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
Activities during the past year have produced important achievements with regard to project research and development goals. In order to improve bean quality and yield (objective 1), adaptive research and trainings with farmers have focused on critical management practices and technologies: local community-based production and sale of quality seed; improved post-harvest storage through solarization and triple bagging; training in group dynamics and gender equity; strengthening group capacity and sustainability; and exchange visits with other farmer groups. Research continues on bean variety and fertilizer interactions that best increase yield. To be able to effectively consolidate learning and to disseminate management practices to new farmers, extension materials using various media are being refined and translated into local languages.

To enhance nutritional value, appeal and consumption of beans (objective 2), we have developed appealing bean-based products, and are teaching farmers about useful ways to prepare bean products. Research had been performed to determine the starch digestibility and the sensory acceptability of a bean-based porridge to be used as a weaning food which maximizes protein. Tests were also performed to evaluate the culinary and sensory characteristics of four local and five improved bean varieties. Farmers have been taught how to prepare the bean flour, how to use it in making soup, and how to use it to augment or substitute for other ingredients in cooking. To increase knowledge retention and accessibility, extension materials were developed on topics such as the basics of feeding young children, methods of preparing beans to reduce cooking time and increase nutrient availability, and how to prepare and use the bean-based flour.

In terms of increasing marketing and consumption of beans and bean products (objective 3), the focus has primarily been on strengthening farmers' groups for analyzing opportunities and constraints associated with collective marketing, and then implementation of strategic plans. Training sessions increased farmers' understanding of group dynamics and business management, and facilitated initial success in marketing collectively. Promotion of new ways of processing and consuming beans is ongoing in rural communities, and urban sales and use of bean-based products are advancing via partnerships with private sector businesses and NGOs.

Project Problem Statement and Justification

Agriculture in East Africa is characterized by women and men working in small scale, rainfed production on fields of poor soil fertility, 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, quality seed, technologies to improve yields and reduce post-harvest losses, and credit. Losses are very high throughout the bean value chain due to poor harvest and post-harvest practices and poor on-farm storage facilities. Beans on the market are typically poor quality and infested. Producers are not well linked to profitable markets, especially emerging sectors of domestic and regional markets. Traders operate on a small scale with limited investment capability. Availability and use of processed products remains very modest. Hunger and poverty are widespread.

The lack of value-added bean products having reduced preparation times makes bean preparation laborious with high fuel requirements; consumers tire of monotonous flavor, reducing their bean consumption despite documented high nutrient content and health benefits. Optimized processing (de-hulling, soaking, milling, fermentation and germination and cooking can enhance digestibility and nutritional value by reducing phytates and polyphenols that limit iron uptake, and can create value-added bean-based 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 understanding prospects for increasing demand for beans and agro-processed products through collaboration with private sector businesses.

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 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.

The objectives of our research, therefore, are to:

1. Improve harvested bean yields and quality.
2. Enhance Nutritional Value and Appeal of Beans through Appropriate Handling and Processing.
3. Identify solutions for constraints to increased marketing and consumption.
4. Increase the capacity, effectiveness and sustainability of agriculture research institutions that serve the bean sector in Uganda and Rwanda.

Results, Achievements and Outputs of Research

Objective 1: Improve harvested bean yields and quality.

Improve Yields and Quality through Evaluation of Better Production Practices

For seasons 2010B and 2011A, 12 trials were set up – two with each of the six farmers groups. For each season, trials were set up with different farmers in each group. Three varieties - K131, NABE 4, and Kanyebwa (farmers variety) were compared under four fertility treatments. The fertility treatments were: (1) Control - no fertilizer added, (2) FYM alone - (9 kg per plot- 10 T/ha), (3) Phosphorous alone - (36 g/plot - 40 kg/ha), and (4) FYM (4.5 kg/plot - 0.5 T/ha) and Phosphorous (18 g/plot - 20 kg/ha). The experiments were set in a randomized complete block design with two replicates. Each on-farm trail had 24 plots each 3 m x 3 m. For season 2011A, an additional 30 seed health trial plots each 3 x 3 m were set up with each of the six farmer groups. Comparative analyses from seed health experiments are ongoing. Similar trails were established for the second season (2011B) but with FYM and Phosphorous amendments as (7.5 kg and 15 kg per plot) and (54 g and 108 g per plot), respectively, because laboratory soil analysis indicated lower levels of both P and N for the six trial sites.

At physiological maturity, beans were harvested from each plot and the following data were collected: number of plants per plot, number of pods per plant determined from 20 randomly chosen plants per plot, number of seeds per pod from 20 randomly chosen pods per plot, total yield per plot, clean yield per plot (shriveled, discolored, cracked seed removed), 100 seed weight, and moisture content for seeds from the various plots was also determined. The seed weight/yield was standardized to 13% moisture content and yield adjusted to kg/ha. Data from each of the seasons were analyzed separately analyzed using PROC GLM in SAS.

Nitrogen and phosphorous are major nutrients required for good plant growth and development to achieve higher yields. Deficiency of both nutrients leads to stunting of bean plants, poor flowering, and flower abortion and, thus, low yields. Nitrogen and phosphorous were generally limiting in the soils used for the trials and their application was aimed at increasing their availability in the soil for plant utilization. The trials demonstrated to farmers the need for soil fertility improvement so as to get better yields. However, the modest increases in yield also demonstrated the complexity of getting consistent and dramatic increases in yield given the differences in trial management by farmers, local environments and trial sites.

For Season 2010B, Analysis of Variance showed that there were significant effects of variety ($p<0.0102$) and location ($p<0.0001$) on total yields of the three bean varieties tested. Variety by location ($p<0.0007$) and variety by fertility treatment ($p<0.0387$) interactions were also

significant. Main effects of fertility treatment on yields were, however, not significant. ANOVA for clean yields had a similar pattern.

Across locations (farmer fields), K131 showed more stability in yield with average yields 365-668 kg/ha, and with 50% of total yields above the variety average of 499 kg/ha. This was followed by NABE4, with total average yields 201-562 kg/ha and 62.5% of the locations having average total yields above the variety average of 380 kg/ha. Variation in yields was greatest for Kanyebwa, with average total yields ranging from 36-570 kg/ha, and only 37.5% of the locations having average total yields above the variety average of 312 kg/ha.

Table 1: Effect of Fertility Treatment on Total and Clean Bean Yield - 2010B Season

Fertility Treatment	**Total Yield (Kg/ha)**			**Clean Yield (Kg/ha)**		
	Kanyebwa	**K131**	**NABE4**	**Kanyebwa**	**K131**	**NABE4**
Control	246B	487A	254B	152B	363B	158B
FYM	320AB	560A	406A	228AB	476A	279A
Phosphorous (P)	297AB	491A	424A	258AB	404AB	290A
FYM + P	401A	458A	443A	331A	322B	250AB

Data have been adjusted to kg/ha and standardized to 13% moisture content.
Means with the same letters down column are not significantly different at p=0.1.

Comparison of fertility treatment within varieties (Table 1) shows that application of fertilizers tended to increase the yields compared to the control. K131 had higher yields compared to the other two varieties. Within varieties, comparison of the highest fertility treatment yield to the control shows that NABE4 had the highest increase in total yield (43%), followed by Kanyebwa (38%) and K131 (13%), respectively.

For Season 2011A, analysis revealed significant location effects on plants per plot, pods per plant, seeds per pod, total yield, and clean yield. There were no significant variety effects on the total and clean yield. However, there were significant variety effects on the number of plants per plot, pods per plant and seeds per pod. Main effects of fertility treatment on yields were, however, not significant. This suggests that overall, the nutrients supplied were not sufficient to lead to significant increases in yields or other extraneous variables such as weed management, water stress, pest and diseases which may be more important. Interaction between variety and location was significant for pods per plant, seeds per pod, and total yield. Further, the variety by fertility treatment interaction was significant for total and clean yield.

Correlation analysis showed that the number of pods per plant (0.3, $p < 0.002$) and number of plants harvested per plot (0.26, $p < 0.1$) had significant positive effects on total yield.

Table 2: Effect of Fertility Treatment on Total and Clean Bean Yield - 2011A Season

Fertility Treatment	Total Yield (kg/ha)			Clean Yield (kg/ha)		
	Kanyebwa	**K131**	**NABE4**	**Kanyebwa**	**K131**	**NABE4**
Control	533AB	726AB	383A	366AB	373AB	201A
FYM	506AB	1010A	515A	359AB	560A	361A
Phosphorous (P)	444B	682B	532A	278B	486A	401.5A
FYM + P	733A	685B	596A	582A	202B	375A

Data adjusted to kg/ha and standardized to 13% moisture content.
Means with the same letters down column are not significantly different at p=0.10.

Overall, K131 yields were higher than the other varieties (Table 2). Application of farm yard manure together with phosphorous led to much higher yields for Kanyebwa, while application of farm yard manure alone led to much higher yields for K131 compared to the other treatments. There were positive though not significant differences in the yield of NABE4 due to the addition of manure. Within varieties, comparison of the highest fertility treatment yield to the control shows that NABE4 had the highest increase in total yield (36%), followed by K131 (28%) and Kanyebwa (27%), respectively. The modest increases in yields with manure indicate that the nutrients still were not sufficient to meet the full requirements of the plant during establishment and seed filling. Alternatively, other constraints such as pests, diseases, and drought may be responsible for limiting yield increases.

Overall, analyses of data from all the on-farm trials show that:

- Improved varieties used in the study had higher average and more stable yields across locations
- K131 yields were consistently higher that other varieties; this could be attributed to its better resistance to diseases and drought
- Improvement of soil fertility by application of manure and phosphorous has consistently led to moderately higher yields. This has demonstrated to farmers that soil improvements together with other good agronomic practices are necessary to obtain better yields.

With agronomic controls, a total of 180 plots were established for seed health experiment in the six farmer groups. Data collection in these experiments involved counting and classifying the number of pests observed on every plant and the data were entered using the recommended CIAT scale (CIAT 1987). The most common pests observed were bean beetles, aphids, thrips, whiteflies and bean pod borers. Two experiments were set up, each consisting of 30 plots per site. One experiment focused on assessing the effect of different seed sources on the yield with treatments being farmers seed from the market, better storage by VEDCO and farmers. The other treatment involved was NABE 4 from better storage by VEDCO and NACRRI, respectively.

The second experiment focused on the pathology and entomology of the most common bean variety in Kamuli (farmers seed). It also consisted of 30 plots. The treatments included five plots having seed with a seed dresser at planting, five plots sprayed with a pesticide, five plots with a fungicide, five plots with having a combination of the pesticide, fungicide and the seed dresser plus five plots serving as the control. Both experiments had three replications, each having five plots of 3 m x 3 m. All 67 farmers participated in this experiment. Analysis of data is pending.

Of the three bean varieties planted, K131 proved to be more tolerant to drought stress compared to farmers seed and NABE 4. In terms of yield per unit area, K131 still performed best with NABE 4 having the lowest yields. However, farmer seed was more susceptible to pests and diseases in the fields.

Of the six CRSP project farmer groups, five groups provided 10 kg each of beans that were used in the anaerobic storage technique. The materials used in this method were clean 10 liter jerrycans with no holes and with tightly fitting seals. There was a significant improvement in the storage of beans, with minimal pest multiplication and bean damage.

Support Community-Based Seed Production (CBSP) by Farmers Groups/Associations

CRSP farmer groups were able to plant 16 acres of beans in the 2011A season, well beyond the 6 acres that they cultivated during the previous season. Despite the April hailstorm which devastated some fields, most groups were able to achieve a good harvest. Group members are also cultivating expanded fields of beans on their own household plots. CRSP farmers were trained in group dynamics and business management by NaCRRI technicians and VEDCO staff to strengthen group cohesion for the challenges of producing quality seed. Farmers were encouraged to use their group constitutions when making decisions, which may range from sharing proceeds of a bumper harvest to disciplinary cases. Training covered major causes of group breakdowns such as not having regular meetings, inhibiting free sharing of views, not addressing issues, dominance within the group by particular individuals, lack of periodic democratic elections, and personal conflicts. Training also covered gender roles, gender equity, how gender roles interact with group dynamics and these interactions, in turn, may influence their efforts in development. These trainings enhance mutual respect and rational assignment of duties within the group, and maintain coherence in group activities. Refresher trainings on recommended management practices for proper bean production: use of approved seed at planting, timely weeding and pest control, drying of the beans on tarpaulins, and proper storage to avoid post-harvest bruchid damage. Business elements are discussed under objective 3 below.

All participating CRSP *farmers* were taken for a field exposure visit at the National Crops Resources Research Institute (NaCRRI) at Namulonge. The goal was to strengthen farmers' capacity in community based seed production. Farmers were taken to on-station bean research plots to understand clearly the recommended site selection and field layout. They also discussed criteria for selection of quality seed for planting.

All CRSP farmers were also taken to meet with members of the Gombe Seed Producers Farmers Association in Wakiso District (south of Kampala). During the visit, the farmers toured the bean fields of the hosts, and shared their knowledge, skills, and success stories for growing beans. Gombe seed producers use a hand driven seed dressing machine and pack their own seed for sale using low cost technology and system of seeds packed in small affordable quantities (0.5 kg, 1 kg, 2 kg) for ease of sale to institutions and other farmers. They have also been able to start an internal lending scheme with its source of capital being the beans.

Evaluate and Promote Adoption of Improved Post-Harvest Handling and Storage Methods

At Makerere University, researchers evaluated the impact of solarization and triple bagging on beans in bulk storage under Ugandan conditions. Of particular interest was reducing post-harvest losses of beans due to bruchid infestation. Also of interest are seed viability (germinability) and

culinary properties of the beans. This involved determine the initial quality parameters of the beans, monitoring the temperature profile of the beans during solarization, assessing monthly the characteristics of the treated beans during a six month storage period, and re- determining the quality parameters after the storage, and determine the effect of treatments on seed germinability. Beans were obtained and dried to 12% moisture content. For each 100 kg of beans, the entire lot was divided into smaller lots by passing all the grain through the Boerner divider multiple times. Representative samples were drawn from the resulting lots.

Table 3: Methods of Determining Initial Characteristics of Beans and Their Viability

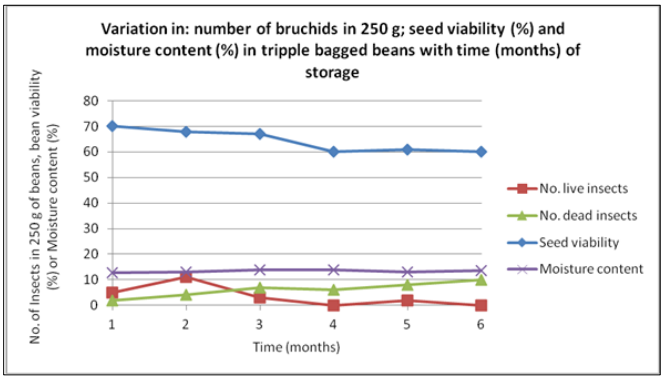
Characteristic	**Units**	**Method**
Moisture Content	%	Electronic hand-held moisture meter
Foreign Material	Weight %	Hand screening and weighing
Damage, Insect Damage, Splits Beans	Weight %	Visual inspection and weighing
Number of Live Insects	# per 250 g	Visual inspection and weighing
Number of Dead Insects	# per 250 g	Visual inspection and weighing

The bean samples were divided into three lots; the first lot was a control, the second was triple bagged, and the third was solarized and triple bagged.

Solarization was done by placing the beans on a tarpaulin laid on the grass (lawn). The beans were then covered with a transparent plastic film and left in the sun for 2 hours on a hot sunny day. Triple bagging was done using woven polyethylene sacks and HDPE sacks of thickness 80 microns that were free of holes. Two HDPE sacks were placed inside the woven sack, filled with beans and each of the sacks successively tied with sisal string, after eliminating all excess air. All three sample types were stored for a period of up to six months in a vermin proof store off the ground (on pallets) and away from the wall. Characteristics of the beans are being assessed at monthly intervals and the results recorded for subsequent analysis.

Beans and maize purchased from farmers shortly after harvesting were dried to 12% moisture content then solarized and then triple bagged. Control samples were stored in the conventional manner, single polypropylene bags. Samples were taken from the controls at one month intervals a different bag of each of the grain was opened at one month intervals and analyzed. Preliminary results indicate that the combination of solarization and triple bagging is effective for killing weevils in both beans and maize stored in bulk (75 kg bags). The control samples of both beans and maize, had increasing numbers of live weevils during a six month storage period. The number of live insects in beans that were triple bagged remained low throughout the six months storage period (see Figure 1).

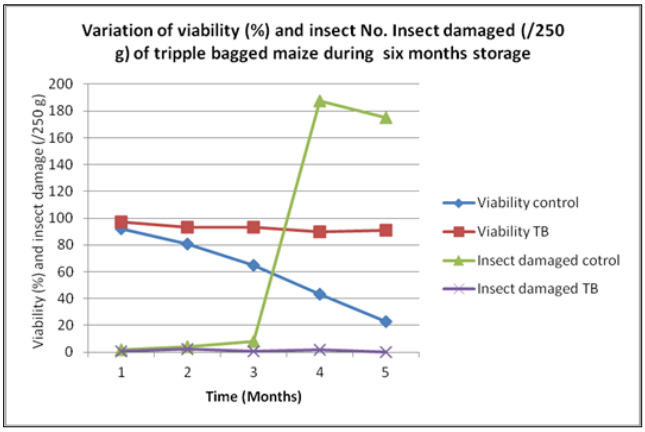
Figure 1 – *Live and Dead Bruchids, Seed Viability & Moisture Content in Triple Bagged Beans*



The moisture content of the triple bagged grains was maintained at the original level of about 12%. Triple bagging minimized moisture pick-up during the six month storage period.
The initial viability of the beans was rather low (60%), likely because the beans had been affected by drought, the harvest was generally poor and the beans were visibly of poor quality. The beans were not sorted but stored as obtained. The quality of the maize was better, and maize had a higher initial viability (>90%). Viability of both beans and maize remained high following solarization and subsequently during storage relative to the original quality of the grain, i.e., initial viability of the control sample. Changes of only about 10% were noted. Viability of poor quality beans that have been triple bagged beans is reduced by a maximum of 8% during six months storage period. The reduction is less in good quality beans, consistent with earlier experiments using better quality beans.

Beans were more resistant to insect damage and their viability was little affected. Triple bagging was also effective for protecting maize from insect damage and loss of viability (see Figure 2).

Figure 2 – *Seed Viability and Insect Damage of Triple Bagged Maize*



Experiments are on-going. Solarization experiments to profile temperature changes and evaluate mortality rate of insects were not successful due the uncharacteristically long rainy season. They will be repeated. The entire experiment is also being repeated to confirm previous observations (the control sample was stolen from the store room, which is now better secured).

Technicians from NACCRI with support from VEDCO staff trained all six groups regarding the roles of materials and procedures used during triple bagging and solarization. Demonstrations used both traditional interactive discussion and demonstrations, and animated videos. The solarization training involved digging a hole of 1.5 m length x 1 m width x 1 ft deep for demonstration purposes at all training venues. This was followed with measuring the percentage moisture content of the beans using a moisture tester. Seeds of the previous season from the group multiplication gardens were used for the demonstrations. Bean samples were collected prior to solarizing to conduct a germination test.

At the beginning of the harvesting period for 2011A when CRSP farmers had beans with which to demonstrate triple bagging and solarization, all received bags and three meters of black and clear polythene materials. Triple-bagged containers of beans were opened after six months and assessed for any bruchid survival and damage. Post-storage test documented 96% germination. Beans stored under these conditions were planted in farmers multiplication gardens during the 2011B growing season.

A potential hindrance to sustainable use of these materials may be cost. For example, each bag costs 3000 UGX (approximately $1.20 U.S.). The real cost declines when bags remain in good condition and are re-used; farmers are receiving follow up training on how to handle the bags and avoid puncturing or tearing them. The process is initially labor intensive, but ultimately significantly labor saving since it is done only once, in contrast to bi-weekly re-sunning the entire bean harvest when using traditional storage methods. Future training will focus on ensuring that proper solarization conditions are achieved and maintained, since farmers will not have thermometers and timers available.

Strengthen Farmers' Collective Capabilities to Learn and Share Innovative Practices

Following the field exposure visits to the National Crops Resources Research Institute (NaCRRI) at Namulonge and the Gombe Seed Producers Farmers Association in Wakiso, Kamuli CRSP farmers were impressed and inspired by the approach and accomplishments of their fellow farmers. Project farmers' capabilities in seed production have been strengthened. As result, CRSP farmers managed to cultivate 16 acres of beans in season 2011A compared to the 6 acres cultivated in 2010B.

Existing extension training materials for bean production and post-harvest management are continually being refined and translated in to Luganda. Topics include: proper site selection, plant and row spacing, weeding, pest management, harvesting, drying, threshing, moisture testing, sorting and seed selection, solarization, and storage (jerrycans and triple bagging). PowerPoint slides, posters, and video clips on various agronomic and post-harvest handling techniques have been developed to ensure quick and efficient knowledge transfer directly to the farmers. Those pertaining to post-harvest management and technologies will soon be tested hundreds of bean growers in Kamuli who have not previously participated in CRSP project activities. NaCRRI and VEDCO are currently exploring the potential for introducing some aspects of this research in other districts, especially the germination test and triple bagging.

<u>Objective 2</u>: Enhance nutritional value and appeal of beans through appropriate handling and processing.

Address Nutritional and Health Problems Among Vulnerable Individuals Through Increased Consumption of Beans, Bean Products, and Complementary Foods

Cold extruded bean flour based snack. 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. The following were the combinations indicated in Table 1 that were found to be acceptable. The preferred combinations were subjected to proximate analysis in the laboratory. Simultaneously storage stability studies were conducted at room temperature (20-25°C) for a period of four months to monitor the snack foods. Storage stability assessed by sensory evaluation showed no changes in terms of color, flavor and odor. The product was acceptable for consumption with no rancidity.

Table 4: Organoleptically Accepted Combinations of Bean Composite Flour

Sample	Bean Variety	Composition of Flour
1	Colta	100% Bean flour
2	Decelaya	70% Bean and 30% Maize
3	RWR 22-45	100% Bean Flour
4	White Beans	60% Bean and 40% Maize

A metallic hand operated extruder was used to cold press the dough before deep frying in hot cooking oil. It consists of a die, dough holder and dough presser. Dies are 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 extrusion was made directly into the hot cooking oil and deep fried.

Figure 3– *Elements of the Hand Held Cold Extruder*

Acceptability of these snack foods varied. For RWR22-45, the accepted blend was 100% and for White variety it was 60%:40% beans to maize. Though the blend of RWR22-45 was not acceptable, it may be used as a single flour in processing of snacks. This indicated that snacks from cereal - bean flour blends and bean flour alone can be processed.

In Uganda, a bean-based weaning food containing pre-processed (germinated and steamed) bean flour (40%), roasted grain amaranth (30%) and rice flour (30%) was developed. It was formulated to have protein and energy levels that contribute significantly to the Recommended Daily Allowances (RDAs) for children ages 2-5 years. A processing protocol aimed at reducing anti-nutrients and cooking time while improving protein and starch digestibility as well as the sensory acceptability for bean flour was developed. The protocol was optimized for minimizing anti-nutritional factors (phytic acid or phytate content and total polyphenol content), while maximizing protein and starch digestibility and overall sensory acceptability of a porridge prepared from the composite flour.

The bean-based composite porridge gave an acceptable viscosity of 2500–3000 cP at a high solid content of 15% compared to 8% for millet flour and 7% for maize flour. The composite porridge could supply 97% of the Estimated Energy Requirements (EER) for females ages 2-3 years compared to 50% from millet porridge and 42% from maize porridge with 3 servings daily (each serving = 500 ml of porridge). It could supply 84% of EER for males ages 2-3 compared to 43% from millet porridge and 37 % from maize porridge with 3 servings a day. For female children ages 4-5, the composite porridge could supply 53% of the EER compared to 27% from millet porridge and 23% from maize porridge with 3 servings a day. For male children ages 4-5, the composite porridge could supply 50% of the EER compared to 25% from millet porridge and 22% from maize porridge with 3 servings a day. Furthermore, the composite could meet 115% of the Recommended Daily Allowance (RDA) for protein of children ages 2-3 compared to 50% by millet and 38% by maize porridges with 1.5 servings per day. For children ages 4-5 years, the composite could meet 78% of the RDA for protein compared to 34% for millet and 26% for maize porridge with 1.5 servings per day. An optimized extruded bean flour protocol is being finalized and will complement this section, with all applicable nutritional evaluation.

In Rwanda, research was conducted to develop nutrient dense bean-based composite flour from bean and 6 other locally grown vegetables. This involved analyzing its nutritive value and functional properties, processing a sample soup from the developed flour, and assessing consumer acceptability of the soup through sensory evaluation. The study is part of the effort to provide affordable adequate nutrition for low income families. Fresh beans were subjected to a combined treatment of soaking, germination, de-hulling, parboiling, drying and milling into flour. For vegetables, the unit operations were: washing, size reduction, blanching, drying and milling. Flours obtained were mixed to different proportions. The mix was termed CRSP/KIST PANAMIX. Four samples (A, B, C, and D) of the composite flour were formulated using bean, moringa leaves, potato, tomato, carrots, leeks and garlic flours in the ratios of 70:10:8:4:4:2:2 (A), 60:20:8:4:4:2:2 (B), 50:30:8:4:4:2:2 (C), and 40:40:8:4:4:2:2 (D). Four samples of soups were developed from theses composite flours; and 15 trained panelists rated the prepared soups. Preliminary sensory evaluation showed that soups processed from samples A and B were the most acceptable.

Then, the two samples underwent laboratory analysis of selected functional properties and nutrients. The functional properties analyzed were bulk density, pH, oil absorption capacity; water absorption capacity and wettability. For PANAMIX No.1 (Sample A), the results obtained were 0.88 g/cc, 5.67 pH, 2.4 ml/g, 5.8 ml/g and 50.6 seconds, respectively. For PANAMIX No.2 (Sample B), the results were 0.86 g/cc, 5.45 pH, 2.65 ml/g, 6.5 ml/g and 53 seconds,

respectively. Appropriate methods of analysis were used to determine the proximate chemical composition of the two first accepted samples, PANAMIX No.1 and PANAMIX No.2.
The results indicated that ash, β-carotene, calcium, carbohydrate, crude fat, crude protein, total energy, crude fiber and moisture content were 10.26%, 79.12 mg/100 g, 0.875%, 51.40%, 7.1%, 11.98%, 317.47 Kcal/g, 13.9% and 5.34%, respectively, for PANAMIX No.1. It was 9.12%, 173.56 mg/100g, 1.06%, 46.26%, 11.00%, 13.825%, 339.34 Kcal/g, 12.42%, and 7.37%, respectively, for PANAMIX No.2. The results from the second sensory evaluation revealed that there was no significant difference between the two samples, PANAMIX No. 1 and PANAMIX No.2 ($p<0.05$). Generally, both composite flours were nutrient dense, but the latter was found to be high in β-carotene, calcium, crude fat, crude protein and total energy when compared to PANAMIX No.1.

Table 5: Nutritional Value of PANAMIX in 100g

Sample	Nutrients	Composition of Flour
1	Carbohydrates (g)	51.4
2	Crude fats (g)	7.1
3	Crude protein (g)	11.98
4	Energy (Kcal)	303.27
5	Fiber (g)	13.9
6	Moisture (g)	5.34
7	β – carotene (mg)	79.12
8	Calcium (g)	0.87

Three topics were identified for which extension materials have been developed:

- Basics of feeding children aged 6-59 months
- Methods of preparing beans that reduce cooking time and enhance nutrient bio-availability
- Preparation of bean-based composite flour and utilizing the flour in porridge

The content is available in two forms; a summary training outline and a detailed training manual. It will soon be translated into local languages and illustrations added.

In Rwanda, two KIST lecturers (Hilda Vasanthakaalam and Aurelia Larry) and five students traveled to Rukomo sector, Nyagatare district, Eastern Rwanda to demonstrate and conduct trainings. They explained and demonstrated processing the CRSP/KIST PANAMIX, and discussed the nutrient content in 100g of the product. Villagers were encouraged to substitute 15–20% of the mix for wheat in cake, biscuit and bread making. They also explained and demonstrated preparation of the bean based soup, and the cold extrusion method. In addition to 60 farmers who registered, several village leaders also participated. Moreover, many other farmers joined the event after being invited by the excited farmers who were registered.

Figure 4 - *Demonstrating Cold Extrusion of Bean Snack*

Soup preparation was also demonstrated. It involves mixing 100 g of PANAMIX with 200 ml of water, which is then added to 750 ml of boiling water. To this is added 15 ml of cooking oil, salt to taste, and everything is boiled for 10 minutes until it thickens and can be served hot.

Figure 5 - *Demonstrating Preparation of Bean Based Soup*

Participants indicated that it could nourish vulnerable segments of the population (children, mothers, sick, and the elderly). Local officials forwarded two significant recommendations following the demonstration. Training 60 health counselors in the district was proposed by the Executive Secretary of Rukomo sector. Demonstrating the techniques to farmers and village authorities in Mimuri sector is also on the agenda; this could not be accomplished during this trip due to the overwhelming number at Rukomo who participated in the demonstration and training.
Farmers in Kamuli District were also trained in preparation of the cold extruded bean snack as well as methods (soaking and sprouting) to enhance nutritional quality of bean dishes fed to children aged less than five years. Grace Nkundabombi from KIST and Catherine Ndagire from

Makerere conducted the training. Sensory evaluation sessions of dishes prepared with soaked and sprouted beans were also carried out to evaluate acceptability of the foods.

Rapid appraisal of the basic knowledge of feeding infants and young children and the extent and use of beans were assessed, and training materials for utilization of beans to improve the quality of meals served to infants and young children in Kamuli were piloted. In Rwanda, arrangements have been made with two NGOs (Africare and World Vision) to assist in this activity. This was determined as a more appropriate initial activity than documentation of nutrition status.

Analyze Culinary Properties, Sensory Characteristics, and Consumer Acceptability of Improved Varieties of Beans

A protocol for rapid screening of culinary properties of pulses was obtained from Prof. Amanda Minnaar, Department of Food Science, at the University of Pretoria. The protocol determines the following characteristics of beans: the water absorption capacity during soaking (g/kg); cooking water absorption (g/kg); seed coat splitting (%); cotyledon splitting (%); soluble solids content (º Brix) and pigment leaching. The protocol also includes a method for screening pulses for sensory characteristics through sensory evaluation. The characteristics for evaluation include: seed aroma; cooked legume aroma; texture (tactile); broth aroma and broth appearance.

In Uganda, this protocol is being used at Makerere University to evaluate culinary and sensory characteristics of local and improved bean varieties. To date, four local and five improved varieties have been analyzed. Preliminary data shows that all the varieties so far analyzed are short cooking, i.e., take less than 120 minutes to cook. Further analysis is underway to determine the variation of cooking times among the varieties. More varieties will be analyzed in the future.

The Department of Food Science and Technology at KIST received for analysis the 16 new bean varieties released by Institut des Sciences Agronomiques du *Rwanda (ISAR)*. Three KIST students conducted preliminary assessment of culinary properties. Complete assessment has been delayed by the government's prohibition of lightweight non-biodegradable plastic bags, such as zip-lock bags that are needed for this assessment. Currently, biodegradable plastics are now available but not of the desired thickness (density) that can withstand boiling. An alternative approach of using basmati rice bags will be used in the near future by KIST students.

The culinary properties of eight local and six improved bean varieties are being analyzed. The beans were purchased from the open market. Their moisture content was determined followed by drying the beans to approximately 12% moisture and storing them in the layers of zip-lock bags. Samples are drawn and subjected to cooking experiments to determine the time required to cook, i.e., being easily crushed between two fingers. After cooking times are confirmed, the different bean varieties will be cooked for the time determined to be adequate and subjected to sensory acceptability testing, using untrained consumer panels. This work was delayed by the 1.5 month closure of Makerere University in August-September.

Incorporate Insights from Analysis of Private Food Processing Industry Regarding Development and Commercialization of Bean-based Products

Four types of incubators were identified: local economic development incubators; academic and scientific incubators; corporate incubators and private investor incubators. The four differed in

their goals, main activities, objectives, targets, constraints and trends. As a public institution engaged in research and development (R&D), the academic and scientific type of incubator is most suitable for activities of the Makerere University Food Technology and Business Incubation Centre (Mak-FTBIC). Mak-TFBIC objectives are emblematic of academic and scientific incubators, including: commercialization of technologies generated by R&D activities; developing an entrepreneur spirit among graduates; fulfilling the public University's mandate of outreach to the public and building a positive image by making a positive contribution to national development; the Center and its activities are supported by a grant from the government of Uganda.

Mak-FTBIC targets projects generated out of internal research activities (technology development projects) as well as external projects, including satellite incubation activities in which private sector businesses are provided technical support in their premises outside of the Mak-FTBIC. The services offered by Mak-FTBIC include: concept testing (internally referred to as technology development projects - in which promising research findings are refined, up-scaled and market tested, in partnership with a private sector businesses); providing technical advice and support to incubatees in areas of business and financial management, design and implementation of quality management systems; and providing advice on intellectual property management. Mak-FTBIC management has currently engaged a consulting firm to undertake a diagnostic study of incubatee businesses to access 'business mentors'/coaches, and attract investments to facilitate 'hatching' of the businesses.

The academic and research incubator type is working well with eight incubatee companies and 12 technology development projects. Undergraduate students are inspired to undertake research projects with prospects for incubation and commercialization, while graduates are gainfully employed and have the opportunity to be entrepreneurs.

Bean processing into value added products has so far been very limited in Uganda and the East African Community (EAC). This project is contributing to its establishment. Experiences from elsewhere in Africa, Europe and North America, highlight the potential of the bean industry in Uganda. The most common processing of beans is canning and is an important industry in developed countries and in South Africa. Asian countries, especially India, sell pre-cooked bean curries and sauces in sachets. Such products have potential for the urban market in Uganda for working families with limited time for meal preparation.

During a visit to the University of Pretoria, Drs. Nakimbugwe and Vasanthakaalam visited the South African Bean Council offices and bean processing facilities in Pretoria. The Bean Council is involved in coordinating bean production, post-harvest handling, including pre-cleaning, sorting and packaging of dry raw beans in consumer packs that are sold in supermarkets. In addition, the bean council collaborates with research organizations to select, produce and multiply bean seeds sold all over the country and beyond. South Africa also has a bean canning industry which constitutes a steady market for beans. The above experiences highlighted the potential market for beans in Uganda, Rwanda and other countries in the East African Community. Currently, there is market for all grains within the EAC, especially Southern Sudan, for which the expanding market can benefit well organized farmers groups engaged in collective marketing. Nutreal Limited is a company currently involved in producing and marketing

nutrient-enhanced foods, including a bean-based product up-scaled from a protocol developed as part of this research project. The company is utilizing increasing amounts of dry beans which will serve as a key market for farmers when production is up-scaled.

Experience with Nutreal Limited to up-scale production of the bean-based composite flour developed from this project indicates that the following are important:

- First and foremost, the technology developed should be compatible with the private company's mission and objectives. In this case, a protocol for a nutrient-enhanced food was developed and fitted very well into Nutreal's mission to produce and market nutrient-enhanced foods.
- R&D-based technologies are valued, as they increase the chances of products' market success; being associated with an R&D institution is also viewed very positively.
- Continued technical support and involvement of the R&D personnel from the institution is key; private sector businesses want to be assured of it.
- The availability of a University-based R&D and business incubation facility encourages private sector involvement as it reduced their initial risks and allows for extensive market testing before heavy investments are made into manufacturing infrastructure.

The collaborative relationship between MAK, NaCRRI and VEDCO provides an ideal framework for linking farmers' groups to industry. Both NaCRRI and VEDCO work with farmers and farmers' groups and are in position to link backwards to production and forward to R&D and processing. The partners already provide technical support to farmers' groups with regard to enhancing production and productivity and improving post-harvest handling and storage, factors that are important for access to markets. The partners also train farmers' groups to improve their nutrition security by using improved preparation and simple processing methods for better health which, in turn, enhances productivity.

Makerere University's Food Technology and Incubation Centre (FTBIC) has provided opportunity for linking farmers' associations to private industries to be suppliers of raw materials. This is already the case for grain amaranth, which is being supplied to processors working in the FTBIC by farmers' groups in Kamuli and other districts. A similar market already exists for beans once production is up-scaled. The FTBIC frequently receives inquiries on possible markets for agricultural products, so producers are aware of the potential.

Nutreal Limited, a private company working in MAK-FTBIC is currently collaborating with our research group to increase the bean-based product range and utilization of pre-processed bean flour. Composite flours, including pre-processed beans, are being developed for food use. Trials to incorporate pre-processed bean flour into baked products are also underway.

Kubumwe Enterprises in Rwanda has discussed collaborating with the Department of Food Science and Technology at Kigali Institute of Science and Technology

Objective 3: Identify solutions for constraints to increased marketing and consumption.

Assess Capabilities and Needs of Farmer Groups and Associations

Farmers in Kamuli own and cultivate an average of 2-2½ acres, and one-half borrow or rent land (averaging 1 acre) for their agricultural activities. Most were growing maize and beans, but only

15% of those farmers were harvesting at least 50 kg of beans. Other important crops are cassava, sweet potatoes, bananas, groundnuts, soybeans, millet, rice, and grain amaranth. Many also raise poultry, goats, and/or pigs, as well as some cattle, for both food security and income. Most households sell some agricultural produce (averaging 1-2 crops), and sold almost exclusively on an individual basis to traders (only 5% sold collectively). One-half of all households engage in one or more of a diverse array of non-agricultural income earning activities in the formal or informal sector. More than one-half borrowed money during the previous year.

Participating in the CRSP project has enhanced farmers' assets and capabilities, both individually and collectively. While the number of farmers participating directly in CRSP activities has not increased due to the nature of training and support required for the array of field experiments, these farmers are all part of larger groups. Their social capital has been enhanced through strengthening their groups and connections made with other groups locally (when others inquire about their new ways of cultivating and handing beans) and through exchange visits. Their human capital has been enhanced through gaining technical knowledge and experience in applying it. Their political capital has been enhanced locally through leadership roles are carried out by members democratically elected by their colleagues for one year term, and externally through awareness of their interests and rights and capabilities of lobbying local government officials for support of their initiatives, particularly regarding marketing. A significant impact on cultural capital - in terms of gender roles - is that five of six groups are currently headed by women. Their natural capital has been enhanced through increasing the amount of land cultivated in response to new opportunities presented by growing and selling beans. Their physical capital has been enhanced through acquiring improved bean varieties that are high yielding and tolerant to environmental stresses, and some groups have acquired oxen and an ox plough. As farmers grow more beans, group members are very interested in labor saving production technologies (threshers, larger scale storage, etc.) that will lessen their work in large scale production, storage and bulking centers for improved marketing and increased access to microfinance services.

Strengthen Farmers' Successful Engagement in Value Chain Development

Farmer groups were trained and supported in various aspects of collective marketing of beans. This involved: improving farmers' understanding of market price variation (among traders, markets, and seasons); enhancing their ability to manage harvested grain to obtain increased prices through loss-minimizing storage, negotiation skills, and coordination of collective marketing; and business planning, record keeping, and analysis. Results to date include:

- project farmers responded successfully to an 'Invitation for Bids' for puchase of beans
- the project team created a two page negotiated contract for all six groups
- 1000+ kg of two varieties were purchased from project farmers for scaling up
- plans to purchase 2 MT from CRSP project farmers when current season is completed

Figures 6 – *Invitation to Bid*

INVITATION FOR BIDS

Bids are invited from competent VEDCO CRSP farmers' groups to bid for supply of quality bean seed in Kamuli district.

Qualification Requirements include:

- The beans **MUST** have a germination percentage not less than 90%
- The beans should have moisture content below 14% and with a very good uniform color.
- Beans should be of good quality (Very clean , well sorted and with no broken/ damaged grains)
- The bidder should have the capacity to collectively supply to a tune of 1000kgs for both NABE 4 and K132 varieties.

Deadline of submission of quotations is 24th/06/2011 before 4:00pm

Figure 7 – *Agreement Form*

AGREEMENT FORM

This agreement is made on this _____day of _____
between …….. Of……
……..(village, sub county, District)
and Volunteer Efforts for Development Concerns (VEDCO) in respect
to supply ……..

Under the Collaborative Research Support Project (CRSP) at a cost of
Ushs…….(words)……
……to be paid
in…….

Signature:_____ Signature:_____

Name:_____ Name:_____

On behalf of the farmers group **On behalf of VEDCO**

The CRSP project, in coordination with the CSRL program in Kamuli, has provided initial training and two varieties of improved bean seeds to 348 farmers to each plant 1/3rd acre of beans in 2011A, and an additional 200 farmers to each plant 1/6th acre of beans in 2011B. Thus, the project is already making excellent progress in scaling up bean production and management practices. Additional training sessions are planned, particularly regarding post-harvest practices.

Assessment of farmer groups interests, capabilities, and needs has led to continued mentoring and support for the bean value chain stakeholders forum which was established in late 2010. This included sharing insights from experiences of collective marketing by farmers associations in Masaka and Rakai, southwest of Kampala, and in Kapchorwa in northeastern Uganda.

Partner meetings were organized in two sub-counties (Butansi and Bugulumbya) in Kamuli district and facilitated by team members from Makerere University and VEDCO to analyze anticipated opportunities and constraints for participatory marketing from the farmers' point of view. They also discussed strategies to achieve successful participatory marketing and prioritize activities, and draft the activity road map. Farmers identified establishment of storage centers as a key factor in helping them obtain better prices for their beans when bulking and selling collectively. They also identified limited access to microfinance and agro-inputs (pesticides and herbicides) as key constraints to boosting their production.

Detailed value chain analysis for bean enterprises is currently being conducted by a Makerere University M.Sc. student in Agricultural Extension and Innovation, George Jjagwe. His interviews with farmers cover extension services accessed, participation in group activities, production inputs and activities, crop and livestock diversity, production costs, sources and credibility of market and price information, crop and livestock sales, income earned, household assets, and food security. He is also conducting interviews with input suppliers, traders, and consumers in district towns. The results of George's work will be very useful for making significant progress in value chain development and farmers livelihoods.

Objective 4: Increase the capacity, effectiveness and sustainability of agriculture research institutions that serve the bean sector in Uganda and Rwanda.

At the Master's level, Catherine Ndagire, M.Sc. student in Human Nutrition at Makerere University, has completed coursework and most of her research. She is currently finalizing her laboratory work and preparing to pilot test in Kamuli District the extension materials that have been developed through her work. George Jjagwe, M.Sc. student in Agricultural Extension and Innovation Studies, has also completed his courses, developed tools for data collection and has embarked on data collection. Grace Nkundabombi, M.Sc. student in Food Technology (from KIST in Rwanda) started her studies at Makerere University during the current academic year. M.Sc. student in Applied Human Nutrition at Makerere University (Aisha Nakitto Musaazi) completed and submitted her thesis for review, and will defend it during the current academic year. Simon Okiror, Agricultural Economics, successfully defended his thesis and graduated. The first manuscript from his thesis is being finalized for submission to a peer-reviewed journal.

At the Ph.D. level, Martin Mutambuka, Ph.D. student from Uganda in Food Science and Human Nutrition at Iowa State University, has passed preliminary exams, is nearing completion of lab research at ISU, will travel to Uganda in December 2011 to conduct sensory evaluation studies and continue writing the dissertation, and return to ISU in April to defend his dissertation and graduate in May 2012. Gerald Sebuwufu, Ph.D. student from Uganda in Crop Physiology and Sustainable Agriculture at Iowa State University, is taking preliminary exams, and progressing well in his field and lab research at ISU. During Spring 2012, he will write dissertation chapters. He will defend his dissertation and graduate in August 2012.

Collaboration among the three Ugandan institutions (VEDCO, NACRRI and MAK) has allowed for inter-organization learning fostering stronger partnership and linkages. Involvement of students in the three organization has also made this learning possible. Collaborators continue to jointly conduct activities and jointly learn. A KIST student who developed a cold extruded bean

product demonstrated the method in Kamuli, Uganda, assisted by a Makerere University student and coordinated by VEDCO.

Project findings to date have been disseminated in various contexts during the past year:

- Mazur RE (2011). "Value Chains - How Can They Achieve Food and Nutrition Security Goals?" West Africa CAADP Nutrition Program Development Workshop. Dakar, Senegal. Nov. 9-12.
- Mazur RE, Musoke H, Nakimbugwe D, Ugen M (2011) "Enhancing Nutritional Value and Marketability of Beans through Research and Strengthening Key Value Chain Stakeholders in Uganda." Conference Note 1 for International Conference on 'Leveraging Agriculture for Improving Nutrition and Health' in New Delhi. Washington, DC: International Food Policy Research Institute.
- Mazur RE, Ugen M, Bwambale N, Sebuwufu G, Nakimbugwe D (2011). "Disseminating Improved Bean Production Management Practices and Technologies and Strengthening Marketing Capabilities." Poster presented at USAID-Collaborative Research Support Programs Council Meeting: Research to Feed the Future in East Africa. Kampala, Uganda. July 25.
- Mutambuka M, Murphy PA, Hendrich S, Reddy MB (2011). "Effect of extraction buffer pH on ferritin yield from common beans (*Phaseolus vulgaris*)." Poster presented at the Annual Meeting of the Institute of Food Technology. New Orleans, LA: June 11-14.
- Sebuwufu G, Mazur RE, Westgate M, Bwambale N, Ugen M (2011) "Improving Common Bean Yields for Rural Development in Uganda." Poster presented at USAID-Collaborative Research Support Programs Council Meeting: Research to Feed the Future in East Africa. Kampala, Uganda. July 25.
- Vasanthakaalam H (2011) Adding Value to Grains – Science, Nutrition and Technology. (includes chapter "The Cold Extrusion Process" (pp. 109-111). Germany: Lambert Academic Publishing, 188 pages. ISBN-10: 3845438479, ISBN-13: 978-3845438474.

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 2011: 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
Training Status during Fiscal Year 2011: full-time student
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 2012
Training Status during Fiscal Year 2011: full-time student
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
Training Status during Fiscal Year 2011: full-time student
Type of CRSP Support (full, partial or indirect): Partial

Trainee #5
First and given names: Marie Grace
Last name: Nkundabombi
Citizenship: Rwandan
Gender: Female
Degree: M.Sc.
Discipline: Food Technology & Nutrition
Host Country Institution to benefit: Kigali Institute of Science and Technology, Rwanda
Training Location: Makerere University
Supervising CRSP PI: Dorothy Nakimbugwe (Co-PI Hilda Vasanthakaalam)
Start date: August 2011
Project completion date: August 2012
Training Status during Fiscal Year 2011: full-time student
Type of CRSP Support (full, partial or indirect): Partial

Explanation for Changes
Rapid appraisal of the basic knowledge of feeding infants and young children and the extent and use of beans were assessed, and training materials for utilization of beans to improve the quality of meals served to infants and young children in Kamuli were piloted. In Rwanda, arrangements have been made with two NGOs (Africare and World Vision) to assist in this activity. This was determined as a more appropriate initial activity than documentation of nutrition status.

Networking and Linkages with Stakeholders
NaCRRI has been multiplying more than 200 nutri-bean lines (lines high in iron, zinc and protein) recently received from the University of Nairobi through CIAT. Through the Material Transfer Agreement (MTA) signed between CIAT-Colombia and Iowa State University, ISU has been receiving 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, the work of Ph.D. student Gerald Sebuwufu. NaCRRI researchers Michael Otim (entomologist) and Pamella Paparu (pathologist) have been conducting research to quantify the incidence of insect pests (bean aphids, thrips, bean stem maggot and flower beetles) and diseases (bean root rot, web blight, and bean rust). Findings will guide advanced training of farmers in pest and disease control to reduce crop losses.

VEDCO holds biannual community review meetings in its areas of operation; CRSP project partners and farmers participate in these review and planning meetings. VEDCO organized the first value chain stakeholder workshop in Kamuli in late 2010, involved 25 participants from 15 organizations (farmer marketing groups and associations, government agencies, non-governmental organizations, private sector traders, transporters, distributors, and processors). Ongoing research on value chain development for beans and maize corresponds to VEDCO's commitment to continue playing a facilitative role.

Visits to ISU by Co-PI from Makerere University (Uganda) resulted in further learning about parallel and complementary research interests, and bases for long term collaboration. ISU faculty members visited Uganda – bringing expertise in agricultural and biosystems engineering, agronomy, development communications, human nutrition, and sociology.

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

Scholarly Activities and Accomplishments
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 and 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 and 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 and 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 and Technology. Kigali, Rwanda: Kigali Institute of Science and Technology.

Musaazi, Aisha Nakitto. 2011. "Developing a quick-cooking bean flour." Final thesis for M.S. degree. Department of Food Science and Technology. Kampala, Uganda: Makerere University.
Mutambuka Martin, Murphy PA, Hendrich S, Reddy MB (2011). "Effect of extraction buffer pH on ferritin yield from common beans (*Phaseolus vulgaris*)." Poster presented at the Annual Meeting of the Institute of Food Technology. New Orleans, LA: June 11-14.

Nkundabombi Marie Grace. 2010. "Processing of cold extruded deep fat fried snack food from bean based composite flour." Final project report for B.S. degree. Department of Food Science and 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 and Agribusiness. Kampala, Uganda: Makerere University.

Literature Cited

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Murdock LL & Shade RE (1991). "Eradication of cowpea weevil (Coleoptera: Bruchidae) in cowpeas by solar heating." *American Entomologist* 37(228-231).

Murdock LL, Seck RE, Ntoukam G, Kitch L, Shade RE (2003) "Preservation of cowpea grain in sub-Saharan Africa - Bean/Cowpea CRSP contributions." *Field Crops Research* 82(169-178).

Van Schoonhoven, A. and M.A. Pastor-Corrales (compilers) (1987). *Standard System for the Evaluation of Beans from CIAT*. Cali, Colombia: Centro Internacional de Agricultura Tropical.

Vasanthakaalam H (2011) The Cold Extrusion Process" (pp. 109-111) in *Adding Value to Grains – Science, Nutrition and Technology*. Germany: Lambert Academic Publishing, 188 pages. ISBN-10: 3845438479, ISBN-13: 978-3845438474.

VEDCO (2011) *Annual Report 2010*. Kampala, Uganda: Volunteer Efforts for Development Concerns.

Contribution of Project to Target USAID Performance Indicators

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

Cumulatively, we have been mentoring 20 students for degree training, seven at graduate level (of whom three are female) and 13 at B.S. level (of whom seven are female). We have exceeded our original estimate due to the efforts of Co-PI Vasanthakaalam and Co-PI Nakimbugwe who actively involve B.S. students in the CRSP project while they undertake research for their 4th year projects at KIST and Makerere University, respectively.

With regard to short term training, 67 farmers (58 women and 9 men) have participated in a series of short-term trainings 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. During 2011A, bean crop management practices and technologies have been disseminated to an additional 90 farmers (47 women and 43 men) during 2011A. During FY12, we plan to disseminate applicable management practices and technologies to more farmers, monitoring and evaluating the process and impacts to identify any barriers and most effective strategies.

We have progressed well in terms of the number of technologies and management practices that are under research (5), and under field testing (3), and ready to be made available for transfer (9) – slightly more than anticipated. The number of additional hectares under improved technologies or management practices (138) exceeds what was originally anticipated (115).

Farmers marketing associations in two sub-counties are directly benefitting from project activities. We are providing technical assistance directly to 51 community based organizations

(CBOs), slightly more than planned. Women constitute the majority of members in these CBOs. There are four host country partner organizations benefitting, as planned.

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. The discussion between Kubumwe Enterprises the Department of Food Science and Technology at Kigali Institute of Science & Technology in Rwanda in may also lead to effective collaboration.

Contribution to Gender Equity Goal

Among the team of research scientists and professional practitioners, there are six women and six men. As noted above, we have been mentoring three female graduate students and seven female undergraduate students; comparable data for males are four and six, respectively. Of the 30 farmers participating directly in the field experiments, 24 are women; similarly, most (58 of 67) farmers participating in project training sessions are women. Approximately ¾ of the additional 548 farmers receiving training and improved bean seeds during 2011 are women.

Progress Report on Activities Funded Through Supplemental Funds

Supplemental funds received in previous years for work in food science and technology at Makerere University and Kigali Institute of Science and Technology have been instrumental in advancing research and development activities addressing objective 2 and parts of objective 1:

- travel to Sokoine University and University of Pretoria (MAK and KIST Co-PIs)
- rapid nutrient analyzer at KIST (2008)
- single screw extruder and supplies at KIST (late 2009)
- degree (M.Sc.) training for KIST staff member at Makerere University
- short term training of M.Sc. graduate student (Catherine Ndagire) from Makerere University at Iowa State University in mid-2010

Recently awarded FY12 funding will support technology dissemination, research, and training:

- Development of new training media (print and video) and materials for improved management practices and technologies to be utilized in training 800 farmers in 20 demonstration sites
- Implementation and evaluation of six combinations of media and methods in training and demonstration: (a) interactive training, (b) animated video, and (c) farmer acted video. One-half of the farmers in each method/combination will receive ‘take home’ printed flyers.
- Capacity building of VEDCO’s Kamuli staff in advanced methods of farmer learning facilitation.

This final supplemental funding will strengthen capacity in our key project implementation partner, VEDCO, as well as Makerere University and Iowa State University faculty and students. It will also consolidate ongoing work that will be useful in future efforts to scale up innovative management practices and technologies to wider populations in Uganda and Rwanda.

Dry Grain Pulses CRSP
Report on the Achievement of "Semi-Annual Indicators of Progress"
(For the Period: October 1, 2010 -- September 30, 2011)

This form should be completed by the U.S. Lead PI and submitted to the MO by October 1, 2011

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			NaCRRI			VEDCO			KIST		
	Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved	
Benchmarks by Objectives	9/30/11	Y	N*	9/30/11	Y	N*	9/30/11	Y	N*	9/30/11	Y	N*	9/30/11	Y	N*
	(Tick mark the Yes or No column for identified benchmarks by institution)														
Objective 1	***Improve Bean Yield and Quality***														
1a. Variety performance and fertility responses analyzed	0			0			0			0			0		
1a. Biological & agronomic controls for pests & diseases initiated	0			0			0			0			0		
1a. Variety perform., fertility respon., bio. & agron. controls analyzed	X	X		0			X			0			0		
1a. Best performing bean varieties reported to breeders	X	X		0			X			X			0		
1a. Seeds provided for post-harvest storage studies	0			0			X			X			0		
1b. Training in group dynamics & mgmt. practices for quality seed	0			0			0			0			0		
1b. Exchange visits to established seed production programs	0			0			0			0			0		
1b. Extension guide for bean CBSP initiated and tested	0			0			0			0			0		
1b. Linkages establ. for breeders, seed processors, marketers	0			0			X			X			0		
1b. Seed storage facilities established	0			0			X			X			0		
1c. Effects of solarization on germination and storage evaluated	0			0			0			0			0		
1c. Farmers trained in effective use of solarization technique	0			0			0			0			0		
1c. Polyethylene for solarization distributed to farmers groups	0			0			0			0			0		
1c. Barriers to adoption of solarization identified and resolved	0			0			0			0			0		
1c. Storage techniques evaluated for pest control and germination	X	X		0			X			X			0		
1c. Farmers trained in new solar techniques	0			0			X			X			0		
1c. Storage materials produced and distributed to farmers	0			0			X			X			0		
1c. Training in mananging bulking facilities completed	0			0			X			X			0		
1d. Exchange visits of other farmer groups conducted	0			0			0			0			0		
1d. Contacts establ. w/ districts to scale technologies & practices	0			0			X			X			0		
1d. Stakeholder workshop to review bean prod. training materials	X	X		0			X			X			0		
1d. Extension materials translated and published	0			0			X			X			0		
Objective 2	***Enhance the Nutritional Value and Appeal of Beans***														
2a. Cold extruded bean products & process developed at KIST	0			0			0			0			0		
2a. Bean-based weaning foods developed for Uganda & Rwanda	X	X		X			0			0			X		
2a. Extension approaches indentifed and content developed	X	X		X			0			X			X		
2a. Farmers trained in bean cold extrusion processing	0			0			0			0			X		
2a. Baseline nutritional status established for feeding studies	X		X	X			0			0			X		
2b. Analysis protocol for culinary properties obtained	0			0			0			0			0		
2b. Analysis of desirable culinary traits of current varities initiated	0			0			0			0			0		
2b. Culinary traits & sensory char. of current varieties documented	X	X		X			0			0			X		

2b. Analysis of culinary traits & sensory char. of improv. var. initiated	0			X			0			0			X		
2c. Tech. incubation & transfer models identified and modifed	0			X			0			0			0		
2c. Local & int'l industries as potential markets for beans identified	0			X			0			0			0		
2c. Private industry interest/conditions to adopt bean tech. evaluated	0			X			0			0			0		
2c. Links establ. btw. farmers' assoc. & private industries	0			X			X			X			0		
2c. Protocols for value-addition w/ private sector partners initiated	0			X			0			0			0		
Objective 3	***Increase Marketing and Consumption of Beans and Bean Products***														
3a. Farmer groups' composition, roles, assets, capabilites identified	0			0			0			0			0		
3a. Farmer groups' needs determined and prioritized	X	X		0			0			X			0		
3b. Farmers trained in group/assoc. dynamics and gender equity	0			0			0			0			0		
3b. Partner meetings held in two sub-counties	0			0			0			0			0		
3b. Participatory market research groups formed	0			0			0			0			0		
3b. Market chain analysis for bean enterprises conducted	X	X		X			0			X			0		
3b. Market information sources assessed	X	X		X			0			X			0		
Objective 4	***Incr. Capacity, Effectiveness & Sustainability of Ag. Research Institut.***														
4. Training M.S. (FST and AgEcon) at MAK on-going	0			0			0			0			0		
4. Training M.S. student in FST from Rwanda on-going	0			0			0			0			0		
4. Training M.S. students at Makerere University completed	0			X			0			0			X		
4. Training Ph.D. students at Iowa State University ongoing	X	X		0			0			0			0		
4. Inter-organizational learning fostered	X	X		X			X			X			X		
4. Prelim. results disseminated (conf., public., websites)	X	X		X			X			X			X		

Name of the PI reporting on benchmarks by institution	**Robert Mazur**	**Dorothy Nakimbugwe**	**Michael Ugen**	**Henry Kizito Musoke**	**Hilda Vasanthakaalam**

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

M Mazur — **Signature**

9-28-11 — **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: October 1, 2010 -- September 30, 2011)

This form should be completed by the U.S. Lead PI and submitted to the MO by October 1, 2011

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			NaCRRI			VEDCO			KIST			
	Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved		
Benchmarks by Objectives	9/30/11	Y	N*	9/30/11	Y	N*	9/30/11	Y	N*	9/30/11	Y	N*	9/30/11	Y	N*	
	(Tick mark the Yes or No column for identified benchmarks by institution)															
Objective 1	***Improve Bean Yield and Quality***															
1a. Variety performance and fertility responses analyzed	0			0			0			0			0			
1a. Biological & agronomic controls for pests & diseases initiated	0			0			0			0			0			
1a. Variety perform., fertility respon., bio. & agron. controls analyzed	X			0			X			0			0			
1a. Best performing bean varieties reported to breeders	X			0			X			X			0			
1a. Seeds provided for post-harvest storage studies	0			0			X			X			0			
1b. Training in group dynamics & mgmt. practices for quality seed	0			0			0			0			0			
1b. Exchange visits to established seed production programs	0			0			0			0			0			
1b. Extension guide for bean CBSP initiated and tested	0			0			0			0			0			
1b. Linkages establ. for breeders, seed processors, marketers	0			0			X			X			0			
1b. Seed storage facilities established	0			0			X			X			0			
1c. Effects of solarization on germination and storage evaluated	0			0			0			0			0			
1c. Farmers trained in effective use of solarization technique	0			0			0			0			0			
1c. Polyethylene for solarization distributed to farmers groups	0			0			0			0			0			
1c. Barriers to adoption of solarization identified and resolved	0			0			0			0			0			
1c. Storage techniques evaluated for pest control and germination	X			0			X			X			0			
1c. Farmers trained in new solar techniques	0			0			X			X			0			
1c. Storage materials produced and distributed to farmers	0			0			X			X			0			
1c. Training in mananging bulking facilities completed	0			0			X			X			0			
1d. Exchange visits of other farmer groups conducted	0			0			0			0			0			
1d. Contacts establ. w/ districts to scale technologies & practices	0			0			X			X			0			
1d. Stakeholder workshop to review bean prod. training materials	X			0			X			X			0			
1d. Extension materials translated and published	0			0			X			X			0			
Objective 2	***Enhance the Nutritional Value and Appeal of Beans***															
2a. Cold extruded bean products & process developed at KIST	0			0			0			0			0			
2a. Bean-based weaning foods developed for Uganda & Rwanda	X			X	X		0			0			X			
2a. Extension approaches indentifed and content developed	X			X	X		0			X			X			
2a. Farmers trained in bean cold extrusion processing	0			0			0			0			X			
2a. Baseline nutritional status established for feeding studies	X			X		X	0			0			X			
2b. Analysis protocol for culinary properties obtained	0			0			0			0			0			
2b. Analysis of desirable culinary traits of current varities initiated	0			0			0			0			0			
2b. Culinary traits & sensory char. of current varieties documented	X			X	X		0			0			X			

2b. Analysis of culinary traits & sensory char. of improv. var. initiated	0			X	X		0			0			X		
2c. Tech. incubation & transfer models identified and modifed	0			X	X		0			0			0		
2c. Local & int'l industries as potential markets for beans identified	0			X	X		0			0			0		
2c. Private industry interest/conditions to adopt bean tech. evaluated	0			X	X		0			0			0		
2c. Links establ. btw. farmers' assoc. & private industries	0			X	X		X			X			0		
2c. Protocols for value-addition w/ private sector partners initiated	0			X	X		0			0			0		
Objective 3	***Increase Marketing and Consumption of Beans and Bean Products***														
3a. Farmer groups' composition, roles, assets, capabilites identified	0			0			0			0			0		
3a. Farmer groups' needs determined and prioritized	X			0			0			X			0		
3b. Farmers trained in group/assoc. dynamics and gender equity	0			0			0			0			0		
3b. Partner meetings held in two sub-counties	0			0			0			0			0		
3b. Participatory market research groups formed	0			0			0			0			0		
3b. Market chain analysis for bean enterprises conducted	X			X	X		0			X			0		
3b. Market information sources assessed	X			X	X		0			X			0		
Objective 4	***Incr. Capacity, Effectiveness & Sustainability of Ag. Research Institut.***														
4. Training M.S. (FST and AgEcon) at MAK on-going	0			0			0			0			0		
4. Training M.S. student in FST from Rwanda on-going	0			0			0			0			0		
4. Training M.S. students at Makerere University completed	0			X	X		0			0			X		
4. Training Ph.D. students at Iowa State University ongoing	X			0			0			0			0		
4. Inter-organizational learning fostered	X			X	X		X			X			X		
4. Prelim. results disseminated (conf., public., websites)	X			X	X		X			X			X		

Name of the PI reporting on benchmarks by institution	Robert Mazur	Dorothy Nakimbugwe	Michael Ugen	Henry Kizito Musoke	Hilda Vasanthakaalam

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

Signature

30th Sept 2011

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: October 1, 2010 -- September 30, 2011)

This form should be completed by the U.S. Lead PI and submitted to the MO by October 1, 2011

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			NaCRRI			VEDCO			KIST		
	Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved	
Benchmarks by Objectives	9/30/11	Y	N*	9/30/11	Y	N*	9/30/11	Y	N*	9/30/11	Y	N*	9/30/11	Y	N*
	(Tick mark the Yes or No column for identified benchmarks by institution)														
Objective 1	***Improve Bean Yield and Quality***														
1a. Variety performance and fertility responses analyzed	0			0			0			0			0		
1a. Biological & agronomic controls for pests & diseases initiated	0			0			0			0			0		
1a. Variety perform., fertility respon., bio. & agron. controls analyzed	X			0			X	√		0			0		
1a. Best performing bean varieties reported to breeders	X			0			X	√		X			0		
1a. Seeds provided for post-harvest storage studies	0			0			X	√		X			0		
1b. Training in group dynamics & mgmt. practices for quality seed	0			0			0			0			0		
1b. Exchange visits to established seed production programs	0			0			0			0			0		
1b. Extension guide for bean CBSP initiated and tested	0			0			0			0			0		
1b. Linkages establ. for breeders, seed processors, marketers	0			0			X	√		X			0		
1b. Seed storage facilities established	0			0			X	√		X			0		
1c. Effects of solarization on germination and storage evaluated	0			0			0			0			0		
1c. Farmers trained in effective use of solarization technique	0			0			0			0			0		
1c. Polyethylene for solarization distributed to farmers groups	0			0			0			0			0		
1c. Barriers to adoption of solarization identified and resolved	0			0			0			0			0		
1c. Storage techniques evaluated for pest control and germination	X			0			X	√		X			0		
1c. Farmers trained in new solar techniques	0			0			X	√		X			0		
1c. Storage materials produced and distributed to farmers	0			0			X	√		X			0		
1c. Training in mananging bulking facilities completed	0			0			X	√		X			0		
1d. Exchange visits of other farmer groups conducted	0			0			0			0			0		
1d. Contacts establ. w/ districts to scale technologies & practices	0			0			X	√		X			0		
1d. Stakeholder workshop to review bean prod. training materials	X			0			X	√		X			0		
1d. Extension materials translated and published	0			0			X	√		X			0		
Objective 2	***Enhance the Nutritional Value and Appeal of Beans***														
2a. Cold extruded bean products & process developed at KIST	0			0			0			0			0		
2a. Bean-based weaning foods developed for Uganda & Rwanda	X			X			0			0			X		
2a. Extension approaches indentifed and content developed	X			X			0			X			X		
2a. Farmers trained in bean cold extrusion processing	0			0			0			0			X		
2a. Baseline nutritional status established for feeding studies	X			X			0			0			X		
2b. Analysis protocol for culinary properties obtained	0			0			0			0			0		
2b. Analysis of desirable culinary traits of current varities initiated	0			0			0			0			0		
2b. Culinary traits & sensory char. of current varieties documented	X			X			0			0			X		

2b. Analysis of culinary traits & sensory char. of improv. var. initiated	0			X			0			0			X		
2c. Tech. incubation & transfer models identified and modifed	0			X			0			0			0		
2c. Local & int'l industries as potential markets for beans identified	0			X			0			0			0		
2c. Private industry interest/conditions to adopt bean tech. evaluated	0			X			0			0			0		
2c. Links establ. btw. farmers' assoc. & private industries	0			X			X	√		X			0		
2c. Protocols for value-addition w/ private sector partners initiated	0			X			0			0			0		
Objective 3	***Increase Marketing and Consumption of Beans and Bean Products***														
3a. Farmer groups' composition, roles, assets, capabilites identified	0			0			0			0			0		
3a. Farmer groups' needs determined and prioritized	X			0			0			X			0		
3b. Farmers trained in group/assoc. dynamics and gender equity	0			0			0			0			0		
3b. Partner meetings held in two sub-counties	0			0			0			0			0		
3b. Participatory market research groups formed	0			0			0			0			0		
3b. Market chain analysis for bean enterprises conducted	X			X			0			X			0		
3b. Market information sources assessed	X			X			0			X			0		
Objective 4	***Incr. Capacity, Effectiveness & Sustainability of Ag. Research Institut.***														
4. Training M.S. (FST and AgEcon) at MAK on-going	0			0			0			0			0		
4. Training M.S. student in FST from Rwanda on-going	0			0			0			0			0		
4. Training M.S. students at Makerere University completed	0			X			0			0			X		
4. Training Ph.D. students at Iowa State University ongoing	X			0			0			0			0		
4. Inter-organizational learning fostered	X			X			X	√		X			X		
4. Prelim. results disseminated (conf., public., websites)	X			X			X	√		X			X		

Name of the PI reporting on benchmarks by institution	**Robert Mazur**	**Dorothy Nakimbugwe**	**Michael Ugen**	**Henry Kizito Musoke**	**Hilda Vasanthakaalam**

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

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: October 1, 2010 -- September 30, 2011)

This form should be completed by the U.S. Lead PI and submitted to the MO by October 1, 2011

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			NaCRRI			VEDCO			KIST		
	Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved	
Benchmarks by Objectives	9/30/11	Y	N*	9/30/11	Y	N*	9/30/11	Y	N*	9/30/11	Y	N*	9/30/11	Y	N*
	(Tick mark the Yes or No column for identified benchmarks by institution)														
Objective 1	*Improve Bean Yield and Quality*														
1a. Variety performance and fertility responses analyzed	0			0			0			0			0		
1a. Biological & agronomic controls for pests & diseases initiated	0			0			0			0			0		
1a. Variety perform., fertility respon., bio. & agron. controls analyzed	X			0			X			0			0		
1a. Best performing bean varieties reported to breeders	X			0			X			X	√		0		
1a. Seeds provided for post-harvest storage studies	0			0			X			X	√		0		
1b. Training in group dynamics & mgmt. practices for quality seed	0			0			0			0			0		
1b. Exchange visits to established seed production programs	0			0			0			0			0		
1b. Extension guide for bean CBSP initiated and tested	0			0			0			0			0		
1b. Linkages establ. for breeders, seed processors, marketers	0			0			X			X	√		0		
1b. Seed storage facilities established	0			0			X			X	√		0		
1c. Effects of solarization on germination and storage evaluated	0			0			0			0			0		
1c. Farmers trained in effective use of solarization technique	0			0			0			0			0		
1c. Polyethylene for solarization distributed to farmers groups	0			0			0			0			0		
1c. Barriers to adoption of solarization identified and resolved	0			0			0			0			0		
1c. Storage techniques evaluated for pest control and germination	X			0			X			X	√		0		
1c. Farmers trained in new solar techniques	0			0			X			X	√		0		
1c. Storage materials produced and distributed to farmers	0			0			X			X	√		0		
1c. Training in mananging bulking facilities completed	0			0			X			X	√		0		
1d. Exchange visits of other farmer groups conducted	0			0			0			0			0		
1d. Contacts establ. w/ districts to scale technologies & practices	0			0			X			X	√		0		
1d. Stakeholder workshop to review bean prod. training materials	X			0			X			X	√		0		
1d. Extension materials translated and published	0			0			X			X	√		0		
Objective 2	*Enhance the Nutritional Value and Appeal of Beans*														
2a. Cold extruded bean products & process developed at KIST	0			0			0			0			0		
2a. Bean-based weaning foods developed for Uganda & Rwanda	X			X			0			0			X		
2a. Extension approaches indentifed and content developed	X			X			0			X	√		X		
2a. Farmers trained in bean cold extrusion processing	0			0			0			0			X		
2a. Baseline nutritional status established for feeding studies	X			X			0			0			X		
2b. Analysis protocol for culinary properties obtained	0			0			0			0			0		
2b. Analysis of desirable culinary traits of current varities initiated	0			0			0			0			0		
2b. Culinary traits & sensory char. of current varieties documented	X			X			0			0			X		

2b. Analysis of culinary traits & sensory char. of improv. var. initiated	0			X			0			0			X		
2c. Tech. incubation & transfer models identified and modified	0			X			0			0			0		
2c. Local & int'l industries as potential markets for beans identified	0			X			0			0			0		
2c. Private industry interest/conditions to adopt bean tech. evaluated	0			X			0			0			0		
2c. Links establ. btw. farmers' assoc. & private industries	0			X			X			X	√		0		
2c. Protocols for value-addition w/ private sector partners initiated	0			X			0			0			0		
Objective 3	***Increase Marketing and Consumption of Beans and Bean Products***														
3a. Farmer groups' composition, roles, assets, capabilites identified	0			0			0			0			0		
3a. Farmer groups' needs determined and prioritized	X			0			0			X	√		0		
3b. Farmers trained in group/assoc. dynamics and gender equity	0			0			0			0			0		
3b. Partner meetings held in two sub-counties	0			0			0			0			0		
3b. Participatory market research groups formed	0			0			0			0			0		
3b. Market chain analysis for bean enterprises conducted	X			X			0			X	√		0		
3b. Market information sources assessed	X			X			0			X	√		0		
Objective 4	***Incr. Capacity, Effectiveness & Sustainability of Ag. Research Institut.***														
4. Training M.S. (FST and AgEcon) at MAK on-going	0			0			0			0			0		
4. Training M.S. student in FST from Rwanda on-going	0			0			0			0			0		
4. Training M.S. students at Makerere University completed	0			X			0			0			X		
4. Training Ph.D. students at Iowa State University ongoing	X			0			0			0			0		
4. Inter-organizational learning fostered	X			X			X			X	√		X		
4. Prelim. results disseminated (conf., public., websites)	X			X			X			X	√		X		

Name of the PI reporting on benchmarks by institution	Robert Mazur	Dorothy Nakimbugwe	Michael Ugen	Henry Kizito Musoke	Hilda Vasanthakaalam

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

Signature

30/09/2011

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: October 1, 2010 -- September 30, 2011)

This form should be completed by the U.S. Lead PI and submitted to the MO by October 1, 2011

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			NaCRRI			VEDCO			KIST		
	Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved		Target	Achieved	
Benchmarks by Objectives	9/30/11	Y	N*	9/30/11	Y	N*	9/30/11	Y	N*	9/30/11	Y	N*	9/30/11	Y	N*
	(Tick mark the Yes or No column for identified benchmarks by institution)														
Objective 1	***Improve Bean Yield and Quality***														
1a. Variety performance and fertility responses analyzed	0			0			0			0			0		
1a. Biological & agronomic controls for pests & diseases initiated	0			0			0			0			0		
1a. Variety perform., fertility respon., bio. & agron. controls analyzed	X			0			X			0			0		
1a. Best performing bean varieties reported to breeders	X			0			X			X			0		
1a. Seeds provided for post-harvest storage studies	0			0			X			X			0		
1b. Training in group dynamics & mgmt. practices for quality seed	0			0			0			0			0		
1b. Exchange visits to established seed production programs	0			0			0			0			0		
1b. Extension guide for bean CBSP initiated and tested	0			0			0			0			0		
1b. Linkages establ. for breeders, seed processors, marketers	0			0			X			X			0		
1b. Seed storage facilities established	0			0			X			X			0		
1c. Effects of solarization on germination and storage evaluated	0			0			0			0			0		
1c. Farmers trained in effective use of solarization technique	0			0			0			0			0		
1c. Polyethylene for solarization distributed to farmers groups	0			0			0			0			0		
1c. Barriers to adoption of solarization identified and resolved	0			0			0			0			0		
1c. Storage techniques evaluated for pest control and germination	X			0			X			X			0		
1c. Farmers trained in new solar techniques	0			0			X			X			0		
1c. Storage materials produced and distributed to farmers	0			0			X			X			0		
1c. Training in mananging bulking facilities completed	0			0			X			X			0		
1d. Exchange visits of other farmer groups conducted	0			0			0			0			0		
1d. Contacts establ. w/ districts to scale technologies & practices	0			0			X			X			0		
1d. Stakeholder workshop to review bean prod. training materials	X			0			X			X			0		
1d. Extension materials translated and published	0			0			X			X			0		
Objective 2	***Enhance the Nutritional Value and Appeal of Beans***														
2a. Cold extruded bean products & process developed at KIST	0			0			0			0			0		
2a. Bean-based weaning foods developed for Uganda & Rwanda	X			X			0			0			X	X	
2a. Extension approaches indentifed and content developed	X			X			0			X			X	X	
2a. Farmers trained in bean cold extrusion processing	0			0			0			0			X	X	
2a. Baseline nutritional status established for feeding studies	X			X			0			0			X		X
2b. Analysis protocol for culinary properties obtained	0			0			0			0			0		
2b. Analysis of desirable culinary traits of current varities initiated	0			0			0			0			0		
2b. Culinary traits & sensory char. of current varieties documented	X			X			0			0			X	X	

2b. Analysis of culinary traits & sensory char. of improv. var. initiated	0			X			0			0			X	X	
2c. Tech. incubation & transfer models identified and modifed	0			X			0			0			0		
2c. Local & int'l industries as potential markets for beans identified	0			X			0			0			0		
2c. Private industry interest/conditions to adopt bean tech. evaluated	0			X			0			0			0		
2c. Links establ. btw. farmers' assoc. & private industries	0			X			X			X			0		
2c. Protocols for value-addition w/ private sector partners initiated	0			X			0			0			0		
Objective 3	***Increase Marketing and Consumption of Beans and Bean Products***														
3a. Farmer groups' composition, roles, assets, capabilites identified	0			0			0			0			0		
3a. Farmer groups' needs determined and prioritized	X			0			0			X			0		
3b. Farmers trained in group/assoc. dynamics and gender equity	0			0			0			0			0		
3b. Partner meetings held in two sub-counties	0			0			0			0			0		
3b. Participatory market research groups formed	0			0			0			0			0		
3b. Market chain analysis for bean enterprises conducted	X			X			0			X			0		
3b. Market information sources assessed	X			X			0			X			0		
Objective 4	***Incr. Capacity, Effectiveness & Sustainability of Ag. Research Institut.***														
4. Training M.S. (FST and AgEcon) at MAK on-going	0			0			0			0			0		
4. Training M.S. student in FST from Rwanda on-going	0			0			0			0			0		
4. Training M.S. students at Makerere University completed	0			X			0			0			X	X	
4. Training Ph.D. students at Iowa State University ongoing	X			0			0			0			0		
4. Inter-organizational learning fostered	X			X			X			X			X	X	
4. Prelim. results disseminated (conf., public., websites)	X			X			X			X			X	X	

Name of the PI reporting on benchmarks by institution	**Robert Mazur**	**Dorothy Nakimbugwe**	**Michael Ugen**	**Henry Kizito Musoke**	**Hilda Vasanthakaalam**

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

Hilda Vasanthakaalam — **Signature**

29/Sept/2011 — **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, 2010 - September 30, 2011)

FY 2011 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 Mazur, Iowa State University
Host Country(s): Uganda, Rwanda

Output Indicators	2011 Target (Oct. 1, 2010 - Sept. 30, 2011)	2011 Actual (Oct. 1, 2010 - Sept. 30, 2011)
Degree Training: Number of individuals enrolled in degree training		
Number of women	2	3
Number of men	3	3
Short-term Training: Number of individuals who received short-term training		
Number of women	75	105
Number of men	48	52
Technologies and Policies		
Number of technologies and management practices under research	5	5
Number of technologies and management practices under field testing	5	3
Number of technologies and management practices made available for transfer	5	9
Number of policy studies undertaken	0	0
Beneficiaries:		
Number of rural households benefiting directly	467	615
Number of agricultural firms/enterprises benefiting	3	3
Number of producer and/or community-based organizations receiving technical assistance	50	51
Number of women organizations receiving technical assistance	50	51
Number of HC partner organizations/institutions benefiting	4	4
Developmental outcomes:		
Number of additional hectares under improved technologies or management practices	115	138