Appendix B

Technical Application - 30 months
(April 1, 2008 to September 30, 2010)

Dry Grain Pulses CRSP Proposal

COVER PAGE (must print on one page)

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

Name(s), institutional affiliation and contact information of Lead U.S. Principal Investigator(s) submitting this proposal:

Robert E. Mazur, Director; Center for Sustainable Rural Livelihoods; 106 Curtiss Hall; Iowa State University; Ames, Iowa 50011; rmazur@iastate.edu; tel. 515-294-9237; fax: 515-294-9477

Name(s) and institutional affiliation of all Host Country (HC) and U.S. Co-PIs

Suzanne Hendrich, Professor; Department of Food Science & Human Nutirtion; 224D MacKay; Iowa State University; Ames, Iowa 50011; shendric@iastate.edu; t: 515-294-4272; f: 515-294-8181

Mark E. Westgate, Professor; Department of Agronomy; 1577 Agronomy; Iowa State University; Ames, Iowa, 50011; westgate@iastate.edu; t: 515-294-9654; f: 515-294-5506

Helen H. Jensen, Professor; Department of Economics; 578E Heady; Iowa State University; Ames, IA 50011; hhjensen@iastate.edu; t: 515-294-6253; f: 515-294-6336

Dorothy Nakimbugwe, Senior Lecturer; Department of Food Science & Technology; Makerere University; Kampala, Uganda; dnakimbugwe@agric.mak.ac.ug; t: 256-782-246089; f: 256-414-531641

Barnabas Kiiza; Senior Lecturer; Department of Agricultural Economics & Agribusiness; Makerere University, Kampala, Uganda; bkiiza@agric.mak.ac.ug, t: 256-772-616540; f: 256-414-531641

Michael A. Ugen, Principal Research Officer; National Crops Resources Research Institute, P.O. Box 7084, Kampala, Uganda; m.ugen@naro-ug.org; t: 256-772-446739

Henry Kizito Musoke, Executive Director; Volunteer Efforts for Development Concerns; Plot 129 Block 2, Bukesa Nakulabye, PO Box 1244, Kampala; vedco@infocom.co.ug; t: 256-414-270598, f: 256-414-348441

Hilda Vasanthakaalan, Senior Lecturer; Dept. of Food Science & Technology; Kigali Institute of Science and Technology; BP: 3900,Kigali, Rwanda; hvasanthak@kist.ac.rw; t: 250-08530367

Proposed Project Period: (30 months maximum, between April 1, 2008 – September 30, 2010)	**Total federal funds requested**	**Total non-federal cost share commitment by U.S. institution(s)**
April 1, 2008 - Sept. 30, 2010	**$450,000**	**$77,927**

Proposed HCs where project activities will be implemented:	Proposed HC institutions to be sub-contracted (abbreviated name):	Proposed budget for a sub-contract to a HC institution	Are you requesting the ME (MSU) to manage the Fixed-Price sub-contract for this HC Institution? (Yes/No)
Uganda	**Makerere**	**$88,376**	**No**
	NaCRRI	**$44,099**	**No**
	VEDCO	**$76,198**	**No**
Rwanda	**KIST**	**$39,490**	**No**

Authorized lead U.S. institutional representative (type name, phone number and e-mail):
Diane Meyer, t: 515-294-5225, f: 515-294-8000, grants@iastate.edu

Signature: Diane M S Meyer **Date:** 11/29/07

Dry Grain Pulses CRSP Proposal
SUMMARY PAGE (must print on one page)

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

Name and Institutional Affiliation of the U.S. Principal Investigator:
Robert E. Mazur, Director; Center for Sustainable Rural Livelihoods; Iowa State University; Ames, Iowa 50011;
rmazur@iastate.edu; tel. 515-294-9237; fax: 515-294-9477

Abstract (Limit: 1800 characters including spaces):

Common beans provide a strategic opportunity to meet Millennium Development Goal targets. The *first strategic aim* is to significantly improve yields and quality of four priority beans varieties through supporting farmer-based experimentation, adoption and dissemination of innovative production techniques. The *second strategic aim* is to enhance nutritional value and marketability of beans through appropriate handling and processing: reducing post-harvest losses through improved harvesting, threshing, drying methods and conditions, packaging and storage; appropriate processing (malting, pre-soaking, roasting); and innovative food combinations and product development. The *third strategic aim* is to increase marketing and consumption of beans and value-added bean products: determining market-based constraints to producing and selling beans; determining consumer demand for beans and establishing preferences for beans and agro-processed products; and identifying ways to effectively and efficiently increase consumer awareness of benefits of consuming beans and value-added products and increase their access to new products.

Ongoing collaboration since 2004 of Iowa State University (ISU), Makerere University (MAK), and an indigenous NGO in Uganda have increased food security and market readiness from 9% to 77% among 800+ farm households. The *proposed collaboration builds on this success by incorporating the expertise* of Uganda's National Crop Resources Research Institute and of Food Science and Technology at Kigali Institute of Science and Technology (KIST) in Rwanda. Training and research of M.S. students at MAK, of B.S. students at KIST, and Ph.D. students at ISU, along with *enhanced farmer group training and dissemination*, ensures significant long-term impacts from this project.

Pulse Crop of Focus *(select at least one between beans and cowpeas)*

Beans ☒ **Cowpeas** ☐ **Other (specify):** ☐

Topical Areas to be Addressed By this Project

Select one or more under Global Themes A-C:

A. To reduce bean and cowpea production costs and risks for enhanced profitability and competitiveness.
- ☐ 1. Genetic Improvement
- ☒ 2. Integrated Crop Management
- ☐ 3. Mitigating Effects of Low Soil Fertility/Drought
- ☐ 4. Grain Quality
- ☐ 5. Sustainable Seed Systems

B. To increase the utilization of bean and cowpea grain, food products and ingredients so as to expand market opportunities and improve community health and nutrition.
- ☒ 1. Health and Nutritional Attributes
- ☒ 2. Consumer Attitudes and Preferences
- ☐ 3. Influencing Decision Makers
- ☒ 4. Urban Consumer Access to Value-added Pulse Foods

C. To improve the performance and sustainability of bean and cowpea value-chains, especially for the benefit of women.
- ☒ 1. Understanding constraints to smallholder pulse farmer participation in markets and trade
- ☒ 2. Identifying "weak links"/constraints in the functionality of dry grain pulse value-chains
- ☐ 3. Identifying strategic public sector interventions to alleviate constraints or market failures.

Select at least one from Global Theme D; If none selected from A-C, then select at least two:

D. To increase the capacity, effectiveness and sustainability of agriculture research institutions
- ☒ 1. Building and promoting partnerships with key stakeholders
- ☐ 2. Strengthening regional dry grain pulse commodity research networks
- ☒ 3. Training young scientists in the use of modern tools for research, management and outreach

Summary Checklist *(select as many as appropriate)*

- ☒ Project addresses IEHA objectives (give anticipated level of effort as % of total budget requested): 81.50 %
- ☒ Project devotes at least 30% of project funds on HC capacity building activities (Global Theme D) (give total % budgeted): 68.56%
- ☐ Project involves research on biotechnology as defined in the RFP (give % effort on biotechnology)____%
- ☐ Project involves the use or generation of genetically modified organisms (GMOs)
- ☒ Project involves human subject approval
- ☐ Project involves animal use approval
- ☒ Project involves M.S. or Ph.D. degree training of HC personnel (how many?) 3 M.S., 2 Ph.D.

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

Abstract

Common beans provide a strategic opportunity to meet Millennium Development Goal targets. The *first strategic aim* is to significantly improve yields and quality of four priority beans varieties through supporting farmer-based experimentation, adoption and dissemination of innovative production techniques. The *second strategic aim* is to enhance nutritional value and marketability of beans through appropriate handling and processing: reducing post-harvest losses through improved harvesting, threshing, drying methods and conditions, packaging and storage; appropriate processing (malting, pre-soaking, roasting); and innovative food combinations and product development. The *third strategic aim* is to increase marketing and consumption of beans and value-added bean products: determining market-based constraints to producing and selling beans; determining consumer demand for beans and establishing preferences for beans and agro-processed products; and identifying ways to effectively and efficiently increase consumer awareness of benefits of consuming beans and value-added products and increase their access to new products.

Ongoing collaboration since 2004 of Iowa State University (ISU), Makerere University (MAK), and an indigenous NGO in Uganda have increased food security and market readiness from 9% to 77% among 800+ farm households. The *proposed collaboration builds on this success by incorporating the expertise* of Uganda's National Crop Resources Research Institute and of Food Science and Technology at Kigali Institute of Science and Technology (KIST) in Rwanda. Training and research of M.S. students at MAK, of B.S. students at KIST, and Ph.D. students at ISU, along with *enhanced farmer group training and dissemination*, ensures significant long-term impacts from this project.

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Problem Statement and Justification

Agriculture in East Africa is characterized by women and men working in small scale, rainfed production, averaging 2 hectares per household (FAO 2006). Erratic bimodal rainfall patterns in recent years further challenge cropping results (ARB 2007). Farmers have very limited access to extension, training, inputs (quality seeds, fertilizers, etc.), improved agronomic practices, new technologies, and credit (KDA 2004; Nkonya et al. 2004). Producers not well linked with profitable markets, especially to emerging sectors of domestic and regional markets (Ehui & Pender 2005). Private traders operate on a small scale with limited investment capability. Availability and use of processed products at present remains very modest. As a result of low production levels, hunger is widespread (WFP 2006) and the vast majority of the rural population lives in absolute poverty (KDA 2004).

Our recent efforts to introduce new agronomic practices and technologies demonstrate encouraging progress (Butler & Mazur 2007). Ongoing collaboration since 2004 of Iowa State University (ISU), Makerere University (MAK), and Volunteer Efforts for Development Concerns (VEDCO) in Uganda's Kamuli District (Mazur et al. 2006; VEDCO 2006) using a sustainable livelihoods approach has increased food security and market readiness from 9% to 77% among 800+ farm households in the past 2½ years (Sseguya 2007). The main crops grown in Kamuli district are maize, beans, sweet potatoes, cassava, bananas, rice and coffee (Sseguya & Masinde 2005). Most (90%) of participating households produce beans, but only 20% sell some in 2007. The SL approach livelihood 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 (Ellis 2000). In combination with SL approaches, scientific knowledge, improved technologies, financial assistance, and changes in government policies can have significant positive local impacts (Helmore & Singh 2001). Participatory research methods can generate knowledge that people can apply to improve their individual and collective well-being (Selener 1997).

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

Central problems limiting high yields of quality beans

- Declining soil fertility and inefficient cropping systems unable to utilize available resources effectively and efficiently
- Limited accessibility and affordability of quality seeds, non-seed inputs and other yield improving technologies
- Effects of drought and other weather related factors compromise productivity and quality
- Diseases (root rot, anthracnose, angular leaf spot, common bacterial blight, viruses, rust, ascochyta blight) and insect pests (bean stem maggots, aphids, storage weevils)

Central problems relating to nutritional value and processing of beans

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

The nutrition value of beans is negatively affected by anti-nutrients such as phytates, trypsin inhibitor, lectins, polyphenols, saponins, oligosaccharides and hemaglutinins (Kebede, et al., 1995). However, treatments such as de-hulling, soaking, milling, fermentation and germination or malting and cooking enhance the digestibility and nutritional value (Matella 2005; Martín-Cabrejas 2006; Shimelis & Rakshit 2007; Nergiz & Gökgöz 2007; Cevdet & Gökgöz 2007).

Central problems inhibiting increased marketing of beans and derived food products

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

Objectives

The ***first strategic aim*** is to improve bean yields and quality significantly through recommended production practices.

The objectives relating to high yields of quality beans are to:

1a. Improve yields of four priority bean varieties
1b. Improve quality of beans through better production practices
1c. Strengthen farmers' collective capabilities to learn and share innovative practices

The ***second strategic aim*** is to enhance the nutritional value and appeal of beans through appropriate handling and processing.

The *objectives of the proposed project relating to nutrition and appeal* are to:

2a. Reduce post-harvest losses through improved practices (timely harvesting, improved threshing methods, appropriate drying methods and conditions, packaging and storage)
2b. Enhance nutritional value through appropriate processing (malting, pre-soaking, roasting)
2c. Introduce innovative food combinations and agro-processed products

The ***third strategic aim*** is to increase marketing and consumption of beans and value-added products.

The *objectives of the proposed project relating to marketing and consumption* are to:

3a. Identify solutions to production and marketing constraints faced by producers of beans
3b. Characterize consumer demand and preferences for beans and agro-processed products
3c. Determine effective and efficient ways to increase consumer awareness of benefits of consuming beans and value-added products and their access to new products

Approaches and Methods

Strategic Aim 1: *To improve yields of high quality common beans, we will:*

- Conduct participatory rural appraisals to determine current local knowledge, attitudes and practices related to planting, weeding, and mitigation/control strategies for diseases and pests in common beans
- Evaluate yield and quality of white dry bean, small seeded (NABE 6) and carioca dry bean (K 131) and red mottled beans (K 132 and, NABE 4) selected for multiple stress resistance and high seed quality through participatory field research. NABE 6 is small seeded white bean favored for market value and ease of cooking. Some farmers report difficulty storing this variety, which provides an opportunity for improving post-harvest management. K 131 is a carioca bean more resilient to harsh conditions. Farmer acceptance is hampered by its hard testa which requires additional fuel for cooking. Research is needed to make it more suitable for cooking to exploit its potential nutritional and economic value. K 132 and NABE 4 are the preferred red mottled beans. NABE 13 and NABE 14 are adapted to higher altitudes and may require additional management inputs to perform well in environments typical of the study sites. The four varieties K 131, K 132, ABE 4 and NABE 6 will provide an excellent basis for this research in terms of food security, markets and value addition.
- Evaluate practical management strategies to increase and stabilize seed yield and seed quality in participatory field research
- Promote adoption of recommended practices to increase yield of quality beans through RDE and farmer training, and facilitating access to superior varieties and priority inputs

Participatory on-farm research will be conducted in two Uganda districts, Luweero and Kamuli. Members of nine groups of farmers, including lead farmers, will be selected in each district (18 total demonstration/adaptation sites). Site selection will be defined by where beans are already grown and consumed, and will encompass the range of soil types and weather conditions typical of each district. Site selection, appraisals of local knowledge and attitudes, and participatory research will be coordinated through VEDCO in partnership with NaCRRI researchers.

The benefits of applying the following treatments will be investigated at each site:

1. *Stress tolerant varieties* (e.g., NABE 6, K 132, K131, NABE 4) or others that are locally adapted for each agro-ecological zone will be used.
2. *Uniform equidistant plant density* - planting configurations (row spacing and population) currently in practice at each site will be compared to a relatively high plant density with equidistant plant spacing (16 pl/m2, 25 cm rows and 25 cm between plants). We anticipate that the equidistant spacing treatment will be more productive when adequate soil moisture is available (Berrada 2003). Some adjustment of row spacing and density may be needed to accommodate local growing conditions (Opio et al. 2001).
3. *Uniform planting depth (5 cm)* - Depth control has been a major problem as planting is done manually resulting in varied depths and times of germination. Improved planting technique with farmer groups can reduce the disparities. Deeper planting in most cases results in poor germination, yet very shallow planting attracts predators. The heavy soils in some places favor slightly shallow planting.
4. *Fertigation* - Half of the area allocated to each variety planted at equidistant spacing and at uniform depth will be irrigated by a drip irrigation system. A gravity fed (or manually

pressurized) drip irrigation system will be used to supply irrigation water and nutrients to the root zone during critical stages of plant development. We will apply fertigation at two critical times: at planting to ensure uniform stand establishment, and during flowering and pod fill to avoid visible stress symptoms and ensure vigorous pod and seed growth. Dry beans are very sensitive to water stress during flowering to early pod fill, thus we anticipate one or more irrigations during this period will boost seed yield significantly. Irrigation water will be applied as needed to prevent visible wilting symptoms. Irrigation will be terminated when lower leaves and pods turn yellow to avoid delaying seed maturation and minimize disease potential (Yonts 1996). We recognize that the distribution system for agricultural products may limit fertilizer availability at some test sights. Locations selected for fertigation treatments will be determined as appropriate by initial surveys of soil conditions, fertilizer availability, and potential for farmer training at these sites. Yield and resistance to disease in dry beans also are very responsive to moderate fertization (Berrada 2003). Liquid fertilizer (N:P:K) will be supplied to the main irrigation line using a commercial siphon system (e.g., E-Z Flo). The ideal ratio of N:P:K for beans is 1:2:3, but actual ratio supplied will depend on locally available materials. The siphon system delivers a constant mixing ratio with changes in flow rate or water pressure as low as 2.5 gallons per hour and 5 pounds per square inch (PSI). Because the fertilizer is not diluted and delivery is concentrated along the drip tape, we anticipate one 3/4 gallon tank will supply sufficient supplemental nutrients for the entire season. The siphon system was chosen because it can be adapted readily to gravity fed systems currently available, it is simple to maintain, and extremely conservative for nutrient and water use.

Data collected for each treatment will include: soil analysis, final plant stand (pl/m), seed yield (kg/ha), disease and insect pest ratings (mid-season for leaves), days to physiological maturity, pods per plant, seed quality (color, % not mature, % mottled, nutritional value (as part of Aim 2), and economic returns/profit. Simple weather recording equipment (thermometers and rain gauges) will be positioned on site for recording temperature and rainfall. Previous experience confirms collaborators at the sites are competent to collect such data.

Strategic Aim 2a: *To reduce post-harvest losses, we will:*

- Conduct participatory rural appraisals through focus group discussions and key informant interviews to determine current knowledge, attitudes and practices related to pre- and post-harvest handling and storage, processing and consumption of beans
- Establish the basis and magnitude of post-harvest losses associated with post-harvest handling and storage (e.g., harvesting times, threshing method, drying, storage, packaging) -- – mechanical, physical, chemical and botanical methods. Seed quality deterioration will be determined in the lab using standard methods and analyses.
- Promoting adoption of recommended pre- and post-harvest handling practices that address the identified major causes (such as timely harvesting and threshing, drying to <15% moisture content, packing in moisture/pest proof materials with complete closure, storing in off the ground to minimize moisture pick-up and infestation, etc.) to minimize post-harvest yield and quality losses through farmer training
- Assess the effect of the above practices on post-harvest losses by comparing between two groups of bean farmers: one group using the recommended practices and the other group not. Bean samples will be collected from the two groups of farmers at regular intervals, transported to the laboratory and assessed for: moisture content, the types and levels of pests

encountered; occurrence of damaged, shriveled and rotten seeds and; occurrence and levels of foreign matter present.

Strategic Aim 2b: *To develop nutritious, value-added bean products,, we will:*

- Determine knowledge, attitudes and practices regarding processing and human consumption of beans via participatory appraisals in districts noted in Aim 1 and in the capital city . The information obtained will inform the product development process.

The quality, nutritional and physico-chemical properties of the beans are affected by the agronomic practices during their production (Paredes-López 1989; Mavromatis et al. 2008) as well as the pre- and post-harvest handling practices (Balamaze et al. 2007). The physico-chemical properties, in turn, may affect processing characteristics of beans and, thus, development of value-added products. The next activities will therefore be to:

- Determine the nutritional and physico-chemical properties of bean varieties in Aim 1 and influences of agronomic and post-harvest handling practices on those properties
- Develop protocols and recipes for nutritious, value-added bean-based products, using the most suitable bean samples among the above
- Conduct consumer acceptability studies for the developed product
- Investigate the effect of pretreatment of the beans (malting, pre-soaking, roasting) on the nutritional value of the products
- Promote the developed value-added bean protocols and recipes for uptake by food processing enterprises and communities respectively, through the MAK DFST Technology and Business Incubation Centre

For the value-added products developed to contribute to increased bean consumption, they have to be highly acceptable to consumers (Vanegas et al. 1992). To deliver maximum nutritional benefits, they have to be of high nutritional value - easily digestible, absorbable and utilizable (Srivastava & Srivastava 2004; Mauer et al. 2005; Mosha et al. 2005; Erkan & Gökgöz 2007; Shimelis & Rakshit 2007).

Nutrient-dense bean flour from the bean cultivars specified in Aim 1 will be developed at the Department of Food Science & Technology using response surface methodology (Alarcon-Valdez et al. 2005), formulated into bean and bean/maize cakes for frying and roasting, and tested with consumer panels in the Ugandan rural districts as above. Our main nutritional aim is to determine the effects of processing methods on nutritional quality of the four bean varieties, focusing on carbohydrate quality, in vitro protein digestibility and amino acid quality (Alarcon-Valdez et al. 2005), and in vitro iron bioavailability using a Caco2 cell model system (Proulx and Reddy 2006). The bean varieties across the processing methods will be analyzed in triplicate for these nutritional qualities as above as well as carbohydrate content - digestible and indigestible, according to AOAC method 991.46 for insoluble dietary fibers (AOAC 2006). Bean starches will be extracted and analyzed for digestion resistance and fermentability according to methods of Sayar et al. (2006), and compared statistically.

Bean carbohydrates may not be readily digestible by humans, and oligosaccharides in beans may cause gastrointestinal distress (Reddy 1980). Thus, their nutritional value may not be readily delivered to the human body. But slow digestibility of bean carbohydrates may have some benefit to humans in terms of preventing high glucose after a meal, which may help diabetics with glucose control, and may also help to prevent obesity and other health complications. Identifying bean cultivars and processing methods with the most positive health effects in terms of carbohydrate quality will be accomplished by human studies following the above analyses.

Equivalent amounts of total carbohydrate of each cultivar/processing method will be fed in single meals to groups of 10-30 human subjects by methods similar to that described in Granfeldt et al. (2006). 50g total carbohydrate in breakfast meals (using products developed as above) will be provided to each subject, from each of the four bean varieties, and from white bread as a high glucose control, in a randomized crossover design on one day per week over five weeks. Young healthy adults who are nondiabetic and not taking any medications will be the subjects. Blood glucose will be measured from finger blood (~0.1 ml samples) at 0, 15, 30, 45, 60, 75, 90, 120, 180, and 240 minutes after the meal. Gastrointestinal symptoms will be recorded over 24h after test meals are ingested. Physiological responses to bean cultivars will be compared by ANOVA.

These studies are likely to help guide agronomists and farmers in choosing bean cultivars that will be most marketable, in terms of consumer acceptability.

Strategic Aim 3: *To increase marketing of beans, we will:*

- Conduct participatory appraisals regarding awareness of market and trade information
- Analyze value chain components and linkages to identify strengths and weaknesses
- Identify ways to improve packaging methods, packaging materials and storage conditions
- Train farmers and farm groups in successfully connecting to emerging markets
- Initiate and facilitate interaction with small, medium and large scale wholesale and retail enterprises to promote distribution and purchase of beans and value-added bean products

In order to contribute to overall improved livelihoods, the recommended agronomic practices and value addition processed have to be economically viable (Barkema 1993). Therefore, we will conduct an economic analysis on the outcomes of Aim 1 and Aim 2.

Baseline surveys of producers and consumers of beans will be used to generate information on production and marketing constraints, terms of trade between farm and non-farm sectors, access to profitable and reliable markets, and institutional constraints such as low public sector investment or poor horizontal/vertical coordination within agro-processing industries (Al-Hassan & Jatoe 2002). In addition, the surveys will generate data on consumption habits, preferences and consumption levels of beans to identify and understand issues related to marketability of novel processed bean products (ties to Aim 2). The surveys will be developed jointly by MAK, ISU, and KIST, designed to assess both rural and urban preferences. Both qualitative and quantitative (econometric) methods will be employed.

Prototype marketing plans and market feasibility studies will be developed using results from the baseline surveys and products and processing outcomes identified under Aim 2. This will include, for example, plans for introduction of new processed products for home and commercial use by small and medium scale processors.

Collaboration with Host Country Institutions

Iowa State University faculty in Food Science & Human Nutrition, Agronomy, Economics and Sociology/Sustainable Rural Livelihoods will work closely with all partner institutions in training, research, farmer-based learning activities, and engaging value chain stakeholders.

Makerere University's Faculty of Agriculture plays a vital role in training and research in Uganda, and has strong linkages with rural development organizations, such as VEDCO, and with policy makers. Key participating departments are Food Science & Technology and Agricultural Economics & Agribusiness. The institution's expertise will contribute to research on agronomic (on-farm), nutrition and processing of beans in addition to supplementing the outreach and dissemination efforts. The Department of Food Science & Technology's Food

Industry Business Incubator will be used to develop and showcase protocols for commercial processing by small and medium enterprises; the Faculty also formally promotes linkages with industry. Faculty members have participated in research and development activities in the proposed study sites, using on-farm experimentation and a range of participatory techniques. This CRSP will contribute to development of new capacities through training of young professionals at the University and developing new outreach initiatives.

The *National Crops Resources Research Institute (NaCRRI)* is part of the National Agricultural Research System of Uganda. It has a strong bean research program which has released 16 new bean varieties (2 in 1994, 3 in 1995, 7 in 1999, 2 in 2003 and 2 in 2006) with stress resistance and suited to different agro-ecological zones of the country. The expertise at NaCCRI will immensely contribute to mainstreaming state-of-the-art innovations in bean management in the CRSP. They will participate in training of farmers together with VEDCO in crop production and management. They also work closely with the Food Science & Technology Department to evaluate bean-based recipes for their nutritional value.

Volunteer Efforts for Development Concerns (VEDCO), a Ugandan non-government organization, has worked since 1986 with smallholder farmers in eight districts in three regions (south-central, eastern and northern) to improve their livelihoods through agriculture for food security, nutrition and marketing. VEDCO's farmer-to-farmer extension for training and agricultural technology provides support to farmers to improve the quality, scope and impact of extension services. Through the Rural Development Extensionist (RDE) approach, VEDCO increased its outreach from 6,425 farmers in 2003 to 15,700 farmers in 2006 by developing 491 RDEs. RDEs are especially useful in continuing extension services when VEDCO halts activities to the area. Currently, VEDCO works with 428 groups (10,700 farmers). Groups establish demonstration and multiplication gardens of improved crops as learning sites and sources of improved planting materials for members. RDEs use these sites, in addition to farm visits and other approved training methods, to improve the knowledge and skills of members. Their teaching methods are flexible and provide for experimentation and sharing of promising practices with VEDCO staff and other groups. The marketing system promoted by VEDCO involves identification and promotion of enterprises in which the groups have an advantage, in addition to directly connecting farmers' groups to buyers who guide them on quality requirements. VEDCO facilitates groups to form higher-level associations through which farmers negotiate for better market prices and bulk sales. VEDCO has its own affiliated microfinance corporation (Rural Credit Finance) with a record of success in facilitating smallholder success in increasing production and marketing of crops.

The *Department of Food Science & Technology at Kigali Institute of Science and Technology (KIST),* Rwanda has strong linkages with the community through the CITTE (Centre for Innovations and Technology Transfer). The CITTE also has TBIF (Technology and Business Incubator Facility). The Department has trained several associations in the country on food processing skills – fruits, vegetables, cereals, etc. The Department has signed MoU with ISAR (Institute Des Sciences Agronomiques du Rwanda) at Rubona, leading to collaborative research projects. The Department will contribute to reduced post-harvest losses, develop nutritious, value-added bean products, and analysis of developed products.

Benefits for the institutions involved include improved inter-institutional, regional and international collaboration, co-supervision of graduate student, co-publication of papers and cross-learning for students and faculty.

Benchmarks

For the objectives relating to high yields of quality beans:

1a. Improve yields of four priority beans varieties
- Established availability of superior red and mottled bean varieties and 18 participatory demonstration sites in two districts
- Quantified yield advantage of priority varieties under standard production practices for two crops seasons each year
- Defined recommended irrigation and fertigation practices for profitable yields.

1b. Improve quality of beans through better production practices
- Established field sampling and laboratory procedures to quantify bean quality
- Quantified harvested bean quality for each crop cycle, demonstration site, and experimental treatment
- Documented benefits for bean quality resulting from improved harvest and storage techniques

1c. Strengthen farmers' collective capabilities to learn and share innovative practices
- Trained farmers and implemented strategic adjustments to participatory research plan based on rural appraisals on knowledge, attitudes and production practices for common beans
- Conducted farmer evaluations of research outcomes for bean yield and quality
- Incorporated participatory research results into RDE training programs

For the *objectives of the proposed project relating to nutrition and appeal*:

2a. Reduce post-harvest losses through improved practices (timely harvesting, improved threshing methods, appropriate drying methods and conditions, packaging and storage)
- Dominant causes of post harvest losses established by mid-term of the project
- At least 50% of participating farmers adopt recommended practices
- Pre- and post-harvest losses reduced by 50% for participating farmers

2b. Enhance nutritional value through appropriate processing (malting, pre-soaking, roasting)
- Processing techniques to remove anti nutritional factors adopted by bean processors
- Determine best processing techniques to protect protein quality, facilitate carbohydrate digestibility, and protect bioavailability of iron
- Developed and promoted at least one processing protocol and one in-home recipe for nutritionally enhanced bean products

2c. Introduce innovative food combinations and agro-processed products
- Incorporated bean flour in developing baked products and assessed acceptability based on consumer studies
- Substitution bean flour for meat/fish for locally-developed home "potage"
- Use of bean flour as a partial substitute in extrusion of food products

For the *objectives of the proposed project relating to marketing and consumption*:

3a. Identified solutions to production and marketing constraints faced by producers of beans
- Identified local stakeholders and partners to address adoption constraints
- Developed priorities for education and training activities

3b. Characterize consumer demand for beans and establish preferences for beans and agro-processed products
- Identified source of top bean products consumed in target communities by consumer groups (age, gender) and market availability

3c. Determine effective and efficient ways to increase consumer awareness of benefits of consuming beans and value-added products and their access to new products
- Strategies and practices identified to promote awareness and purchase

Host Country Institutional Capacity Building

Building and Promoting Partnerships with Relevant Research Scientists (CRSPs, IARCs, etc.)

- The multidisciplinary team of scientists involved in the Iowa State project is committed to an active collaboration to the extent possible with scientists involved in previous Bean/Cowpea CRSP and new Pulse CRSP projects to utilize their expertise, experience and technologies as appropriate. The knowledge generated on integrated crop management of pulse-based cropping systems and CRSP technologies for eastern and southern Africa will be particularly valuable.

- Our approach to *strengthening key value chain components* for marketing will take advantage of economics and marketing expertise on the part of the Michigan State-Bernsten CRSP through their value chain analyses to increase smallholder incomes and expand availability of marketed beans and other pulses. Our approach to *enhancing nutritional value and marketability of beans* will be especially responsive to opportunities to test improved varieties released by CRSP supported germplasm development programs in the U.S.

- We will utilize the outcomes of our CRSP project to inform ongoing CRSP variety development programs in the U.S. about specific improvements in seed composition needed to realize enhanced nutritional value and marketability of dry beans and other pulses. We anticipate such interaction would expand the impact of these CRSP-funded variety development programs, which are currently focused primarily on resistance to biotic and abiotic stresses (e.g., Michigan State-Kelly, Puerto Rico, UC-Riverside).

- Dr. Michael Ugen and colleagues at NaCRRI in Uganda have been having close collaboration with CIAT and ECABREN (East and Central Africa Bean Research Network) under PABRA (Pan African Bean Research Alliance) in the following activities: germplasm exchange, sharing equipment and research results, trainings, support to monitoring tours, exchange of scientists, backstopping national research programs (breeding, pathology, participatory monitoring and evaluation and seed system), supervision of students, co-designing 5-year collaborative research programs

- There has been great collaboration between Uganda and Rwanda (Institut des Sciences Agronomiques du Rwanda/ISAR) through PABRA (CIAT and ECABREN) in the area of exchange of germplasm, esp. snap beans, climbing beans and root rot resistant bean lines.

- As we develop our workplans during the 2008 Global PI meeting, we will take into account opportunities for collaboration discussed with other CRSP scientists in Barcelona.

- We see many areas where our project can collaborate with Prof. Kelly's project in Rwanda; collaborators are already there in the project whom researchers in NaCRRI have worked together for a long time, develop mutual trust in exchange of ideas and knowledge.

Building and Promoting Partnerships with Key Stakeholders

To realize project objectives and actively promote institutionalization of positive impacts of research project finds and impacts, we will effectively engage diverse key stakeholders throughout all project stages and in annual workshops.

- Work with farmers, groups and associations using participatory methods to understand local livelihoods, agronomic practices, their previous and current linkages with various types of institutions and service providers (governmental and non-governmental), private sector traders, transporters, their livelihood aspirations, assets, capabilities, and strategies [Involvement of local leadership very important for mobilization]

- Interact regularly with various types of institutions and service providers (governmental and non-governmental), private sector traders, transporters, small, medium and large scale processors and distributors etc., to gain and maintain appropriately broad perspectives on key issues in the value chain, benefit from their special expertise, and build consensus and collaborative relationships for high levels of continued success

- Institute periodic planning and review meetings to involve all partners so that challenges and constraints are discussed and strategies to deal with them developed together

- Facilitate broad involvement in research design, data collection instruments and processes, and data analysis

- Share results from various stages of the project to encourage constructive criticism and strengthen usefulness, impact and sustainability of intervention results

- Involve other developmental partners with similar interests for complementarily and dissemination of results to other areas and countries

- Develop new partnerships and linkages and strengthen already existing ones

- Strengthen partnerships among academic and research institutions in human capacity building

- Strengthen partnerships of academic and research institutions, development organizations, small-medium-large scale private sector businesses, and government agencies

Training Young Scientists in the Use of Modern Tools for Research, Management, Outreach

- Two PhD students from Uganda or Rwanda will be trained at Iowa State University – one in the Department of Agronomy and one in the Department of Food Science & Human Nutrition.

  [CRSP funds cover two ¼-time research assistantship stipends, tuition, and international travel for the period of the project. While it is Iowa State University's policy not to show matching funding in excess of the required cost share amounts in proposal budgets, the College of Agriculture and Life Sciences will ensure that there will be adequate funding to support these Ph.D. level student assistantships at Iowa State University.]

- Two MS students will be trained at Makerere University – one in the Department of Food Science & Technology, and one in Agricultural Economics & Agribusiness.

  [CRSP funds cover two ½-time research assistantship stipends, tuition, and travel for the period of the project.]

- Ph.D. student at Iowa State U. and M.Sc. student at Makerere U. in Agronomy will help:
  - Determine primary limitations on productivity
  - Quantify yield from replicated trials
  - Quantify seed composition (protein, oil, carbohydrate, selected minerals)
  - Identify genotypes and management having greatest economic/nutritional value for local growing conditions
  - Establish environmental stability of yield and value-added composition
  - Assess the effects of fertigation system for a subset of most promising varieties

- Ph.D. student at Iowa State U. and M.Sc. student at Makerere U. in Food Science will help:
  - Design basic food products for quality testing, design drying/packaging/storage experiment, perform testing on first harvest
  - Develop nutritional quality evaluation methods (iron bioavailability, protein and carbohydrate quality) and design basic processing experimental protocol, perform processing protocol with first harvest beans
  - Refine processing protocols and repeat nutritional quality evaluation, design and implement human study for carbohydrate quality evaluation
  - Begin design of new food products through consumer panels
  - Design 1-2 new products each year, and perform consumer acceptance testing on products

- Innovative approaches to Ph.D. training
  - The Ph.D. students' respective Program of Study advisory committees at ISU will work with them to plan appropriate coursework. For the Food Science student, additional courses in nutrition, agronomy and/or economics may be appropriate, depending on the student's background.

- ISU now has an interdisciplinary nutrition Ph.D. degree; thus, an interdisciplinary approach to training and research will be supported and encouraged.
- The Ph.D. students will have the opportunity to enroll in the ISU Sustainable Agriculture Program as a double-major with Agronomy or as a minor. This interdepartmental major is for students interested in understanding relationships between food security, environmental quality, rural development, and farming practice. Students in this program develop take a series of team-taught core courses that integrate perspectives from agricultural production disciplines, ecology, environmental science, and social sciences.
- Ph.D. students will have the opportunity to apply for the Agronomy Research Training Fellowship Program. This unique graduate training program is designed for superior students to foster their development into new world-class leaders in agronomic research. The program provides financial support and exceptional academic support through a mentored team training program coupled with specific guidance from a primary research advisor. The Training Program Components include: research mentoring, mentoring in teaching and/or extension, peer mentoring and interaction through work groups, external experience, and ethics and Professionalism training.
- Students will participate in Annual World Food Prize activities held in Des Moines, Iowa, and at ISU. These activities include attending the Norman E. Borlaug International Symposium, interaction with World Food Prize winners including Founder Dr. Norman Borlaug, and participation in research symposia on campus.

- Undergraduate research experiences for students at Kigali Institute of Science and Technology are integral to the research plan.

- International educational opportunities associated with annual site visits to Rwanda and Uganda are planned for undergraduate students in Agronomy at Iowa State University.

- Graduate and undergraduate student will be involved in all phases of research design, data collection and data analysis to develop relevant research skills.

- Graduate students will participate in development of outreach methods best suited for dissemination of production and value added technologies.

- Direct student contact with the farming community to provide a practical basis for application of research, production, and outreach activities.

- Research/Demonstration/Training Program designed to attract highly qualified students into top-flight Research Institutions in Rwanda or Uganda.

- Purchase of a laboratory-scale mill directly contributes to research capacity building within the Department of Food Science & Technology at Makerere University.

- Inter-Institution collaborative linkages strengthen local, regionally, and international capacities and broaden student opportunities for career development.

Contribution to USAID Objectives and Initiatives

USAID agricultural initiatives in Africa seek to build economies, establish and enhance partnerships, and harness science and technology to meet the needs of the vulnerable and impoverished. This project has the ability to help USAID meet its goals for the well-being of Uganda and Rwanda through agricultural activities designed to promote best practices, develop and market nutritious bean-based value-added products, and successfully link farmers and producers to markets. This project contributes specifically to the objectives of the *USAID Agricultural Strategy* and the *Initiative to End Hunger in Africa.*

The conceptual framework of *USAID Agricultural Strategy: Linking Producers to Markets* includes building research institutions that ensure a flow of new and adapted technologies to producers and post-harvest enterprises. This project will train students at three levels (B.S.,M.S., and Ph.D.) who will enhance research capacities in their respective institutions and countries.

IEHA works to break the cycle of famine by supporting sustainable agricultural programs will be supported by this project's efforts which will collaborate with international donors and organizations to improve rural livelihoods, food security, income and nutrition.

UGANDA SO 617-007 Economic Growth, Agriculture and Trade

USAID assistance seeks *to increase and diversify commercial agricultural production* and increase Uganda's *competitiveness in local and international markets*. This will be accomplished by *improving agricultural productivity and strengthening producer organizations, increasing access to credit and savings services for rural people,* and *ensuring greater food security*. By increasing the production and marketing of food and cash crops, such as coffee, vanilla, and dairy products, rural incomes will rise (Regional Programs - USAID's Strategy in Uganda).

This project will contribute to USAID's mission of strengthening producer organizations by working with farmers groups in a participatory manner, providing appropriate training to trainers, and building capacity of groups and associations. They will be trained in improved sustainable agricultural practices including: recommended practices for increased yields of quality bean varieties, pre- and post-harvest handling, development of nutrient enhancing bean-based products use, and successful strategies to connect to emerging markets.

Promoting recommended practices for cultivation to increase yield of quality beans through training and facilitating access to beans and priority inputs

This project's work to improve bean yields and quality builds on many USAID goals and initiatives that seek to increase and diversify agricultural production, improve productivity, and strengthen producer organizations. This project will give Ugandan communities the capacity to learn, share and implement innovative agricultural strategies that will increase the vitality of the farmers and their communities.

Developing and introducing nutrient enhanced bean-based products recipes suitable for home use through appropriate processing

This project will develop innovative food products that are processed using existing or easily accessible technologies allowing Ugandans to increase their incomes through the production of value added products. These products would be suitable for home use and provide nutritional content that is currently lacking or declining. Through these activities, the project will directly contribute to USAID goals of improving food security and nutrition. By having greater accessibility to products that can be easily incorporated into existing dietary patterns, Ugandans will improve their health and in turn be better able to improve their livelihoods.

Increasing consumer awareness of the benefits of consuming beans and train farmers and farmer groups to successfully connect with emerging markets

USAID seeks to increase and diversify commercial agricultural production in Uganda and this project will be able to contribute to this goal by training farmers to use improved agricultural practices, resulting in increased yields and better quality beans; through development of nutrient enhanced bean-based products; and through improvement of connections to emerging markets. This project will help educate consumers about the benefits of bean-based products and train farmers and producers to connect with markets. These new value-added products will allow Uganda to be more competitive in local and international markets and increase rural incomes. Work in this project is closely aligned with USAID's goals: improving agricultural productivity, increasing and diversifying commercial agricultural production, increasing competitiveness in local and internationals markets, and ensuring greater food security through increased incomes.

RWANDA SO 696-007 Economic Growth, Agriculture and Trade

USAID's economic growth program *expands opportunities in rural areas and increases the diversity of off-farm productive enterprises, agricultural productivity, house-hold level incomes, employment, and corresponding rural financial services* for targeted communities. Food assistance activities contribute to employment, introduction of improved agricultural technologies, agribusiness development, incomes and food security (Regional Programs - USAID's Strategy in Rwanda).

Promoting recommended practices for cultivation to increase yield of quality beans through training and facilitating access to beans and priority inputs

Food scientists from Rwanda and Uganda will directly contribute to core project activities. USAID's goals in Rwanda include increasing agricultural productivity. Knowledge and experiences gained through the value chain activities in Uganda will enable the food scientist in Rwanda to disseminate information and best practices to communities in Rwanda.

Development and introduction of nutrient enhanced bean-based products recipes suitable for home use through appropriate processing

Not only will these activities improve nutrition of Rwandan communities but they will also expand opportunities in rural areas by diversifying off-farm productive enterprises. Through the development and or reassignment of suitable technologies, Rwandan farmers and rural entrepreneurs are able to produce value-added bean-based products that will increase their incomes and nutrition. This new sector will provide entrepreneurial and employment opportunities for residents rural communities.

Increase consumer awareness of the benefits of consuming beans and train farmers and farmer groups to successfully connect with emerging markets

Farmers and producers will be educated and trained with strategies for successfully connecting to and entering emerging markets. This project will increase awareness among consumers about the benefits of consuming beans which will also help grow the market. Through the efforts of this project, rural farmers will be able to produce increased yields of better quality beans, allowing them to increase their incomes. These beans will then be processed and marketed, providing further economic benefits, while providing critical nutritional content. Through the implementation of this project USAID and stakeholders will not only gain research for the subject populations, but there will also be project examples in real communities that will improve the livelihoods of communities in Uganda and Rwanda. The funding of the project will enhance the initiatives and projects that USAID has and is currently involved with and move it closer to reaching the Millennium Development Goals that are set forth for both countries.

Strategy for Achieving Developmental Impacts

- Participatory approach involving all stakeholders
- Proper participatory monitoring and evaluation (PME) tools, procedures, systems
  - Participatory monitoring and evaluation is an integral feature of CSRL's work with its partner organizations and rural communities in Uganda since 2004. VEDCO has a Monitoring and Evaluation (M&E) Program Officer who oversees the work in all districts. A M&E Assistant Project Officer is directly responsible for district level activities. In addition, a Makerere University faculty member, currently working toward a Ph.D. at ISU, has been strengthening the capabilities of VEDCO staff though training and collaborative work. A comprehensive in-depth evaluation will be conducted in late 2008 to identify strengths and weaknesses with our approach and implementation, and to capture 'lessons learned,' to guide development of CSRL's second 5-year program in Uganda (2009-2014).
  - Participatory monitoring and evaluation will be an integral feature of the CSRP project. While all participating institutions will contribute to the M&E process, key responsibilities will be borne by VEDCO, Makerere University, and CSRL (ISU) in Uganda. Current plans are for research to also be conducted in two sites/districts in Rwanda, ideally in conjunction with the Rwanda-based CRSP program headed by Dr. James Kelly.
- Improved rural household incomes through crop diversification, better quality beans and value-added bean products, and establishing links to diverse types of buyers
- Increased farmer incomes from encouraging farm associations technical assistance to place their product in the market
- Conservation of natural resources (especially trees and water) as a result of using faster cooking beans and their products
- Training of Rural Development Extensionists, farmer group members
- Strengthening of farmer groups and marketing associations
- Proper understanding of the production to market/consumption value chain
- Aligning agricultural production, food processing and nutritional quality
- Assess nutritional quality of human foods will be enhanced (e.g., use of cell culture models for rapid and human-relevant iron bioavailability testing) by this institutional collaboration.
- Actively contributing to better community health through increased consumption of more nutritious bean products
- Technological capabilities for performing human nutritional studies and for assessing human bioavailability of dietary carbohydrates will be enhanced through this partnership
- Workshops and publicity for developed products

- Development of training manuals / leaflet and circulation among stakeholders
- Widespread dissemination through VEDCO's network in eight districts
- Dissemination through VEDCO's association with other development organizations
- Assessment and exploration of the potential for scaling up and/or transfer of the approach in the design, implementation and evaluation of the CRSP project
  - Developing a robust working model has been the goal of CSRL's work with its partner organizations in Uganda since 2004; our self-critical approach has enabled us to modify our strategy and implementation periodically, leading to enhanced program success. We are very interested in identifying both the potential and pathways for transfer and scaling up of the approach.
  - The potential and pathways for transfer and scaling up of the approach will feature as integral considerations in all aspects of our project.

Annex - Logical Framework

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

	Intervention Logic	*Objectively Verifiable Indicators*	*Sources of Verification*	*Risks and Assumptions*
Principal Objective	Improve the quality of life for small and medium holder farmers through development of dry grain pulse value-chains	70% of the farmers involved in the project benefit from the project.	• Baseline reports • Research reports • Project reports	
Specific Objective1	Improve the quantity and quality of products for four bean varieties through better production practices and farmer training programs.	An increase of 70% in the quantity and quality of beans and their processed products.	• Baseline reports • Monitoring and Evaluation (M&E) reports • Farmers' records	• Farmers accept to grow the new bean varieties • Links between farmers, researchers and marketing institutions are well developed and maintained through the project period
Results	• Farmers organized to participate in research and development on the four bean varieties. • A farmer-to-farmer extension system developed. • Farmers supported to produce, process, utilize and market more beans.	• 60% of participating farmers adopt new technologies and improved practices • 18 RDEs trained to provide extension services to other farmers. • Farmers involved in the project increase production by 70%.	• Project reports. • Field surveys • M&E system reports • Project evaluation report • Training attendance lists	• Major droughts, diseases or pest(s) infestations may overwhelm intervention strategies for the selected bean varieties. • Farmers have access to agro inputs for irrigation and fertigation • Sufficient seed of selected bean varieties are available for distribution.

Activities	**A. Farmers organized to participate in research on the four bean varieties** • Mobilize and sensitize stakeholders at sub-county and group level to participate in the project. • Select farmers groups and conduct a situation analysis (using PRA methodologies) to establish current bean quality, quantities produced and constraints. • Train selected farmers on the research design (s) and their roles at different stages. **B. A farmer-to-farmer extension system developed.** • Select 18 lead farmers (Rural Development Extensionists, RDEs) from 18 groups. • Train the RDEs in bean production practices • Set up 18 demonstration sites for irrigation and fertigation practices	• Methods used to mobilize and sensitize stakeholders • Methods used for analysis (PRA, discussions) • Delivery of training modules (lectures, demonstrations, tours).	• Project reports • RDE Training and assessment materials • Irrigation systems incorporated into demonstration sites	• Research resources are released in a timely manner • Stakeholders and farmers actively participate in the appraisals and demonstration projects.

Specific Objective 2	Enhance the nutritional value and marketability of beans through appropriate handling and processing.	• Constraints to enhanced nutritional value of beans identified • Consumption of beans increases by 20%	• Baseline report • Research reports • Project report	• Processing and nutritional assessment methodologies are well developed
Results	• At least five post-harvest handling practices for beans identified • Six bean processing practices developed, tested and disseminated to farmers and other stakeholders • At least four new quality products from beans developed	• 70% of participating farmers adopt post-harvest handling practices • 70% of participating farmers adopt recommended bean processing practices • Acceptability of bean products is positive and increases by at least 50%.	• Research reports • Project report	• Practices for post-harvest handling and processing of beans are affordable by farmers • The development of bean-based food products with good consumer acceptability is feasible.
Activities	• Identification of existing bean processing practices • Identification of existing post-harvest handling practices for beans • Conducting research on potential practices for better bean post-harvest handling • Developing new bean products through research • Testing consumer acceptability of the post-harvest handling practices and processed products • Testing the physiological effects of the bean products • Dissemination of findings	• Number of farmers involved in the surveys • Research procedures used for identifying the post-harvest handling practices generate adequate information • Research procedures used to develop bean products are effective • Number of people targeted for the dissemination	• Research reports • Training and assessment materials • Dissemination of findings through RDE programs	• Information on existing bean post-harvest handling resources are accessible • Project participants are cooperative and knowledgeable about the project focus

Specific Objective 3	Increase marketing and consumption of beans and value-added bean products.	Over 50% of farmers involved in the project marketing their beans Bean consumption increases by 60% in project area	• Baseline reports • Research reports • Project reports	• Market opportunities are available • Consumption of beans is compatible with other foods
Results	• Farmers organized to participate in marketing of beans. • Marketing linkages established between farmers and buyers • Constraints to bean market linkages identified and addressed	• 60% of participating farmers market their beans • 10 bean marketing linkages established	• Baseline reports • Research reports • Market survey reports • Project reports	• Potential buyers accept established linkages with producers • Data on bean markets is accessible to producers • Farmers produce adequate bean quantities for market
Activities	• Analyzing bean value chain components and linkages • Conducting appraisals on bean market and trade information • Identifying ways to improve packaging methods, packaging materials and storage conditions • Training farmers and farm groups in successfully connecting to emerging markets	• Number of farmers and chains involved in the surveys and appraisals • Number of people targeted for the training in market identification	• Research reports • Training and assessment materials • Dissemination of findings through RDE programs	• Selected farmers are able to produce sufficient quantities for market • Effective packaging and storage methods are available • Training methods and experiences exist to enable farmers to connect successfully with emerging markets

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