would have required performing the activity in Uganda where the population is already consuming beans and is the target of new developed products, but the equipment and facilities required to collect primary data are not available in-country.

Develop Processing Techniques with Improved Efficiency, Feasibility and Consumer Acceptance of Bean-Based Food Products

In Rwanda, beans were soaked in water (ratio 1:1) for 16 hours at ambient temperature. The beans doubled their weight upon soaking and were subjected to germination for 4-6 days at ambient temperature. They were de-hulled and dried at 105°C for 5 hours. The de-hulled beans were milled and made into flour. The flour was made into dough (1:0.4 flour to water ratio) and fermented for 8 hours at ambient room temperature. It was dried in a mechanical drier at 105°C for 3 hours and then milled to obtain uniform flour. This treatment can be applied in the development of processed weaning foods for children.

The effect of thermal processing methods on the functional properties of bean flour was also studied. The thermal processing treatments were boiling, roasting and autoclaving. In the boiling method, 2 kg of dry common beans were boiled in a closed pan for 2 hours, until soft to touch when pressing between the fingers. The samples were oven dried overnight at 70°C followed by sun drying. In the roasting method, 1 kg of dry beans was mixed with clean fine sand and stirred

frequently to prevent burning of the seed coat and to ensure uniform distribution of heat. The materials were roasted for 30 minutes. The sand was thereafter separated from the seeds (sorting) and allowed to cool. In the autoclaving method, 2 kg of bean seeds were autoclaved at 121°C for 30 minutes and then sun dried. All the processed samples and the raw seeds were mechanically milled.

Bulk density (net weight of the flour divided by the volume of the container), water absorption capacity (Beuchat 1977), oil absorption capacity (Beuchat 1977), emulsion capacity (Beuchat 1977), foam capacity and stability (Coffman & Gracia 1991) of raw, boiled, roasted, and autoclaved common bean flours were determined. The results showed that there was no change in bulk density of bean flours. The bulk density values reported are slightly higher than the value (0.29 g/ml) observed by Glami et al. (1992) for full fat winged bean flour but lower than 0.93 g/ml reported (Bello & Okesie 1982) for winged bean protein isolated. The value 0.55 g/ml obtained for common beans compares favorably with 0.55 g/ml reported for African bread fruit kernel flour but lower than 0.7g/ml reported for wheat flour (Akubor & Badifu 2004). For a reduction of paste thickness, a high bulk density is desirable; this in an important factor in convalescence and child feeding.

Water absorption was higher in roasted common bean flour and no difference was observed between raw, boiled and autoclaved bean flours. Water absorption represents the ability to process beans under conditions where water is limiting, e.g., dough and pastes. Proteins are capable of binding large quantities of water due to their ability to form hydrogen bonds between water molecules and polar groups on the polypeptide chains. These properties enable bakers to add more water to dough and, as such, improve on the handling qualities and maintain freshness in the bread. The higher water uptake by the processed seed flours compared with their raw form could be due to the more exposed active surface area in the latter. The increased absorption capacity of heat processed flours is due to heat-induced dissociation (denaturation) of proteins, gelatinization of carbohydrate in the flours, and swelling of crude fiber.

The results obtained suggest that common bean flour can be an important functional ingredient in bakery products. Oil absorption was high in autoclaved bean flour and low in raw bean flour. The oil absorption capacity determines whether the protein material of the flour will perform well as meat extenders or analogs. Fats improve flavor and increase the mouth feel of foods. Fat absorption is therefore a significant factor in food formulations (Eke & Akobundu 1993). In this research, fat absorption capacities were higher in processed common bean samples than in the raw one. The increase in oil absorption of processed samples over the raw one could be due to both the heat dissociation of the proteins and denaturation. The oil absorption capacity of protein is required in ground meat formulations, meat replacers and extenders, doughnuts, pancakes, baked foods and soups. Less oil absorption components are lower flavor retainers (Narayania & Narasing 1982). The lower oil absorption capacity might be due to low hydrophobicity proteins which show superior binding of lipids (Kinsella 1976).

Wettability among the samples varied according to the dispersability. It is important in food formulations. Wettability of protein is affected by surface polarity, texture, and area and microstructure of the protein particles. In this research, the flours were very stable and there was

no quick movement of water through bean flours; the most stable flour was from boiled common beans.

Emulsion capacity was high in raw bean flour and low in boiled bean flour. The emulsion capacity of the raw common bean flour is higher than that of processed bean flours. Protein modification associated with heat was responsible for the reduction in the value obtained from the processed common bean samples. The reduction in values is attributed to protein denaturation and similar to the results of steeped, malted, and roasted African yam bean flours (Eke & Akobundo 1993). From our research results, it is evident that boiling as a processing method is less effective when compared to autoclaved and roasted beans for which emulsion capacity of the flour is required for spread formulation.

Differences between foaming capacity of flour from unprocessed beans and those from beans processed before blending were identified: foam of raw bean flour after whipping = 49 ml, boiled bean flour = 12 ml, autoclaved bean flour = 4 ml, and roasted bean flour = 7ml. These differences in functional properties showed that there was denaturation of proteins which affect the reactivity, attraction and binding capacity of common bean flours with other food compounds. From the study, it is recommended that boiled and roasted bean flours can be used as thickeners and in child feeding because they are denser. It is also recommended that raw bean flour be used as aerating agents in food systems such as whipped toppings and ice cream mixes which require the production of high stable foam volumes when whipped.

In Uganda, the optimized protocol for producing bean flour, using variety K131 as the model, has been up-scaled to semi-commercial level. Clean dry beans are soaked for 24 hours in large plastic bins, malted for 48 hours between moist sisal mats, roasted at 200-220°C for 40-60 minutes with constant stirring, and then milled into a fine flour. Roasting was selected because of its practicality compared to steaming under pressure. The optimization was done in collaboration with Nutreal Limited, a private company partnering with the business incubation program of the Department of Food Science & Technology (DFST) at Makerere University. DFST is providing technical support for production, product branding, acceptability and shelf-life studies, all of which are currently underway.

In Rwanda, formulation of composite flour of bean and maize was carried out after appropriate pre-treatments. They were blended in different combination and the cold extruded snack was processed and subjected to organoleptic evaluation (Kamala 2009; Ramasamy & Suseelama 2005). The combinations indicated in Table 4 were acceptable. These combinations were subjected to proximate analysis in the laboratory. Simultaneously, storage stability studies were conducted, and results indicated that the product was shelf stable for a period of four months.

Table 4: Organoleptically Acceptable Combinations of Bean Composite Flour

Bean Variety	**Composite Flour**
Colta	100% Bean flour
Decelaya	70% Bean, 30% Maize
RWR 22-45	100% Bean flour
White beans	60% Bean, 40% Maize

In Rwanda, a metallic hand operated extruder was used to cold press the dough before frying in oil. The extruder consists of a die, dough holder and dough presser. The dies used were of different shapes: star, round, rectangle, etc. The selected die was placed and screwed in the die holder of the dough holder. The dough made out of the blended flour was placed in the dough holder. The dough presser was placed on the dough and squeezed by pressing the handles of both the dough holder and the dough presser. This resulted in the extrusion of the snack. The extruded product was directly placed into hot cooking oil and deep fried. The cooked snack food was then cooled, since the cooling process improves the crispness of the product. Finally, the product was vacuum packed and placed in a plastic container.

<u>Objective 3</u>: To Identify Solutions for Constraints to Increased Marketing & Consumption.

Approaches and Methods:

Obj. 3a. Identify Solutions to Production and Marketing Constraints Faced by Bean Producers

- Identify strategies to address barriers and challenges in market access faced by farmers/producers. This work builds on the 'Baseline Data for Participating Households in Kamuli Bean Production and Marketing' questionnaire in 2009. A follow up household survey will be conducted in Feb.-Mar. 2010.
- Identify strategies and approaches to strengthen value chain and returns to producers through value-added marketing efforts. This work builds on the 'Business and Trading' questionnaire in 2009. A follow up survey will be conducted in Feb.-Mar. 2010. Case studies of successful marketing efforts will be developed.
- Help farmers and farm groups to more successfully market beans by developing chain partnerships. This involves improving market information systems, building farmers' entrepreneurial and negotiation skills, and training them to participate effectively in decision making.

Benchmarks

Oct. 2009 – Mar. 2010

- Value chain and marketing analyses completed
- Successful producer marketing strategies identified

Apr. 2010 – Sept. 2010

- Market information system improved
- Farmers and farmer organizations trained in improved bean marketing

Obj. 3b. Characterize Consumer Demand and Preferences for Beans and Agro Processed Products

- Determine market values of bean varieties and products. Collect market price information on bean varieties sold in market and at different stages in the value chain. This analysis will be used to identify opportunities for improved marketing, as well as confirm values attached to different bean varieties by consumers and by processors.
- Develop and evaluate marketing information and marketing plans that incorporating market values and production traits in marketing plan.

Benchmarks

Oct. 2009 – Mar. 2010

- Identify value of various bean varieties and value-added products in the market.

Apr. 2010 – Sept. 2010

- Train farmers in developing marketing plans by incorporating market and production information.

Obj. 3c. Increase Awareness of Benefits of Consuming Beans and Value-Added Products and their Access to New Products

- Investigate the role of nutritional awareness in consumer choice and valuation of beans and bean products. This follows up nutrition education efforts.
- Develop and evaluate marketing strategies that take account of consumers' enhanced nutritional awareness.
- Assess emerging opportunities for processors and others in the bean value chain

Benchmarks

Oct. 2009 – Mar. 2010

- Identification of successful marketing approaches to consumers and for value added products
- Training of producers on effective bean marketing

Apr. 2010 – Sept. 2010

- Training of producers on successful marketing methods for beans and new products
- Training of processors and others in value chain on successful marketing methods for beans and new products

Results, Achievements and Outputs of Research:

Identify Solutions to Production and Marketing Constraints Faced by Bean Producers

Research by MSc. agricultural economics student Simon Okiror found that although there has been an increase in bean market participation (42%) among households compared to 2005 when only 20% of the surveyed households in rural Kamuli had sold some beans, bean production has tended to be for domestic consumption rather than for commercial purposes. The average farm-household markets a relatively small quantity of beans (33 kg). Price is positively associated with the probability of selling beans. Barriers to market participation by smallholder farmers include the transaction costs of marketing, especially market distance and searching for market information. The marketing information system for VEDCO assisted farmers has been improving throughout Kamuli district. Market price boards in all VEDCO operation areas publicly display market prices for crops that are updated on a weekly basis. In addition, farmers are being informed about market prices for crops through cell phone messages.

VEDCO has recently invested in a new text-based information technology system that will enable messages to be sent and received in both English and Luganda. During the first phase, VEDCO can send text messages to the mobile phones of registered farmers or other units. Messages can contain current market prices and/or 'extension' information, targeting specific crops and/or regions. During the second stage, VEDCO could receive questions, comments, etc. from farmers. The system could be used to systematically collect questions about farmers' concerns and then disseminate responses to them. It could also be used to collect trend data to inform field activities. Further, it is possible that farmers' remarks could be posted adjacent to messages from VEDCO extension staff (this could be done on a text-based system by simply labeling the origin of the message). This system takes advantage of existing technology available to the small farmers and conveys market information rapidly and at times when farmers are making critical production and marketing decisions.

Costs associated with the process by which farmers obtain and submit information needs to be changed before this initiative moves ahead. Currently, farmers must pay when they send a text message to obtain or submit information. They do not pay to receive messages. Given scarce resources, farmers might initiate a text message only when having net positive value or perhaps only when necessary. Similarly, it would cost VEDCO $1,000 per message if 10,000 farmers signed up and current billing rates ($0.10 per message) continue to apply to send a text message to all of them.

To enhance its capacity to monitor the new information system users and design appropriate messages for them, VEDCO is currently planning to hire a communication manager who would work with field staff to assess needed messages, and then help design messages for delivery via the new system (as well as other appropriate channels). It is expected that this new person will start working by March 2011 or earlier.

There is recognized value in encouraging and strengthening associations for collective marketing among farmers. In addition, proper management of the crop will result in higher quality grain, thereby stimulating participation in the market. The improved management through collective marketing efforts effectively increases the quantity harvested and enables farmers to obtain higher prices for higher quality produce. Schools, hospitals and central markets are some of the channels that farmers have identified for marketing their beans. They also identified establishment of storage facilities as important to enable them to earn more by controlling the timing of sales, and further stimulate production increases.

VEDCO organized the first value chain stakeholder workshop in Kamuli on September 22, 2010, and is committed to playing a facilitative role to achieve success in value chain development. The focus of the collective efforts of the 25 participants from 15 organizations (farmer marketing groups and associations, government agencies, non-governmental organizations, private sector traders, transporters, distributors, and processors) is development of the maize and bean value chains. Participants committed themselves to coordinate efforts to accomplish these intermediate and long terms goals:

- Establish a forum for stakeholders to meet regularly and share information regarding production and marketing practices and strategies
- Strengthen the role of business principles and profit orientation in producer organizations
- Facilitate the development of farmer-trader associations and build strong networks
- Increase the expertise and capacity of all stakeholders in the value chain
- Develop an accessible and effective market information system
- Invest in the value chain (attract private sector businesses to invest in finance, extension and related services, storage facilities, transportation infrastructure, product development)
- Advocate for governance along the value chain (self-regulation, price stabilization, etc.)
- Advocate for a food reserve agency

Characterize Consumer Demand and Preferences for Beans and Agro-Processed Products

The MSc. agricultural extension student George Jjagwe carried out a rapid market survey to establish the extent to which nutrient enhanced foods are present in different types of market channels in Kampala. He surveyed a range of outlets, including small retail outlets, medium and large supermarkets. The survey focused on flours used for preparing nutrient-dense porridges, e.g., weaning foods and supplementary feeding for children, ready-to-eat foods, and snacks such as bread, made with nutrient enhanced flours. A very limited range of such nutrient-enhanced products was observed, implying that there is great potential to increase the range. A more detailed survey to establish the consumer levels of nutrition knowledge as well as their criteria for buying nutrient enhanced foods (influencing factors) among others is needed.

Flour for porridge is in 1-2 kg packages that sell for U.S. $1-2, depending on the size and locality of the retail outlet. In a planned consumer survey, the consumers' values regarding product frequency usage as well as perceived nutritional and health benefits awareness will be determined. The survey tool for assessing consumer knowledge and preferences has been developed and is under review. Both qualitative and quantitative consumer considerations will be determined. The market channels identified during the rapid market assessment include processors who also function as wholesalers and transporters of products, delivering them directly to retail outlets where consumers access them.

Increase Awareness of Benefits of Consuming Beans and Value-Added Products and their Access to New Products

On September 22-23, 2010, in Nyagatare in Rwanda's Eastern province, farmer community extension was carried out by Dr. Hilda Vasanthakaalam four 3rd and 4th year undergraduate students from KIST (3 male and 1 female). The demonstrated the cold extrusion method to rural community members in 2 villages with 15 farmer participants in each village. Ingredients used for processing the cold extruded snack food**:** composite flour (150g), rice flour - for binding (15g), black pepper powder (2.5g), oil (5g), turmeric (a pinch), salt (to taste), Asofoetida powder - used to decrease flatulence (a pinch), water, and oil for frying. The farmers were excited to see this demonstration and learn about this process. Farmers also indicated their interest to mobilize 100 farmers the following month so that many more could benefit. One farmer expressed interest in becoming a bean flour processing entrepreneur.

In September, 2010, recipes developed by NaCRRI were used for training 68 CRSP farmers in six groups in Uganda's Kamuli district in the preparation of a variety of bean recipes. An experienced NaCRRI trainer, Hellen Ayedu, was facilitated by Makerere University while VEDCO organized and oversaw the training. Recipes included cakes, cookies, shortcakes, bean fingers, half cakes, bean pie, and 'daddies' – snacks traditionally made with wheat flour and eggs, and then fried. Some of these recipes were identified by participants as potentially very useful for generating household income. A video recording, to be used in future community training, was also made.

A 'bean cook day' was later organized in Naluwoli parish in Kamuli district, during which the farmer group members in the CRSP project participated in a cooking competition using beans. A quick-cooking bean flour, developed at Makerere University's DFST, was available for farmers to utilize and evaluate. The participating farmers/farmer groups were evaluated on knowledge of the nutritional benefits of beans, ways of combining beans to have a balanced diet, importance of hygiene in food preparation and appropriate of different bean dishes for different age groups and individuals. Members of the community, from different backgrounds and age groups, tasted and evaluated the prepared food their overall acceptance as well as attributes like taste, flavor and appearance. Following the bean cook competition, winning recipes will be promoted in the community.

The Technology Business Incubation Centre in the Department of Food Science & Technology at Makerere University is currently working with a private sector company (Nutreal Limited) to refine, brand and market bean-based composite flour, suitable for use both in porridge and sauces. The product was based on the composite flour developed by Catherine Ndagire as part of her MSc. work for the project. Packaging has been designed; nutrient composition of the products determined and shelf-life studies are underway. The product has appeared in several exhibitions, including the Uganda Manufacturers' Association Annual Exhibition and received promising feedback.

Objective 4: To Increase the Capacity, Effectiveness and Sustainability of Agriculture Research Institutions that Serve the Bean Sector in Uganda and Rwanda

The training programs of two M.Sc. Ugandan students at Makerere, Simon Okiror in Agricultural Economics & Agribusiness, and Aisha Nakitto in Food Science & Technology, are essentially completed. Simon's thesis is in final review and a manuscript is in preparation. Aisha is conducting her final experiments and writing her thesis. Training of the student from KIST, Cyrille Sinayobye, was terminated when he withdrew from the university.

Two new MSc. students at Makerere University are making contributions to the project. Catherine Ndagire in the Department of Food Science & Technology is pursuing a specialization in human nutrition. George Jjagwe in the Department of Agricultural Extension / Education officially registered in May 2010.

Another student from KIST, Ms. Rose Kambabazi, wrote an initial research proposal and helped with KIST B.S. students in their research. The Co-PI at Makerere submitted and followed up Rose's application documents and facilitated her trip to Uganda for an interview. However, Makerere University's Graduate School required evidence that the university that she attended in Algeria is chartered / certified; such evidence has not been received to date.

In Rwanda, the four undergraduate student projects are in progress. They are continuing analysis and write up; their reports are expected to be ready by early December 2010. Their findings will inform ongoing research and community-based dissemination activities in the coming year.

Gerald Sebuwufu is making good progress in courses required for his Ph.D. in Crop Production and Physiology, with a minor in Sustainable Agriculture. Recent courses covered plant growth and development, protein techniques, plant transformation organic agriculture, foundations of sustainable agriculture, and program development and evaluation. In 2011, Gerald will finish with courses in sustainable agriculture and seed science. His dissertation research focus is on understanding the physiological basis for accretion of iron and zinc in the common bean seed and assessing the effect of genotype and soil fertility interactions on seed yield and seed composition. Experiments at ISU aimed at understanding the basis for partitioning of Fe and Zn to the seed are ongoing and collaboration has been initiated with CIAT - Colombia for provision of germplasm needed for the study. In Uganda, the focus is on understanding the physiology of genotype x soil fertility effects on the yield of common beans. Three seasons have been planted and more experiments on soil fertility and inter-cropping are planned for 2011.

Martin Mutambuka is making good progress in courses required for his Ph.D. in Food Science and beginning to write up his dissertation on the effects of processing technologies on phytate/polyphenol content and iron bioavailability and development of nutritional and consumer acceptable bean products. Content of the first three chapters have been discussed and approved by his advisors. Research is ongoing to address the two principal research questions. Partial results are available but not yet conclusive for publication of manuscripts.

Project collaborators in VEDCO, Makerere, and NaCRRI communicate regularly and co-organize events and activities in Kamuli. Most prominent during the past year have been the farmers' field day, training and experimentation with bean recipes, and the bean cook day completion. Occasionally, Ugandan collaborators visit the Rwandese collaborator and vice versa. Four ISU collaborators visited and participated in project activities in Uganda. In addition, ISU

specialists in development communication and agricultural and biosystems engineering traveled to Uganda to contribute to CSRL program and CRSP project activities. Similarly, Co-PIs from VEDCO, Makerere (along with the M.Sc. student in Food Science & Technology), and KIST, visited ISU to work and plan activities with the Lead PI and Co-PIs based at ISU.

Catherine Ndagire, MSc. in Food Science and Technology, disseminated her research findings on bean storage to the farmers in Kamuli District as did Simon Okiror, MSc in Agricultural Economics / Agribusiness, regarding his findings about marketing.

During the farmers' community field day, Co-PI Dorothy Nakimbugwe (Makerere University) and research technicians from NaCRRI staff made presentations on issues related to research findings to date. Proceedings of the day were video recorded and will be used in developing or refining training materials.

KIST Co-PI Hilda Vasanthakaalam has worked with the Centre for Communication and Extension of the Ministry of Agriculture. Several processing and value addition methods for selected bean varieties in Rwanda have completed in the Food Science & Technology lab at KIST. The results are being assembled in book form for publication. In addition, reports for three of the seven research projects carried out this year at KIST are being prepared for publication.

Degree Training:

Trainee #1
First and Other Given Names: Gerald
Last Name: Sebuwufu
Citizenship: Ugandan
Gender: Male
Degree: Ph.D.
Discipline: Agronomy
Host Country Institution to Benefit: National Crops Resources Research Institute, Uganda
Training Location: Iowa State University
Supervising CRSP PI: Mark Westgate
Start Date of Degree Program: August 2008
Program Completion Date: August 2012
Training Status during Fiscal Year 2010: full-time student
Type of CRSP Support (full, partial or indirect): Partial

Trainee #2
First and Other Given Names: Martin
Last Name: Mutambuka
Citizenship: Ugandan
Gender: Male
Degree training: Ph.D.
Discipline: Food Science and Human Nutrition
Host Country Institution to Benefit: Makerere University, Uganda
Training Location: Iowa State University
Supervising CRSP PI: Patricia Murphy
Start Date: January 2009

Projected Completion Date: May 2012
Type of CRSP Support (full, partial or indirect): Partial

Trainee #3
First and given names: Catherine Tamale
Last name: Ndagire
Citizenship: Ugandan
Gender: Female
Degree: M.Sc.
Discipline: Food Science & Technology
Host Country Institution to benefit: Makerere University, Uganda
Training Location: Makerere University and Iowa State University
Supervising CRSP PI: Dorothy Nakimbugwe
Start date: August 2009
Project completion date: May 2011
Type of CRSP Support (full, partial or indirect): Partial

Trainee #4
First and given names: George
Last name: Jjagwe
Citizenship: Ugandan
Gender: Male
Degree: M.Sc.
Discipline: Agricultural Extension & Education
Host Country Institution to benefit: Makerere University, Uganda
Training Location: Makerere University
Supervising CRSP PI: Dorothy Nakimbugwe (Co-PI Paul Kibwika)
Start date: August 2010
Project completion date: August 2012
Type of CRSP Support (full, partial or indirect): Partial

Short-Term Training:
Type of Training: Mentored refinement and implementation of lab experiments
Description of Training Activity: Development of nutritious, quick-cooking composite flour
Status of this Activity as of September 30, 2010: Completed
When did the Short Term Training Activity occur? May 18 – August 18, 2010
Location of Short Term Training: Iowa State University
If Training was not completed as planned, provide a rationale: N/A
Who benefitted from this Short Term Training Activity? Makerere University
Number of Beneficiaries by Gender: Male - 0
Female - 1
Total - 1

Explanation for Changes

Plans to assess the effect of bean consumption on human metabolism were eliminated due to logistical constraints and cost. Implementation would have required performing the activities in Uganda and Rwanda where the population is already consuming beans and is the target of new developed products, but the equipment and facilities required to collect primary data are not available in-country.

Networking and Linkages with Stakeholders

- NaCRRI recently received over 200 nutri-bean lines (lines high in iron, zinc and protein) from the University of Nairobi through CIAT for multiplication.
- Collaboration has been initiated and a Material Transfer Agreement (MTA) signed between CIAT-Colombia and Iowa State University. With this agreement, ISU will receive germplasm from breeders that reflects variation in drought and seed nutritive composition. Recombinant Inbred Lines and their parents will be very useful in understanding the physiology of seed nutrient composition.
- NaCRRI researchers Michael Otim (entomologist) and Pamella Paparu (pathologist) are developing research activities that will involve advanced training of farmers to identify insect pests (bean aphids, thrips, bean stem maggot and flower beetles) and diseases (bean root rot, web blight, and bean rust) and participatory evaluation of biological and cultural control for key pests and diseases, to reduce crop losses and diseases.
- VEDCO organized the first value chain stakeholder workshop in Kamuli in September, 2010, and is committed to playing a facilitative role to achieve success in value chain development for beans and maize. The initial workshop involved 25 participants from 15 organizations (farmer marketing groups and associations, government agencies, non-governmental organizations, private sector traders, transporters, distributors, and processors).
- Visits to ISU by Co-PIs from Makerere University (Uganda) and KIST (Rwanda) resulted in useful learning about parallel and complementary research interests, and discussions regarding bases for long term collaboration
- ISU faculty members visited Uganda – bringing expertise in agricultural and biosystems engineering, agronomy, development communications, human nutrition, and sociology.
- VEDCO holds biannual community review meetings in its areas of operation; CRSP project partners and farmers participate in these review and planning meetings.

Leveraged Funds
Name of PI receiving leveraged funds: Mark Westgate
Description of leveraged Project: Partial support for Ph.D. student from Uganda in Agronomy
Dollar Amount: $46,089
Funding Source: ISU

Name of PI receiving leveraged funds: Robert Mazur
Description of leveraged Project: Partial support for Ph.D. student from Uganda in Food Science & Human Nutrition
Dollar Amount: $46,089
Funding Source: ISU

List of Scholarly Activities and Accomplishments
Bikorimana, Alexis. 2009. "Effect of germination and fermentation on the nutritional composition." Final project report for B.S. degree. Department of Food Science & Technology. Kigali, Rwanda: Kigali Institute of Science and Technology.

Habanabakize, Telesphore. 2010. "Processing and product development of orange flesh sweet potato and dry beans blended flours for weaning foods.' Final project report for B.S. degree. Department of Food Science & Technology. Kigali, Rwanda: Kigali Institute of Science and Technology.

Habiyaremye, Idrissa. 2010. "Potential utilization of improved dry bean in the processing of cereal-legume weaning flour". Final project report for B.S. degree. Department of Food Science & Technology. Kigali, Rwanda: Kigali Institute of Science and Technology.

Karuhanga, William. 2010. " Processing of extruded snack food products using decalaya and colta varieties of bean based flour." Final project report for B.S. degree. Department of Food Science & Technology. Kigali, Rwanda: Kigali Institute of Science and Technology.

Kasabiiti, Annet. 2009. "Development of modified atmosphere to create an environment lethal for the survival of insects in stored beans." Final project report for B.S. degree. Department of Food Science & Technology. Kigali, Rwanda: Kigali Institute of Science and Technology.

Mugabo, Emmanuel. 2009. "Effect of combined treatments on the nutritional composition of beans." Final project report for B.S. degree. Department of Food Science & Technology. Kigali, Rwanda: Kigali Institute of Science and Technology.
Mulinda, Noel Valentin. 2010. "Effects of thermal processing techniques on the functional properties of dry common bean flours." Final project report for B.S. degree. Department of Food Science & Technology. Kigali, Rwanda: Kigali Institute of Science and Technology.

Musaazi, Aisha Nakitto. 2010. "Developing a quick-cooking bean flour." Final thesis for M.S. degree. Department of Food Science & Technology. Kampala, Uganda: Makerere University.

Mutambuka Martin, Murphy PA, Hendrich S, Reddy MB (2010). "Validation of ferritin assay protocol for screening high iron bioavailability *Phaseolus vulgaris* varieties." Poster presented at

the Eighth Annual Norman Borlaug Lectureship Poster Competition. Ames, Iowa: Iowa State University. Oct. 11, 2010.

Nkundabombi Marie Grace. 2010. "Processing of cold extruded deep fat fried snack food from bean (RWR22-45 and white variety) based composite flour." Final project report for B.S. degree. Department of Food Science & Technology. Kigali, Rwanda: Kigali Institute of Science and Technology.

Nyirabunani, Felecite. 2009. "Influence of different processing (soaking, germination, fermentation and puffing) on the bioavailability of selected amino acids in dried beans." Final project report for B.S. degree. Department of Food Science & Technology. Kigali, Rwanda: Kigali Institute of Science and Technology.

Okiror, Simon. 2010. "Analysis of Factors affecting market participation of smallholder bean farmers in Kamuli district, Uganda." Thesis for M.S. degree. Department of Agricultural Economics & Agribusiness. Kampala, Uganda: Makerere University.

Contribution of Project to Target USAID Performance Indicators

Our project has a strong record of achieving performance indicators/targets:

We have been mentoring 12 students for degree training, of whom 5 are women. Exceeding our original estimate is due to the efforts of Co-PI Nakimbugwe and Co-PI Vasanthakaalam who actively involve B.S. students in the CRSP project while they undertake research for their 4th year projects at Makerere University and KIST, respectively.

With regard to short term training, 58 women and 9 men have participated in a series of short-term training for farmers in Kamuli. Other members of their six farmer groups (which average 20-25 members each) have also participated in some of the training sessions, according to their respective interests.

As planned, we have progressed well in terms of the number of technologies and management practices that are under research (7), and under field testing (4), and ready to be made available for transfer (3).

The number of farmers receiving training and participating in the project's set of field trial experiments is 67, as planned. However, management practices and technologies are already being informally disseminated within the farmers' communities. The field day and community recipe extension demonstrations are benefitting an additional 200 households. Since CSRL's Kamuli program is now providing assistance to 1,200 farm households, we plan to utilize this opportunity in FY11 to begin disseminating applicable management practices and technologies to more farmers, monitoring and evaluating the process and impacts to identify any barriers and most effective strategies. In FY12, we expect to be able to reach even more farmers. Moreover, VEDCO's network of 30,500+ farm households in eleven other districts (VEDCO 2010) and NaCRRI's nationwide network will greatly facilitate even wider dissemination as project work continues and lessons are learned. Two farmers marketing associations are directly benefitting from project activities. We are providing technical assistance directly to six community based organizations (CBOs) and indirectly to an additional eight, as planned. Women constitute the

majority of members in these CBOs. There are four host country partner organizations benefitting, as planned.

The number of additional hectares under improved technologies or management practices (15) corresponds to what was originally anticipated.

The public-private sector partnership between Makerere University and Nutreal Limited is being established as a result of this USAID-funded project. Others may emerge as the bean value chain stakeholder forum in Kamuli continues and effectively realizes its goals.

Contribution to Gender Equity Goal

Among the team of research scientists and professional practitioners, there are 7 women and 5 men.

During the recently completed year, there are 2 female and 4 male students receiving graduate level training and mentorship in research at Makerere and ISU. There have been 4 female and 4 male undergraduate students involved in project research at KIST.

Of the 30 farmers participating directly in the field experiments, 24 are women; similarly, the majority (58 of 67) of farmers participating in project training sessions are women. Approximately two-thirds of the 150 participants in the farmer field day are women, as were the majority of those involved in the rural recipe training and 'bean cook day.'

Progress Report on Activities Funded Through Supplemental Funds

Supplemental funds were provided to cover travel and research expenses at Iowa State University for Catherine Ndagire, MSc student in Food Science & Technology at Makerere University, whose work focuses on development of a nutritious, quick-cooking composite bean-based flour. During her period of research at ISU (May 18 – August 18, 2010), Catherine received training and mentoring from ISU Co-PIs regarding refinement and implementation of a series of lab experiments and sensory evaluation. All planned research activities were completed on schedule. She also made a presentation of her research question, methodology, and results in early August before returning to Uganda.

Supplemental funds provided to KIST for the purchase of a single screw extruder and supplies have helped strengthen the research capacity in food extrusion methods in the Department of Food Science & Technology.

Literature Cited

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Bello AA & BO Okezie (1982) Effect of extraction conditions on the extractability of winged bean proteins. Paper presented at the fourth Biennial Research Symposium of the 1890 Land Grant College and State Universes, Oct. 27:258-261.

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Coffman CW & VV Gracia (1977) Functional Properties and amino acid content of protein isolate from mung bean flour. J. Food Tec., 12: 473- 484

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Kamala K (2009) www.cookatease.com/mixture-colourful-indian-snack

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Narayana K & MS Narasinga Rao (1982) Functional properties of raw and heat processed winged bean flour. J. Food Sci. 47: 1534-1538. Nutr. 1: 219- 229.

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VEDCO (2010) Annual Report 2009. Kampala, Uganda: Volunteer Efforts for Development Concerns.

Dry Grain Pulses CRSP
Report on the Achievement of "Semi-Annual Indicators of Progress"
(For the Period: April 1, 2010 -- September 30, 2010)

This form should be completed by the U.S. Lead PI and submitted to the MO by October 1, 2010

Project Title: **Enhancing Nutritional Value and Marketability of Beans through Research and Strengthening Key Value Chain Stakeholders in Uganda and Rwanda**

	Abbreviated name of institutions														
	Iowa State			Makerere			NaCCRI			VEDCO			KIST		
	Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved	
Benchmarks by Objectives	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*
	(Tick mark the Yes or No column for identified benchmarks by institution)														
Objective 1	***Improve Bean Quality and Yields***														
1a. Meta-analysis report on effect of water & temp. stress on yields	0			0			0			0			0		
1a. Completed experiments on sensitivity of varieties to water stress	0			0			0			0			0		
1a. Documented impact of stress on seed nutrient composition	0			0			0			0			0		
1a. Increased quantities of seed for processing & nutritional studies	0			0			0			0			0		
1a. Manuscripts on physiological studies & meta-analysis completed	x	√		0			x			0			0		
1a. Collaborative studies initiated, selected stress tolerant varieties	x	√		0			x			0			0		
1b. Collected and analyzed 2009 yield data	0			0			0			0			0		
1b. Analyzed 2009 seed composition from field trials	0			0			0			0			0		
1b. Document. impacts on quality from improved harvest & storage	0			0			0			0			0		
1b. Conducted 2010 trials using improved production practices	x	√		0			x			x			0		
1b. Confirmed yield and nutritional profile of priority varieties	x	√		0			x			0			0		
1b. Provided seed from field trials for analyses in Objective 2	x	√		0			x			0			0		
1b. Identified agro-ecological regions for using stress tolerance char.	x	√		0			x			0			0		
1c. Developed materials for post-harvest training	0			0			0			0			0		
1c. Completed farmers' training in pre- and post harvest handling	0			0			x			x			0		
1c. Evaluated influence of innovations on post-harvest losses	x	√		0			x			x			0		
1d. Farmers/group members trained in research methods	0			0			0			0			0		
1d. Open field days conducted at selected trial sites	0			0			0			0			0		
1d. Farmer knowledge put into practice for field trial	0			0			x			x			0		
1d. Trainee follow-up conducted	0			0			x			x			0		
1d. Recommended research results incorporated into training	0			0			x			x			0		
1d. Field days conducted	0			0			x			x			0		
1d. Results applied to other bean producing districts	0			0			x			x			0		
Objective 2	***Enhance the Nutritional Value and Appeal of Beans***														
2a. Nutritional analysis of effects of agronomy on harvested beans	x	√		x			0			0			0		
2a. Analysis of effects of processing on nutrition quality	x	√		x			0			0			0		
2b. Processing protocol for an extruded bean snack developed	0			0			0			0			0		
2b. Nutritional and sensory characteristics of bean snack optimized	0			0			0			0			0		

2b. Effects of processing on nutritional quality determined	0			0			0			0			0		
2b. Bean flour for soups & porridges produced from extruded flour	x		√	0			0			0			0		
2b. Effect of bean consumption on human metabolism assessed	x		√	0			0			0			0		
2c. Protocol for producing bean flour up scaled and refined	0			0			0			0			0		
2c. Recipes using bean flour developed & evaluated in competition	0			0			0			0			0		
2c. Winning recipes promoted in communities	0			x			0			0			x		
2c. Protocol for bean flour-based product developed and optimized	x	√		x			0			0			x		
2c. Contribution of bean-based products to nutrient intake assessed	x	√		x			0			0			x		
Objective 3	***Increase Marketing and Consumption of Beans and Bean Products***														
3a. Value chain and marketing analyses completed	0			0			0			0			0		
3a. Consumer requir. & market channels for bean flour identified	0			0			0			0			0		
3a. Successful producer marketing strategies identified	0			0			0			0			0		
3a. Market information system improved	x	√		x			x			x			0		
3a. Farmers/farmer orgs. trained in improved bean marketing	x	√		x			x			x			0		
3b. Consumer req. & market channels for bean products identified	0			0			0			0			0		
3b. Value of bean vars. and value-added prod. in markets identified	0			0			0			0			0		
3b. Consumer req. for the bean flour-based food determined	x	√		x			x			x			0		
3b. Farmers & farmer orgs. trained in developing marketing plans	x	√		x			x			x			0		
3c. Identification of successful marketing approaches	0			0			0			0			0		
3c. Producers trained on effective bean marketing	0			0			0			0			0		
3c. Producers trained on marketing for new beans products	x	√		x			x			x			0		
3c. Processors/value chain trained to market beans, new products	x	√		x			x			x			0		
Objective 4	***Incr. Capacity, Effectiveness & Sustainability of Ag. Research Institut.***														
Training 2 new M.S. (FST and AgEcon) at MAK initiated	0			0			0			0			0		
Training M.S. student in FST from Rwanda on-going	0			0			0			0			0		
Training 3 M.S. students at Makerere University completed	0			x			0			0			x		
Training 2 Ph.D. at Iowa State University ongoing	x	√		0			0			0			0		
Inter-organizational learning fostered	x	√		x			x			x			x		
Preliminary results disseminated (conferences, publications, websites)	x	√		x			x			x			x		

Name of the PI reporting on benchmarks by institution	R. Mazur	D. Nakimbigwe	M. Ugen	H.K. Musoke	H. Vasanthakaalam

Name of the U.S. Lead PI submitting this Report to the MO **Robert E. Mazur**

M Mazur
Signature

09/30/10
Date

* *Please provide an explanation for not achieving the benchmark indicators on a separate sheet.*

Dry Grain Pulses CRSP
Report on the Achievement of "Semi-Annual Indicators of Progress"
(For the Period: April 1, 2010 -- September 30, 2010)

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	Abbreviated name of institutions														
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	Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved	
Benchmarks by Objectives	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*
	(Tick mark the Yes or No column for identified benchmarks by institution)														
Objective 1	***Improve Bean Quality and Yields***														
1a. Meta-analysis report on effect of water & temp. stress on yields	0			0			0			0			0		
1a. Completed experiments on sensitivity of varieties to water stress	0			0			0			0			0		
1a. Documented impact of stress on seed nutrient composition	0			0			0			0			0		
1a. Increased quantities of seed for processing & nutritional studies	0			0			0			0			0		
1a. Manuscripts on physiological studies & meta-analysis completed	x			0			x			0			0		
1a. Collaborative studies initiated, selected stress tolerant varieties	x			0			x			0			0		
1b. Collected and analyzed 2009 yield data	0			0			0			0			0		
1b. Analyzed 2009 seed composition from field trials	0			0			0			0			0		
1b. Document. impacts on quality from improved harvest & storage	0			0			0			0			0		
1b. Conducted 2010 trials using improved production practices	x			0			x			x			0		
1b. Confirmed yield and nutritional profile of priority varieties	x			0			x			0			0		
1b. Provided seed from field trials for analyses in Objective 2	x			0			x			0			0		
1b. Identified agro-ecological regions for using stress tolerance char.	x			0			x			0			0		
1c. Developed materials for post-harvest training	0			0			0			0			0		
1c. Completed farmers' training in pre- and post harvest handling	0			0			x			x			0		
1c. Evaluated influence of innovations on post-harvest losses	x			0			x			x			0		
1d. Farmers/group members trained in research methods	0			0			0			0			0		
1d. Open field days conducted at selected trial sites	0			0			0			0			0		
1d. Farmer knowledge put into practice for field trial	0			0			x			x			0		
1d. Trainee follow-up conducted	0			0			x			x			0		
1d. Recommended research results incorporated into training	0			0			x			x			0		
1d. Field days conducted	0			0			x			x			0		
1d. Results applied to other bean producing districts	0			0			x			x			0		
Objective 2	***Enhance the Nutritional Value and Appeal of Beans***														
2a. Nutritional analysis of effects of agronomy on harvested beans	x			x	Y		0			0			0		
2a. Analysis of effects of processing on nutrition quality	x			x	Y		0			0			0		
2b. Processing protocol for an extruded bean snack developed	0			0			0			0			0		
2b. Nutritional and sensory characteristics of bean snack optimized	0			0			0			0			0		

2b. Effects of processing on nutritional quality determined	0			0			0			0			0		
2b. Bean flour for soups & porridges produced from extruded flour	x			0			0			0			0		
2b. Effect of bean consumption on human metabolism assessed	x			0			0			0			0		
2c. Protocol for producing bean flour up scaled and refined	0			0			0			0			0		
2c. Recipes using bean flour developed & evaluated in competition	0			0			0			0			0		
2c. Winning recipes promoted in communities	0			x	Y		0			0			x		
2c. Protocol for bean flour-based product developed and optimized	x			x	Y		0			0			x		
2c. Contribution of bean-based products to nutrient intake assessed	x			x	Y		0			0			x		
Objective 3	***Increase Marketing and Consumption of Beans and Bean Products***														
3a. Value chain and marketing analyses completed	0			0			0			0			0		
3a. Consumer requir. & market channels for bean flour identified	0			0			0			0			0		
3a. Successful producer marketing strategies identified	0			0			0			0			0		
3a. Market information system improved	x			x	Y		x			x			0		
3a. Farmers/farmer orgs. trained in improved bean marketing	x			x	Y		x			x			0		
3b. Consumer req. & market channels for bean products identified	0			0			0			0			0		
3b. Value of bean vars. and value-added prod. in markets identified	0			0			0			0			0		
3b. Consumer req. for the bean flour-based food determined	x			x	Y		x			x			0		
3b. Farmers & farmer orgs. trained in developing marketing plans	x			x	Y		x			x			0		
3c. Identification of successful marketing approaches	0			0			0			0			0		
3c. Producers trained on effective bean marketing	0			0			0			0			0		
3c. Producers trained on marketing for new beans products	x			x	Y		x			x			0		
3c. Processors/value chain trained to market beans, new products	x			x	Y		x			x			0		
Objective 4	***Incr. Capacity, Effectiveness & Sustainability of Ag. Research Institut.***														
Training 2 new M.S. (FST and AgEcon) at MAK initiated	0			0	Y		0			0			0		
Training M.S. student in FST from Rwanda on-going	0			0			0			0			0		
Training 3 M.S. students at Makerere University completed	0			x	Y		0			0			x		
Training 2 Ph.D. at Iowa State University ongoing	x			0			0			0			0		
Inter-organizational learning fostered	x			x	Y		x			x			x		
Preliminary results disseminated (conferences, publications, websites)	x			x	Y		x			x			x		

Name of the PI reporting on benchmarks by institution	R. Mazur	D. Nakimbugwe	M. Ugen	H.K. Musoke	H. Vasanthakaalam

Name of the U.S. Lead PI submitting this Report to the MO

Signature

30th Sept. 2010
Date

* *Please provide an explanation for not achieving the benchmark indicators on a separate sheet.*

Dry Grain Pulses CRSP

Report on the Achievement of "Semi-Annual Indicators of Progress"

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	Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved	
Benchmarks by Objectives	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*
	(Tick mark the Yes or No column for identified benchmarks by institution)														
Objective 1	***Improve Bean Quality and Yields***														
1a. Meta-analysis report on effect of water & temp. stress on yields	0			0			0			0			0		
1a. Completed experiments on sensitivity of varieties to water stress	0			0			0			0			0		
1a. Documented impact of stress on seed nutrient composition	0			0			0			0			0		
1a. Increased quantities of seed for processing & nutritional studies	0			0			0			0			0		
1a. Manuscripts on physiological studies & meta-analysis completed	x			0			x	Y		0			0		
1a. Collaborative studies initiated, selected stress tolerant varieties	x			0			x	Y		0			0		
1b. Collected and analyzed 2009 yield data	0			0			0			0			0		
1b. Analyzed 2009 seed composition from field trials	0			0			0			0			0		
1b. Document. impacts on quality from improved harvest & storage	0			0			0			0			0		
1b. Conducted 2010 trials using improved production practices	x			0			x	Y		x			0		
1b. Confirmed yield and nutritional profile of priority varieties	x			0			x	Y		0			0		
1b. Provided seed from field trials for analyses in Objective 2	x			0			x	Y		0			0		
1b. Identified agro-ecological regions for using stress tolerance char.	x			0			x	Y		0			0		
1c. Developed materials for post-harvest training	0			0			0			0			0		
1c. Completed farmers' training in pre- and post harvest handling	0			0			x	Y		x			0		
1c. Evaluated influence of innovations on post-harvest losses	x			0			x	Y		x			0		
1d. Farmers/group members trained in research methods	0			0			0			0			0		
1d. Open field days conducted at selected trial sites	0			0			0			0			0		
1d. Farmer knowledge put into practice for field trial	0			0			x	Y		x			0		
1d. Trainee follow-up conducted	0			0			x	Y		x			0		
1d. Recommended research results incorporated into training	0			0			x	Y		x			0		
1d. Field days conducted	0			0			x	Y		x			0		
1d. Results applied to other bean producing districts	0			0			x	Y		x			0		
Objective 2	***Enhance the Nutritional Value and Appeal of Beans***														
2a. Nutritional analysis of effects of agronomy on harvested beans	x			x			0			0			0		
2a. Analysis of effects of processing on nutrition quality	x			x			0			0			0		
2b. Processing protocol for an extruded bean snack developed	0			0			0			0			0		
2b. Nutritional and sensory characteristics of bean snack optimized	0			0			0			0			0		

2b. Effects of processing on nutritional quality determined	0			0			0			0			0		
2b. Bean flour for soups & porridges produced from extruded flour	x			0			0			0			0		
2b. Effect of bean consumption on human metabolism assessed	x			0			0			0			0		
2c. Protocol for producing bean flour up scaled and refined	0			0			0			0			0		
2c. Recipes using bean flour developed & evaluated in competition	0			0			0			0			0		
2c. Winning recipes promoted in communities	0			x			0			0			x		
2c. Protocol for bean flour-based product developed and optimized	x			x			0			0			x		
2c. Contribution of bean-based products to nutrient intake assessed	x			x			0			0			x		
Objective 3	***Increase Marketing and Consumption of Beans and Bean Products***														
3a. Value chain and marketing analyses completed	0			0			0			0			0		
3a. Consumer requir. & market channels for bean flour identified	0			0			0			0			0		
3a. Successful producer marketing strategies identified	0			0			0			0			0		
3a. Market information system improved	x			x			x	Y		x			0		
3a. Farmers/farmer orgs. trained in improved bean marketing	x			x			x	Y		x			0		
3b. Consumer req. & market channels for bean products identified	0			0			0			0			0		
3b. Value of bean vars. and value-added prod. in markets identified	0			0			0			0			0		
3b. Consumer req. for the bean flour-based food determined	x			x			x	Y		x			0		
3b. Farmers & farmer orgs. trained in developing marketing plans	x			x			x	Y		x			0		
3c. Identification of successful marketing approaches	0			0			0			0			0		
3c. Producers trained on effective bean marketing	0			0			0			0			0		
3c. Producers trained on marketing for new beans products	x			x			x	Y		x			0		
3c. Processors/value chain trained to market beans, new products	x			x			x	Y		x			0		
Objective 4	***Incr. Capacity, Effectiveness & Sustainability of Ag. Research Institut.***														
Training 2 new M.S. (FST and AgEcon) at MAK initiated	0			0			0			0			0		
Training M.S. student in FST from Rwanda on-going	0			0			0			0			0		
Training 3 M.S. students at Makerere University completed	0			x			0			0			x		
Training 2 Ph.D. at Iowa State University ongoing	x			0			0			0			0		
Inter-organizational learning fostered	x			x			x	Y		x			x		
Preliminary results disseminated (conferences, publications, websites)	x			x			x	Y		x			x		

Name of the PI reporting on benchmarks by institution	R. Mazur	D. Nakimbigwe	M. Ugen	H.K. Musoke	H. Vasanthakaalam

Name of the U.S. Lead PI submitting this Report to the MO

Signature **Date**

** Please provide an explanation for not achieving the benchmark indicators on a separate sheet.*

Dry Grain Pulses CRSP

Report on the Achievement of "Semi-Annual Indicators of Progress"

(For the Period: April 1, 2010 -- September 30, 2010)

This form should be completed by the U.S. Lead PI and submitted to the MO by October 1, 2010

Project Title: Enhancing Nutritional Value and Marketability of Beans through Research and Strengthening Key Value Chain Stakeholders in Uganda and Rwanda

	Abbreviated name of institutions														
	Iowa State			Makerere			NaCCRI			VEDCO			KIST		
	Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved	
Benchmarks by Objectives	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*
	(Tick mark the Yes or No column for identified benchmarks by institution)														
Objective 1	*Improve Bean Quality and Yields*														
1a. Meta-analysis report on effect of water & temp. stress on yields	0			0			0			0			0		
1a. Completed experiments on sensitivity of varieties to water stress	0			0			0			0			0		
1a. Documented impact of stress on seed nutrient composition	0			0			0			0			0		
1a. Increased quantities of seed for processing & nutritional studies	0			0			0			0			0		
1a. Manuscripts on physiological studies & meta-analysis completed	x			0			x			0			0		
1a. Collaborative studies initiated, selected stress tolerant varieties	x			0			x			0			0		
1b. Collected and analyzed 2009 yield data	0			0			0			0			0		
1b. Analyzed 2009 seed composition from field trials	0			0			0			0			0		
1b. Document. impacts on quality from improved harvest & storage	0			0			0			0			0		
1b. Conducted 2010 trials using improved production practices	x			0			x			x	√		0		
1b. Confirmed yield and nutritional profile of priority varieties	x			0			x			0			0		
1b. Provided seed from field trials for analyses in Objective 2	x			0			x			0			0		
1b. Identified agro-ecological regions for using stress tolerance char.	x			0			x			0			0		
1c. Developed materials for post-harvest training	0			0			0			0			0		
1c. Completed farmers' training in pre- and post harvest handling	0			0			x			x	√		0		
1c. Evaluated influence of innovations on post-harvest losses	x			0			x			x	√		0		
1d. Farmers/group members trained in research methods	0			0			0			0			0		
1d. Open field days conducted at selected trial sites	0			0			0			0			0		
1d. Farmer knowledge put into practice for field trial	0			0			x			x	√		0		
1d. Trainee follow-up conducted	0			0			x			x	√		0		
1d. Recommended research results incorporated into training	0			0			x			x	√		0		
1d. Field days conducted	0			0			x			x	√		0		
1d. Results applied to other bean producing districts	0			0			x			x	√		0		
Objective 2	*Enhance the Nutritional Value and Appeal of Beans*														
2a. Nutritional analysis of effects of agronomy on harvested beans	x			x			0			0			0		
2a. Analysis of effects of processing on nutrition quality	x			x			0			0			0		
2b. Processing protocol for an extruded bean snack developed	0			0			0			0			0		
2b. Nutritional and sensory characteristics of bean snack optimized	0			0			0			0			0		

2b. Effects of processing on nutritional quality determined	0			0			0			0			0		
2b. Bean flour for soups & porridges produced from extruded flour	x			0			0			0			0		
2b. Effect of bean consumption on human metabolism assessed	x			0			0			0			0		
2c. Protocol for producing bean flour up scaled and refined	0			0			0			0			0		
2c. Recipes using bean flour developed & evaluated in competition	0			0			0			0			0		
2c. Winning recipes promoted in communities	0			x			0			0			x		
2c. Protocol for bean flour-based product developed and optimized	x			x			0			0			x		
2c. Contribution of bean-based products to nutrient intake assessed	x			x			0			0			x		
Objective 3	***Increase Marketing and Consumption of Beans and Bean Products***														
3a. Value chain and marketing analyses completed	0			0			0			0			0		
3a. Consumer requir. & market channels for bean flour identified	0			0			0			0			0		
3a. Successful producer marketing strategies identified	0			0			0			0			0		
3a. Market information system improved	x			x			x			x	√		0		
3a. Farmers/farmer orgs. trained in improved bean marketing	x			x			x			x	√		0		
3b. Consumer-req. & market channels for bean products identified	0			0			0			0			0		
3b. Value of bean vars. and value-added prod. in markets identified	0			0			0			0			0		
3b. Consumer req. for the bean flour-based food determined	x			x			x			x	√		0		
3b. Farmers & farmer orgs. trained in developing marketing plans	x			x			x			x	√		0		
3c. Identification of successful marketing approaches	0			0			0			0			0		
3c. Producers trained on effective bean marketing	0			0			0			0			0		
3c. Producers trained on marketing for new beans products	x			x			x			x	√		0		
3c. Processors/value chain trained to market beans, new products	x			x			x			x	√		0		
Objective 4	***Incr. Capacity, Effectiveness & Sustainability of Ag. Research Institut.***														
Training 2 new M.S. (FST and AgEcon) at MAK initiated	0			0			0			0			0		
Training M.S. student in FST from Rwanda on-going	0			0			0			0			0		
Training 3 M.S. students at Makerere University completed	0			x			0			0			x		
Training 2 Ph.D. at Iowa State University ongoing	x			0			0			0			0		
Inter-organizational learning fostered	x			x			x			x	√		x		
Preliminary results disseminated (conferences, publications, websites)	x			x			x			x	√		x		

Name of the PI reporting on benchmarks by institution	R. Mazur	D. Nakimbigwe	M. Ugen	H.K. Musoke	H. Vasanthakaalam

Name of the U.S. Lead PI submitting this Report to the MO

Signature

23/9/2010

Date

** Please provide an explanation for not achieving the benchmark indicators on a separate sheet.*

Dry Grain Pulses CRSP

Report on the Achievement of "Semi-Annual Indicators of Progress"

(For the Period: April 1, 2010 -- September 30, 2010)

This form should be completed by the U.S. Lead PI and submitted to the MO by October 1, 2010

Project Title: Enhancing Nutritional Value and Marketability of Beans through Research and Strengthening Key Value Chain Stakeholders in Uganda and Rwanda

	Abbreviated name of institutions														
	Iowa State			Makerere			NaCCRI			VEDCO			KIST		
	Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved	
Benchmarks by Objectives	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*
	(Tick mark the Yes or No column for identified benchmarks by institution)														
Objective 1	*Improve Bean Quality and Yields*														
1a. Meta-analysis report on effect of water & temp. stress on yields	0			0			0			0			0		
1a. Completed experiments on sensitivity of varieties to water stress	0			0			0			0			0		
1a. Documented impact of stress on seed nutrient composition	0			0			0			0			0		
1a. Increased quantities of seed for processing & nutritional studies	0			0			0			0			0		
1a. Manuscripts on physiological studies & meta-analysis completed	x			0			x			0			0		
1a. Collaborative studies initiated, selected stress tolerant varieties	x			0			x			0			0		
1b. Collected and analyzed 2009 yield data	0			0			0			0			0		
1b. Analyzed 2009 seed composition from field trials	0			0			0			0			0		
1b. Document. impacts on quality from improved harvest & storage	0			0			0			0			0		
1b. Conducted 2010 trials using improved production practices	x			0			x			x	√		0		
1b. Confirmed yield and nutritional profile of priority varieties	x			0			x			0			0		
1b. Provided seed from field trials for analyses in Objective 2	x			0			x			0			0		
1b. Identified agro-ecological regions for using stress tolerance char.	x			0			x			0			0		
1c. Developed materials for post-harvest training	0			0			0			0			0		
1c. Completed farmers' training in pre- and post harvest handling	0			0			x			x	√		0		
1c. Evaluated influence of innovations on post-harvest losses	x			0			x			x	√		0		
1d. Farmers/group members trained in research methods	0			0			0			0			0		
1d. Open field days conducted at selected trial sites	0			0			0			0			0		
1d. Farmer knowledge put into practice for field trial	0			0			x			x	√		0		
1d. Trainee follow-up conducted	0			0			x			x	√		0		
1d. Recommended research results incorporated into training	0			0			x			x	√		0		
1d. Field days conducted	0			0			x			x	√		0		
1d. Results applied to other bean producing districts	0			0			x			x	√		0		
Objective 2	*Enhance the Nutritional Value and Appeal of Beans*														
2a. Nutritional analysis of effects of agronomy on harvested beans	x			x			0			0			0		
2a. Analysis of effects of processing on nutrition quality	x			x			0			0			0		
2b. Processing protocol for an extruded bean snack developed	0			0			0			0			0		
2b. Nutritional and sensory characteristics of bean snack optimized	0			0			0			0			0		

2b. Effects of processing on nutritional quality determined	0			0			0			0			0		
2b. Bean flour for soups & porridges produced from extruded flour	x			0			0			0			0		
2b. Effect of bean consumption on human metabolism assessed	x			0			0			0			0		
2c. Protocol for producing bean flour up scaled and refined	0			0			0			0			0		
2c. Recipes using bean flour developed & evaluated in competition	0			0			0			0			0		
2c. Winning recipes promoted in communities	0			x			0			0			x		
2c. Protocol for bean flour-based product developed and optimized	x			x			0			0			x		
2c. Contribution of bean-based products to nutrient intake assessed	x			x			0			0			x		
Objective 3	***Increase Marketing and Consumption of Beans and Bean Products***														
3a. Value chain and marketing analyses completed	0			0			0			0			0		
3a. Consumer requir. & market channels for bean flour identified	0			0			0			0			0		
3a. Successful producer marketing strategies identified	0			0			0			0			0		
3a. Market information system improved	x			x			x			x	√		0		
3a. Farmers/farmer orgs. trained in improved bean marketing	x			x			x			x	√		0		
3b. Consumer-req. & market channels for bean products identified	0			0			0			0			0		
3b. Value of bean vars. and value-added prod. in markets identified	0			0			0			0			0		
3b. Consumer req. for the bean flour-based food determined	x			x			x			x	√		0		
3b. Farmers & farmer orgs. trained in developing marketing plans	x			x			x			x	√		0		
3c. Identification of successful marketing approaches	0			0			0			0			0		
3c. Producers trained on effective bean marketing	0			0			0			0			0		
3c. Producers trained on marketing for new beans products	x			x			x			x	√		0		
3c. Processors/value chain trained to market beans, new products	x			x			x			x	√		0		
Objective 4	***Incr. Capacity, Effectiveness & Sustainability of Ag. Research Institut.***														
Training 2 new M.S. (FST and AgEcon) at MAK initiated	0			0			0			0			0		
Training M.S. student in FST from Rwanda on-going	0			0			0			0			0		
Training 3 M.S. students at Makerere University completed	0			x			0			0			x		
Training 2 Ph.D. at Iowa State University ongoing	x			0			0			0			0		
Inter-organizational learning fostered	x			x			x			x	√		x		
Preliminary results disseminated (conferences, publications, websites)	x			x			x			x	√		x		

Name of the PI reporting on benchmarks by institution	R. Mazur	D. Nakimbigwe	M. Ugen	H.K. Musoke	H. Vasanthakaalam

Name of the U.S. Lead PI submitting this Report to the MO

Signature

23/9/2010

Date

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Dry Grain Pulses CRSP
Report on the Achievement of "Semi-Annual Indicators of Progress"
(For the Period: April 1, 2010 -- September 30, 2010)

This form should be completed by the U.S. Lead PI and submitted to the MO by October 1, 2010

Project Title: **Enhancing Nutritional Value and Marketability of Beans through Research and Strengthening Key Value Chain Stakeholders in Uganda and Rwanda**

	Abbreviated name of institutions														
	Iowa State			Makerere			NaCCRI			VEDCO			KIST		
	Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved	
Benchmarks by Objectives	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*	9/30/10	Y	N*
	(Tick mark the Yes or No column for identified benchmarks by institution)														
Objective 1	***Improve Bean Quality and Yields***														
1a. Meta-analysis report on effect of water & temp. stress on yields	0			0			0			0			0		
1a. Completed experiments on sensitivity of varieties to water stress	0			0			0			0			0		
1a. Documented impact of stress on seed nutrient composition	0			0			0			0			0		
1a. Increased quantities of seed for processing & nutritional studies	0			0			0			0			0		
1a. Manuscripts on physiological studies & meta-analysis completed	x			0			x			0			0		
1a. Collaborative studies initiated, selected stress tolerant varieties	x			0			x			0			0		
1b. Collected and analyzed 2009 yield data	0			0			0			0			0		
1b. Analyzed 2009 seed composition from field trials	0			0			0			0			0		
1b. Document. impacts on quality from improved harvest & storage	0			0			0			0			0		
1b. Conducted 2010 trials using improved production practices	x			0			x			x			0		
1b. Confirmed yield and nutritional profile of priority varieties	x			0			x			0			0		
1b. Provided seed from field trials for analyses in Objective 2	x			0			x			0			0		
1b. Identified agro-ecological regions for using stress tolerance char.	x			0			x			0			0		
1c. Developed materials for post-harvest training	0			0			0			0			0		
1c. Completed farmers' training in pre- and post harvest handling	0			0			x			x			0		
1c. Evaluated influence of innovations on post-harvest losses	x			0			x			x			0		
1d. Farmers/group members trained in research methods	0			0			0			0			0		
1d. Open field days conducted at selected trial sites	0			0			0			0			0		
1d. Farmer knowledge put into practice for field trial	0			0			x			x			0		
1d. Trainee follow-up conducted	0			0			x			x			0		
1d. Recommended research results incorporated into training	0			0			x			x			0		
1d. Field days conducted	0			0			x			x			0		
1d. Results applied to other bean producing districts	0			0			x			x			0		
Objective 2	***Enhance the Nutritional Value and Appeal of Beans***														
2a. Nutritional analysis of effects of agronomy on harvested beans	x			x			0			0			0		
2a. Analysis of effects of processing on nutrition quality	x			x			0			0			0		
2b. Processing protocol for an extruded bean snack developed	0			0			0			0			0		
2b. Nutritional and sensory characteristics of bean snack optimized	0			0			0			0			0		

2b. Effects of processing on nutritional quality determined	0			0			0			0			0		
2b. Bean flour for soups & porridges produced from extruded flour	x			0			0			0			0		
2b. Effect of bean consumption on human metabolism assessed	x			0			0			0			0		
2c. Protocol for producing bean flour up scaled and refined	0			0			0			0			0		
2c. Recipes using bean flour developed & evaluated in competition	0			0			0			0			0		
2c. Winning recipes promoted in communities	0			x			0			0			x	√	
2c. Protocol for bean flour-based product developed and optimized	x			x			0			0			x	√	
2c. Contribution of bean-based products to nutrient intake assessed	x			x			0			0			x	*	✗
Objective 3	***Increase Marketing and Consumption of Beans and Bean Products***														
3a. Value chain and marketing analyses completed	0			0			0			0			0		
3a. Consumer requir. & market channels for bean flour identified	0			0			0			0			0		
3a. Successful producer marketing strategies identified	0			0			0			0			0		
3a. Market information system improved	x			x			x			x			0		
3a. Farmers/farmer orgs. trained in improved bean marketing	x			x			x			x			0		
3b. Consumer req. & market channels for bean products identified	0			0			0			0			0		
3b. Value of bean vars. and value-added prod. in markets identified	0			0			0			0			0		
3b. Consumer req. for the bean flour-based food determined	x			x			x			x			0		
3b. Farmers & farmer orgs. trained in developing marketing plans	x			x			x			x			0		
3c. Identification of successful marketing approaches	0			0			0			0			0		
3c. Producers trained on effective bean marketing	0			0			0			0			0		
3c. Producers trained on marketing for new beans products	x			x			x			x			0		
3c. Processors/value chain trained to market beans, new products	x			x			x			x			0		
Objective 4	***Incr. Capacity, Effectiveness & Sustainability of Ag. Research Institut.***														
Training 2 new M.S. (FST and AgEcon) at MAK initiated	0			0			0			0			0		
Training M.S. student in FST from Rwanda on-going	0			0			0			0			0		
Training 3 M.S. students at Makerere University completed	0			x			0			0			x	*	✗
Training 2 Ph.D. at Iowa State University ongoing	x			0			0			0			0		
Inter-organizational learning fostered	x			x			x			x			x	√	
Preliminary results disseminated (conferences, publications, websites)	x			x			x			x			x	√	

Name of the PI reporting on benchmarks by institution	R. Mazur	D. Nakimbigwe	M. Ugen	H.K. Musoke	H. Vasanthakaalam

Name of the U.S. Lead PI submitting this Report to the MO

Hilda Vasanthakaalam 30/09/10

Signature **Date**

* *Please provide an explanation for not achieving the benchmark indicators on a separate sheet.*

Dry Grain Pulses CRSP
Research, Training and Outreach Workplans
(October 1, 2009 – September 30, 2010)

PERFORMANCE INDICATORS
for Foreign Assistance Framework and the Initiative to End Hunger in Africa (IEHA)

Project Title: Enhancing Nutritional Value and Marketability of Beans through Research and Strengthening Key Value Chain Stakeholders in Uganda and Rwanda
Lead U.S. PI and University: Robert E. Mazur, Iowa State University
Host Country(s): Uganda, Rwanda

Output Indicators	2010 Target (October 1 2009-Sept 30, 2010)	2010 Actual (October 1 2009-Sept 30, 2010)
Degree Training: Number of individuals enrolled in degree training		
Number of women	1	2
Number of men	4	4
Short-term Training: Number of individuals who received short-term training		
Number of women	56	56
Number of men	11	11
Technologies and Policies		
Number of technologies and management practices under research	7	7
Number of technologies and management practices under field testing	4	4
Number of technologies and management practices made available for transfer	3	3
Number of policy studies undertaken	0	0
Beneficiaries:		
Number of rural households benefiting directly	67	67
Number of agricultural firms/enterprises benefiting	2	2
Number of producer and/or community-based organizations receiving technical assistance	14	14
Number of women organizations receiving technical assistance	14	14
Number of HC partner organizations/institutions benefiting	4	4
Developmental outcomes:		
Number of additional hectares under improved technologies or management practices	15	15
Public-Private Sector Partnerships		
Number of public-private sector partnerships formed as a result of USAID assistance	USAID added 09/09	0