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

Title of Proposal

Enhancing biological nitrogen fixation of leguminous crops grown on degraded soils in Uganda, Rwanda, and Tanzania

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

Mark E. Westgate
Director, Center for Sustainable Rural Livelihoods
Iowa State University
110 Curtiss Hall
Ames, IA 50011
515-294-9106 westgate@iastate.edu

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

Mateete Bekunda: Makerere University Department of Soil Science, Kampala, Uganda. ph: +256-414-542-277, Fax: +256-414-531-641, mateete@agric.mak.au.ug

Lynne Carpenter-Boggs: Washington State University, Director Center for Sustaining Agriculture and Natural Resources, Dept. Crop and Soil Sciences, (509) 335-1553. lcboggs@wsu.edu

Karen Cichy: USDA-ARS, Sugarbeet and Bean Research Unit, East Lansing, MI, 48824-1325 ph: 517- 353-9262 ext. 4, Fax: 517- 337-6782, karen.cichy@ars.usda.gov

James D. Kelly: Michigan State University, Department of Crop & Soil Sciences, East Lansing, MI 48824-13254. Ph: 517-355-0271 x 1181, Fax: 517-353-5174. kellyj@msu.edu.

Phillip Miklas: USDA-ARS, Vegetable and Forage Crop Research, Prosser, WA 99350 ph: 509-786-9258; cell: 509-786-8492; fax: 509-786-9277; phil.miklas@ars.usda.gov

Henry Kizito Musoke: Volunteer Efforts for Developmental Concerns, Kampala, Uganda. ph: +256-414-270-598, henrykizito@vedco.or.ug

Susan Mchimbi-Msolla: Crop Science and Production, Sokoine University of Agriculture, Morogoro, Tanzania, nchimbi@giant.suanet.ac.tz

Augustine Musoni: Institit des Sciences Agronomiques du Rwanda (ISAR), Nygatare Research Station, fmusoni@yahoo.com

Eda Reinot: Becker Underwood, Inc. P.O. Box 667, Ames, IA, 50010, USA ph: 800-232-5907, Fax: 515-232-5961, eda.reinot@BeckerUnderwood.com

Hamisi Tindwa: Department of Soil Science, Sokoine University of Agriculture, P. O. Box 3008, Morogoro, Tanzania, tindwa@yahoo.com.

Michael Ugen: National Crops Research Institute, Namulonge, Uganda ph: +256-414-573-016, Fax: +256-752-726-554, michaelugen@yahoo.com

Peg Armstrong-Gustafson: (collaborator) amson technology l.c., 4010 University Avenue, Des Moines, IA 50311. Ph: 515-279-7767, Fax: 515-255-6101, peg@tmgmanagement.com

Proposed Project Period: (3 years maximum, between October 1, 2009 – September 29, 2012)	**Total federal funds requested**	**Total non-federal cost share commitment by U.S. institution(s)**
Jan. 1, 2010 to Sept. 28, 2012	$985,471	$154,236 (25% of US costs)

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**
Uganda	VEDCO	$80,811
	Makerere University	$67,650
	NaCRRI	$78,030
Rwanda	ISAR	$54,945
Tanzania	Sokoine University	$87,220

Authorized lead U.S. institutional representative (type name, phone number and e-mail):

Suzanne Schuknecht
Ph: 515-294-5225 grants@iastate.edu

Signature: Suzanne Schuknecht **Date:** 1/29/2009

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

Title of Proposal: Enhancing biological nitrogen fixation of leguminous crops grown on degraded soils in Uganda, Rwanda, and Tanzania

Name and Institutional Affiliation of the U.S. Principal Investigator:

Mark E. Westgate
Director, Center for Sustainable Rural Livelihoods
Iowa State University
110 Curtiss Hall
Ames, IA 50011
515-294-9106, westgate@iastate.edu

Abstract **(Limit: 1800 characters including spaces—about 200-250 words):**

Low soil fertility of degraded soils and lack of access to inorganic fertilizer are major constraints for overcoming poverty and mal-nutrition of small landholder farm families in Sub-Saharan Africa. The *first strategic aim* is to improve biological nitrogen fixation and grain yields of common beans significantly using novel biological inoculants through farmer-based experimentation and adoption of innovative production techniques. The *second strategic aim* is to examine the inheritance of genetic and environmental variation in BNF in common bean, and to identify molecular markers associated with QTL conditioning for enhanced BNF. The *third strategic aim* is to improve the productivity, profitability, and sustainability of agricultural systems on degraded soils through effective dissemination of new information and technologies to small-landholder farmers through on-farm demonstrations, mass media, field schools, and local forums.

Ongoing collaboration since 2004 between the Center for Sustainable Rural Livelihoods at Iowa State University (ISU), Makerere University (MAK), Volunteer Efforts for Developmental Concerns (VEDCO), and the National Crop Resources Research Institute (NaCRRI) in Uganda have increased food security and market readiness from 9% to 77% among 800+ farm households. The proposed project builds on this success by collaborating with legume geneticists/physiologists in the USDA-Agricultural Research Service at Michigan State University (MSU) and Washington State University (WSU) and their research/development partners at the Institit des Sciences Agronomiques du Rwanda (ISAR) in Rwanda and Sokoine University of Agriculture (SUA) in Tanzania. Training and research of numerous host-country graduate students and undergraduate interns 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 from Topical Areas 1-3:

☒ 1. Enhancing Biological Nitrogen Fixation (BNF) in common bean and cowpea production systems

☐ 2. Achieving nutritional security for improved health of target populations

☐ 3. Improving the performance and sustainability of pulse value-chains

Select at least one from Global Theme 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 devotes at least 30% of project funds on HC capacity building activities (Global Theme D) (give total %) 45.3%

☐ 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?) 7 M.S.

Title: Enhancing biological nitrogen fixation (BNF) of leguminous crops grown on degraded soils in Uganda, Rwanda, and Tanzania

Abstract
Low soil fertility of degraded soils and lack of access to inorganic fertilizer are major constraints for overcoming poverty and mal-nutrition of small landholder farm families in Sub-Saharan Africa. The *first strategic aim* is to improve biological nitrogen fixation and grain yields of common beans significantly using novel biological inoculants through farmer-based experimentation and adoption of innovative production techniques. The *second strategic aim* is to examine the inheritance of genetic and environmental variation in BNF in common bean, and to identify molecular markers associated with QTL conditioning for enhanced BNF. The *third strategic aim* is to improve the productivity, profitability, and sustainability of agricultural systems on degraded soils through effective dissemination of new information and technologies to small-landholder farmers through on-farm demonstrations, mass media, field schools, and local forums.

Ongoing collaboration since 2004 between the Center for Sustainable Rural Livelihoods at Iowa State University (ISU), Makerere University (MAK), Volunteer Efforts for Developmental Concerns (VEDCO), and the National Crop Resources Research Institute (NaCRRI) in Uganda have increased food security and market readiness from 9% to 77% among 800+ farm households. The proposed project builds on this success by collaborating with legume geneticists/physiologists in the USDA-Agricultural Research Service at Michigan State University (MSU) and Washington State University (WSU) and their research/development partners at the Institit des Sciences Agronomiques du Rwanda (ISAR) in Rwanda and Sokoine University of Agriculture (SUA) in Tanzania. Training and research of numerous host-country graduate students and undergraduate interns along with enhanced farmer group training and dissemination, ensures significant long-term impacts from this project.

3. Table of Contents

3. Technical Approach

Problem Statement and Justification

Agriculture in East Africa is characterized by male and female farmers working in small scale, rain-fed production, averaging two hectares per household (FAO 2006). Erratic bimodal patterns of rainfall in recent years have limited crop production, further challenging food security (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 are not well linked to profitable markets, especially the 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). Recent efforts by the ISU Center for Sustainable Rural Livelihoods to introduce new agronomic practices and technologies demonstrate encouraging progress (Butler & Mazur 2007). Ongoing collaboration with 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 (Sseguya 2007). The Sustainable Livelihoods (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 (Ellis 2000, Ellis and Bahiigwa 2003). 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 wellbeing (Selener 1997). This cooperative interaction US and HC researcher, HC development workers, and local farmer groups is an integral aspect of our CRSP program.

Increasing legume production provides a strategic opportunity to help meet the Millennium Development Goal targets of reducing hunger and poverty. Common beans are the most important legume crop in Uganda, Rwanda and Tanzania occupying a very large proportion of land devoted to legumes – FAO Website. For example, over 45% of the protein intake by Ugandans comes from beans providing 25% of dietary calories. Likewise, over 75% of rural households in Tanzania depend on beans for daily subsistence. The common bean is an important source of protein for low-income families in rural and urban areas providing about 38% of utilizable protein and 12-16% of daily caloric requirements (Xavery et al 2006). Improved bean production in Uganda, Rwanda, and Tanzania offers unique opportunities to address the deteriorating food security situation there and elsewhere in sub-Saharan Africa. It is particularly noteworthy that the demand for these seed has skyrocketed due to the poor harvest and the need to change the feeding habits from animal protein to more of plant source.

Loss of soil fertility is recognized as the most important constraint to food security in sub-Saharan Africa (CIAT 2002, Bationo 2004). Low levels of nitrogen and phosphorous are the primary fertility constraints (Ndakidemi et al 2006). Because soils are increasingly becoming degraded, a n affordable means of improving soil fertility and productivity of nitrogen-accumulating crops is critical.

Critical problems limiting legume yields in Sub-Saharan Africa (NAP 2008)

- **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)

Use of inorganic fertilizers can improve yield, but their use is very limited due to poor availability and expense. Use of organic fertilizers also is limited to a few home garden crops such as banana, which are mostly grown near homesteads. Often ‘organic fertilizer’ comes in the form of disposed kitchen waste and refuge (Ugen, personal communication). Enhancing biological nitrogen fixation (BNF) by stable legumes such as beans would replace the need for (in)organic fertilizer application to a large extent. Rhizobial inoculants selectively provide an economic and sustainable source of nitrogen to their legume host. Due to the nitrogen-fixing ability of legumes inoculated with rhizobia, the need for commercial nitrogen fertilizer can be reduced or eliminated. Properly nodulated legumes can leave up to 350 kg nitrogen per hectare in the soil. The exact amount depends on effectiveness of the nitrogen fixation process, type of legume, length of time the legume is grown, soil nutrient levels and nitrogen already available. Continuous use of fresh rhizobia inoculants will maximize yield benefits, as these rhizobia will out-compete the indigenous rhizobia for root nodulation (Becker Underwood, Inc). Inoculum is much cheaper than the inorganic fertilizers and simpler for farmers to apply. Both factors support the use of inoculants as an affordable and sustainable way to improve production and nutritional quality of nitrogen fixing legumes.

Numerous studies have shown the potential of improving legume productivity by enhancing nodulation through proper use of a biological inoculant (e.g. Ndakidemi et al 2006, Silver and Nkwiine 2007). Yet field trials in sub-Saharan Africa have provided mixed results (Nkwiine 1999, Musdandu and Joshua 2001). There are a number of likely causes for variable response including poor quality control of inoculant formulation, failure to compete with local rhizobia, inhibition by indigenous microbial flora, or failure of the inoculant species to survive in low pH and/or droughty soils (Graham, 1981). Modern inoculant formulations designed to deliver a synergistic suite of biological and chemical enhancements for biological nitrogen fixation under stressful soil conditions have been made available to our collaborative research project by Becker Underwood, Inc. (see letter of collaboration). Becker Underwood’s **BioStacked®** inoculant technologies for legume crops consist of well stabilized *Rhizobium* bacteria, a biological fungicide, plant growth promoting rhizobacteria, and other biologically derived proprietary biostimulant technologies which promote plant growth and overall plant health. It is particularly significant that Silver and Nkwiine (2007) in a review of rhizoshpere biota in Uganda identified production of growth promoting substances and bio-control agents as having ‘untapped potential’ for improving BNF. These stacked inoculants have been shown to decrease chemical fertilizer use in crop rotations, increase legume yields, suppress root diseases, and improve rhizosphere conditions for root growth. These inoculants are suitable for use on a variety of legume crops such as soybean, common bean, cowpea, and pigeon pea. We anticipate they will be particularly effective under degraded soil conditions encountered on small-landholder farms in Uganda, Rwanda, and Tanzania.

To optimize BNF, it also is essential to identify germplasm with greatest capacity for this trait (Bliss et al 1989, Diouf et al 2008). Although common bean has the potential for BNF, it is reported to have the lowest percent N_2 derived from N fixation among legumes (Martinez-Romero 2003). The relatively poor N fixing capacity may be due in part to lack of selection for this trait. Genetic variation for BNF has been reported within the primary gene pool, and lines with superior BNF have been identified (Bliss, 1993; Graham et al., 2003). Superior BNF lines such as Puebla 152 and BAT 477 (Vadez et al., 1999; Miklas et al., 2006) have been used as parents in crosses to generate populations for genetic studies and to examine selection and breeding for improved BNF. Few breeding lines with improved BNF, however, have been developed. Heritability estimates for BNF and related traits are low to moderate signifying that BNF traits are quantitatively inherited and influenced by environment, thus difficult to breed for. The optimal selection environment for BNF is under low soil N since application of nitrogen fertilizer reduces N fixation capacity (Schulze 2004). Thus, marker-assisted selection under such conditions is highly sought after as a means to facilitate breeding for traits like BNF with low to moderate heritability.

There have been few molecular mapping studies conducted for BNF in legumes. But there are many available recombinant inbred mapping populations within the bean breeding community that are ideal for a BNF-QTL study. Molecular mapping in combination with germplasm screening and marker assisted selection (MAS) would be a powerful way to improve locally adapted germplasm for BNF in a host country.

Recombinant inbred populations are ideal for tagging and mapping genes that influence quantitative traits (QTLs). These populations provide segregating inbred lines that can be replicated over space and time and maintained for many years, which is ideal for characterizing traits conditioned by many genes and influenced by environment. Few QTLs associated with BNF have been identified to date, and those identified have not been validated. Therefore, identification and subsequent validation of QTL conditioning enhanced BNF would represent a major contribution to the scientific community, and represent a major step toward generating capacity for marker-assisted selection for BNF. Flavonoid compounds from seed exudates also act as signals for the development of legume-rhizobium symbiosis (Ndakidemi and Dakora 2003; Melnikova and Omelchuk 2009). Therefore, measuring seed flavonoids and BNF related traits simultaneously might provide information on how to best to develop improved germplasm for both traits.

Our CRSP program objectives address the need to identify production systems that enhance BNF, develop germplasm that benefits most from symbiotic inoculation, and aggressively share this new information with small landholder farmers in sub-Saharan Africa whose health and well being depend heavily on legume production.

- **Objectives**

The ***first strategic aim*** is to improve BNF and seed yields of common beans significantly using superior seed inoculants such as Becker Underwood's BioStacked® inoculant through farmer-based experimentation and adoption of innovative production techniques.

The objectives relating to improving BNF and grain yield of common beans are to:

1a. Evaluate effectiveness of biologically stacked inoculants on local and improved germplasm

1b. Quantify genotype by environment interactions and constraints to enhancing BNF of inoculated plants

The ***second strategic aim*** is to examine the inheritance of genetic and environmental variation in BNF in common bean, and to identify molecular markers associated with QTL conditioning for enhanced BNF.

The objectives relating identifying molecular markers to enhance legume BNF are:

2a. Identify parental materials for inheritance studies of BNF.

2b. Phenotype existing mapping populations for BNF response, populate with molecular markers, and conduct QTL analysis.

The ***third strategic aim*** is to improve the productivity, profitability, and sustainability of agricultural systems on degraded soils through effective dissemination of new information and technologies to small-landholder farmers through on-farm demonstrations, mass media, field schools, and local forums.

The objectives relating to dissemination of new knowledge and technologies are:

3a. Improve farmer awareness of inoculation technologies

3b. Conduct on-farm demonstrations comparing inoculant strategies

3c. Strengthen farmers' collective capabilities to purchase inoculants and incorporate them into a profitable and sustainable system for small landholders.

- **Approaches and Methods**

Strategic Aim 1: *improve BNF and grain yields of common beans using superior biological inoculants*

1a. Evaluate effectiveness of biologically stacked inoculants on local and improved germplasm

In Rwanda, Tanzania, and Uganda multiple sites will be used to evaluate popular cultivars of both determinate bush and indeterminate vine growth habit types for response to different rhizobia-inoculum treatments. Site selection will be defined by where beans are already grown and consumed, and will encompass the range of soil types and weather conditions documented at each site (1c). Four cultivars will be chosen representing different market types, evolutionary origin, in addition to the different plant types. For example in Tanzania popular cultivars (genotypes) representing the major speckled purple-Kablanketi (Type III, Andean), yellow-Njano (Type I, Andean), Red Kidney (Type I, Andean), and Carioca (Type II, MA) market types would be tested. Adapted non-nodulating genotype(s) (~BAT477, DOR364 from CIAT) will be useful for this and subsequent BNF trials as checks. Rhizobia inoculum treatments will include **Bio-stacked®**, other commercially available inoculants (e.g. Bio-N-Fix), and no inoculum. The **Bio-stacked®** inoculum from Becker-Underwood, Inc. is formulated for enhanced BNF under stressful soil conditions (see product note from Becker Underwood, Inc.). A RCBD with four replications, and moderately large plot size will be used (4 to 6 rows wide by 5 to 7 m length), Established research station sites will be used initially and expanded to on farm and community co-op trials using select genotypes which exhibit greatest BNF response. It is envisioned by year 2 that HC Extension personnel, NGO, or other business partners will be identified to help develop and implement strategies for technology dissemination to numerous farmers (Strategic Aim 3). A low N treatment will be targeted the first few years and expanded to include low and high N in subsequent years as HC and US project participants gain training and experience with experimental protocols and procedures.

Standard agronomic practices will be employed in the controlled location studies (Opio et al 2001). Incidence and severity of disease and pest damage will be recorded to determine their indirect impact on N-fixation, plant performance and response to inoculant treatments. Agronomic data collected for each treatment includes: 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, and economic return on investment in the inoculant technology. The latter will be assessed by careful record keeping of agronomic input costs and grain sales. Thermometers, rain gauges, and soil moisture sensors will be positioned on site for recording local weather conditions. Plant N (multiple subsamples per plot), seed N (multiple subsamples per plot), biomass, and seed yield at harvest maturity on a plot basis will be used to measure BNF response of the different genotypes and treatments. These measurements are the most affordable in terms of cost and labor and correlate well with seasonal BNF. Select genotypes or treatments with large or interesting BNF responses, could be further characterized by evaluation of root biomass, nodulation number and mass, isotope assays, or post crop response. Data collection will be coordinated by HC scientists and students.

1b. Quantify genotype by environment interactions and constraints to enhancing BNF of inoculated plants.

The main environmental factors that constrain BNF in the tropics are physical (temperature, moisture) and chemical (acidity, aluminum, nutrient deficiencies) (Giller, 2001). But survival of rhizobia introduced into new environments can be influenced by competition (e.g. for nutrients) and antagonisms (e.g. predation, lysis and bacteriocins) from other soil organisms (Giller, 2001). These physical, chemical, and biological factors will be documented at each site, as well as seasonal weather conditions and variation in soil moisture at 15 cm. Soils for the test sites and specific treatments will be sampled before and after the experiments and tested for macronutrients (N, P), micronutrients (molybdenum, cobalt, nickel, iron, selenium and zinc) deficiencies which could restrict BNF), and other properties (pH, organic matter content, bulk density, etc.). HC scientists and students will conduct these physical and chemical analyses following standard methods in the TSBF Handbook.

Soil samples will be divided into two subsets, one for HC laboratory analyses and another for US laboratory analyses. Soil DNA extractions will be assayed with conserved rhizobia probes to obtain PCR amplification profiles for indigenous strains. DNA from applied inoculants will be similarly tested. These baseline data will be used to determine and quantify which rhizobium source(s) are colonizing nodules. It is expected that this assay will require significant development, and be limited to select experiments, and be conducted initially by US laboratories.

Current populations of rhizobia will be assessed using a most probable number assay on a trap crop, which also allows for isolation of resident strains. Locally isolated rhizobia can then be selected for successful growth in the conditions of concern, such as low pH or cobalt. An environmentally tolerant subset of rhizobia will then be used for studies of N fixation in bean hosts. These assays and selection will be performed by HC scientists and students. Additional study of the longer term effect on BNF resulting from prolonged rhizobial inoculation will be considered by monitoring repeat bean crop rotations at select test sites in anticipation of continued funding.

Strategic aim 2: *identify molecular markers associated with genetic and environmental variation in BNF in common bean .*

2a. Identify parental materials for inheritance studies of BNF

We will collect and increase seed of representative commercial market types and advanced breeding lines from host countries Rwanda, Uganda, Tanzania and the US; lines known to differ for BNF (BAT 477, Pueblo 152, CAL 143, RIZ lines, etc.); super-nodulating and non-nodulating; and select parents of existing mapping populations; in total about 50 materials. These materials will be tested for BNF response under low N conditions in the field (single locations in Rwanda, Tanzania, and Uganda) and greenhouse (US-WSU). The materials will be split into groups of 30 genotypes each. The plan is to test half the lines in Rwanda and the other half in Tanzania in Year 1, and vice versa in Year 2. The plots will be smaller (single row, 3 m length) and with fewer reps (2 to 3).

The materials will also be tested in the greenhouse in the US (WSU and ISU). Single plants will be sown in 1 liter pots containing 50% sand/potting soil mixture, N-deficient fertilizer solution, and arranged in RCBD with 5 replications, and at least two treatments – non-inoculated and inoculated (with mixture of rhizobia strains). The materials will be similarly grouped (20 to 30 materials each group) for the GH experiments conducted over a period of two years. BNF response will be measured by plant N (multiple subsamples per plot), seed N (multiple subsamples per plot), biomass, and seed yield at harvest maturity for field studies. For greenhouse studies, plant biomass on shoot/root basis, nodulation score, and plant N concentration at 12wks after planting will be used to measure BNF response. Greenhouse screening will also be used to select rhizobia strains for specific soil conditions acid-low pH, low micronutrient, etc., representative of host country bean production regions. This side study will conducted in Years 2-3 (WSU and ISU). Collection of field data will be coordinated by HC scientists and students, and greenhouse data by US scientists and students. For select materials, advanced characterization of BNF using N^{15} and other tests will be conducted in Year 3.

Crosses will be conducted between parents with contrasting BNF response (low vs. high) to initiate generation of genetic mapping populations (recombinant inbred line – RIL populations). It takes three years to obtain mapping populations and increase seed for F5 or later derived RILs for replicated multi-site testing. Four populations will be developed (two by ARS-Prosser and two by ARS-East Lansing) consisting of approximately 150 lines each. Efforts will be made to cross high X low parents that are adapted for each country (Rwanda, Tanzania, Uganda, and US). Extensive phenotyping these populations, populating with molecular markers, and QTL analysis will not be possible during this funding cycle. But basic agronomic information will be collected, e.g. biomass at flowering, biomass at harvest, shoot N at harvest, seed yield, seed N, HI and NHI. In collaboration with plant pathologist George Awabi, selected lines will be examined for root health and nodulation. From these RIL populations we expect to obtain advanced breeding lines with good BNF, good agronomic performance, and identify acceptable HC market types.

2b. Phenotype existing mapping populations for BNF response, populate with molecular markers, and conduct QTL analysis.

Given the three year time frame necessary to generate new mapping populations, existing mapping populations with promise for mapping QTL conditioning BNF response will be tested in HC and US. Two existing mapping populations will be phenotyped for BNF response (EP=Eagle/Pueblo 158, 78 F8 RILs, 357 markers; RC=Rojo/CAL 143, 147 F5 RILs, no markers). Seed of the RILs will be increased (January-May, Year 1, EP by ARS, East Lansing and RC by ARS-Prosser). The parents for EP, RC, and a few other bi-parental populations will be tested in the GH to confirm divergent phenotypic response for BNF (January – Year 1, WSU). Given divergent response for the parents the EP population will be tested at two sites (ARS-Prosser and -East Lansing) under low N, using 1-2 row plots and 3-4 reps as determined by seed availability, using a RCBD design (summer Year 1). The RC population would be similarly tested but the test sites would be located in Rwanda, Tanzania, and Uganda (spring rainy season – Year 2). Each population would be tested in two separate years.

The BNF response will be measured by plant N (multiple subsamples per plot), seed N (multiple subsamples per plot), biomass, and seed yield at harvest maturity for field studies. Divergent RILs will be investigated for BNF in GH studies to assess correlated response of QTL for both field and GH environments. The EP population will require population by SSRs (ARS-East Lansing) and ARS-Prosser will examine potential for mapping BNF candidate gene homologues in this population. The RC population will require extensive generation of markers (ARS-East Lansing and –Prosser). Identified QTL will be validated using additional populations (IBC, RI) being developed with the same donor parents (Year 3+). The field, molecular marker, and QTL analyses are ideal for HC graduate student thesis projects. We are aware that BNF QTL studies have been conducted in bean and we plan to leverage previously identified QTL locations in our mapping efforts. In addition, synteny between Phaseolus and Soybean whole genome sequence, and new genomic tools from the BeanCAP and Bean Sequencing projects, will be utilized to facilitate QTL identification in our studies. With funding beyond Year 3, CAP, SCAR, SSR, SRAP, RAPD, and TRAP markers will be used to populate newly generated maps. Mapping populations with both phenotypic (BNF response) and molecular marker data will be analyzed for QTLs using regression (SAS) and software programs (QTL cartographer). Joinmap 4.0 software will be used to construct the genetic linkage maps. Potential for Association Mapping to identify QTL using a subset of the ~100 materials tested above will be examined.

Strategic aim 3: *effective dissemination of new information and technologies to small-landholder farmers through on-farm demonstrations, mass media, field schools, and local forums.*

3a. Improve farmer awareness of inoculation technologies

Our team's experience working closely with farmers and farmer groups over 20+ years clearly indicates that field demonstrations are only part of the effort needed to convince farmers to adopt new farming practices. The outreach component of this project includes training, demonstrations, and advocacy efforts that are conducted essentially on a continual basis. We will disseminate information about the application of inoculant technologies directly to small landholder farmers through our partner connections in PELUM. PELUM is an a network of 207 civil society organizations in Eastern, Central and Southern Africa working towards poverty eradication, food security, and sustainable community development (see http://www.pelumrd.org/). PELUM's work focuses on enhancing farmers' livelihoods through sustainable agriculture, seed and food security. PELUM has active networks in 10 countries: Botswana, Kenya Lesotho, Malawi, Rwanda, South Africa, Tanzania, Uganda, Zambia and Zimbabwe. The network's mission is "to promote and nurture an environment that is responsive to the needs of small holder farmers".

As a network their strength lies in efficient and effective collaboration and communication. The bean inoculum initiative fits very well within the network's core business. **Currently VEDCO-Uganda holds the chair to the PELUM Board, and as such plays a key leadership role in promoting this and other technologies on small scale farms throughout the region**. We will begin the outreach activities by working through PELUM Kenya, PELUM Tanzania, PELUM Uganda and PELUM Rwanda. Then expand the outreach of positive research outcomes to all 10 participating countries in the PELUM association. Although results of field trials will not be available until the end of year 1, there are numerous outreach activities in year 1 that must be undertaken. For example: training VEDCO/SUA/ISAR staff on the use and potential benefits of inoculation technology, selecting farmers to participate in on-farm trials, sensitizing farmers and farmer groups about inoculant technology, training farmers on proper methods for conducting on-farm trials, data management, economic returns, and supporting data collection for site characterization.

3b. Conduct on-farm demonstrations comparing inoculant strategies

A participatory approach for testing and technology adaptation where research, extension agents/NGO-VEDCO and farmers are involved in evaluation early in its development is a better option to developing technologies that are more acceptable to farmers. It also gives farmers an early opportunity to accept a technology in a way that suits their needs. Therefore, involving farmers and other stakeholders including local government early in the development and testing of the BNF technology will be very appropriate. The approach will be to use farmer groups and identify sites, which are appropriate for the testing of the technologies (Technology Development and Testing Sites). As these will not be refined technologies, they will be research/NGO managed but with greater participation of farmers and other stakeholders in the evaluation and refinement of the technologies. As the technologies become more refined, the testing and evaluation sites will then be increased with more management responsibilities given to farmers/farmer groups (Farmer Managed trial sites). This approach will give farmers and stakeholders get more involved in technology development at an early stage with higher probability of adoption of the technologies. A host of program activities will be undertaken to increase farmer awareness. These include: developing training modules/IEC materials for their Rural Development Extensionist, including program information in farmer field days, conducting on-farm demonstrations for knowledge transfer, presenting information on radio talk shows at school club training and community drama fairs. In collaboration with HC scientists, farmer field days will be conducted at the research sites in Years 2 and 3 to demonstrate different varieties of beans respond to inoculant on fertile soils and on poor soils. To ensure relevance to small landholders, locally preferred varieties will be included along with improved varieties. The approach of side-by-side comparisons has worked exceptionally well for demonstrating the benefits of using improved bean germplasm in our current pulse CRSP project in Uganda (Robert Mazur, PI).

3c. Strengthen farmers' collective capabilities to purchase inoculants and incorporate them into a profitable and sustainable system for small landholders

Providing opportunities for small landholder farmers to participate in collective marketing has proven to be an effective strategy to increase household income. Through our HC partners in the PELUM network, we will provide training to farmers and farmer groups to incorporate effective inoculants into their production systems, provide a cost-benefit analysis of inoculant technology, and conduct value chain analyses for pulse-crop marketing opportunities. Additional activities in year 2 and 3 include: linking farmers to micro-credit providers, conducting cost/benefit analyses, developing farmer training materials for Rural Development Extensionists, and other national Extensionists, and support farmers to have dialogue with policy makers on issues associated with bean production and marketing.

There are numerous challenges associated with lack of quality seed and poor quality inoculant produced in SSA. We will seek to increase the availability of high quality inoculant in three HCs in our project and beyond through Becker Underwood's current technology transfer programs in Burkina Faso, Niger, Tanzania, and Mali funded by Lutheran World Relief. It is also anticipated that positive outcomes of our project will be transferred to seed companies and small-scale farmers in these countries as well.

- **Collaboration with Host Country Institutions**

Iowa State University Center for Sustainable Rural Livelihoods (CSRL) is the lead institution and will provide oversight for program management and execution. The program PI, Mark Westgate is a faculty member in the Department of Agronomy with expertise in legume physiology. As Director for CSRL, he has worked closely with the HC partner institutions in Uganda through CSRL programs 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. The Department of Soil Science at Makerere University provides expertise for agronomic (on-farm) research, laboratory analysis of soil-microbial-plant interactions, inoculant formulation and application, in addition to supplementing the outreach and dissemination efforts. 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. Dr. Ugen has developed an exceptionally strong bean research program, which has released numerous improved bean varieties with stress resistance and suited to different agro-ecological zones of the country. The initial analysis of harvested samples for seed yield components and seed composition will be conducted at the NaCRRI lab in Namulonge. They also work closely with VEDCO in training of farmers in crop production and management using inoculants. The scientific expertise at NaCRRI and their influence on regional legume initiatives will contribute immensely to mainstreaming state-of-the-art innovations in legume management in the CRSP.

Volunteer Efforts for Development Concerns (VEDCO), a Ugandan non-government organization, has worked since 1986 with smallholder farmers in south-central, eastern and northern Uganda 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 works with more than 10,000 farmers. Their teaching methods are flexible and provide for experimentation and sharing of promising practices with VEDCO staff and other agricultural groups. 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. VEDCO is the key partner for dissemination of CRSP project discoveries and outcomes.

Becker Underwood, Inc. (BU) is an international developer of bio-agronomic and specialty products. The company is the leading global producer of inoculants, beneficial nematodes, and a wide range of agricultural and horticultural products. BU will produce the **Bio-stacked®** legume inoculants (see http://www.beckerunderwood.com/en/newsreleases/100104) for distribution to HC and US researchers in this CRSP project. BU has worked with numerous universities around the world and has implemented quality assurance programs and technical support to ensure proper formulation and field application.

Sokoine University of Agriculture is the leading institution for training students in agricultural research in Tanzania. The Department of Crop Science and Production is the University authority for matters pertaining to field and horticultural crops. The faculty have expertise in plant breeding, molecular genetics, plant pathogen-interactions and agronomic practice. CRSP project interactions with SUA will build upon an ongoing collaboration between Dr. Phil Miklas' lab at Washington State University and Dr. Susan Mchimbi in the Department of Crop Sciences and Production. Dr. Mchimbi is associate professor of plant breeding and genetics. She is using molecular markers to enhance selection for resistance to common bean diseases and developing seed multiplication and production systems for common bean. An important component of this CRSP collaboration will be training of young HC professionals at Washington State University in molecular marker techniques.

Institit des Sciences Agronomique du Rwanda (ISAR) consists of fifteen research and demonstration stations throughout Rwanda. Research on soil microbiology in ISAR focuses on legume productivity enhancement by improvement of nitrogen fixation capacity and selection of high yielding varieties, adapted to different agro-ecological conditions. A key research goal is to develop, disseminate and utilize bio-fertilizer technologies to improve soil fertility and increase productivity for food security and income generation. CRSP project interactions with SUA will build upon an ongoing collaboration between Dr. Jim Kelley and Dr. Karen Cichy at Michigan State University and Augustine Musoni, director of the Nygatare Agriculture and Livestock Research Station in eastern Rwanda. CRSP collaboration emphasizes identifying improved BNF germplasm, and training HC professionals in molecular genetics and biochemistry.

- **Benchmarks**

For the Specific Aim to improve BNF and grain yield of common bean*:*

1a. Evaluate effectiveness of biologically stacked inoculants on local and improved germplasm

- (6 mo) Identify genotypes and research demonstration sites at HC institutions
- (12 mo) Quantified yield advantage of inoculation for two crops seasons
- (18 mo) Analysis of plant/soil/weather data completed, unique responses identified
- (24 mo) Quantified yield advantage of inoculation for two crops seasons
- (30 mo) Analysis of plant/soil/weather data completed, root/nodulation study initiated
- (33 mo) Determined economic return for inoculation treatments at all yield levels

1b. Quantify genotype by environment interactions and constraints to enhancing BNF of inoculated plants.

- (6 mo) Quantified soils physical and chemical characteristics at all test sites
- (12 mo) Established field sampling and laboratory procedures to quantify BNF
- (18 mo) Soil DNA extracted and analyzed for indigenous rhizobia strains
- (24 mo) Established indigenous rhizobia levels and environmentally tolerant strains
- (30 mo) Initial controlled studies on strain x host interactions for BNF completed
- (33 mo) Identified most effective genotype-inoculant combinations for each agro-ecological zone

For the Specific Aim to identify molecular markers to enhance legume BNF:

2a. Identify parental materials for inheritance studies of BNF.

- (6 mo) Obtained experimental and adapted common bean germplasm
- (6 mo) Crosses to generate mapping populations completed
- (12 mo) Screened germplasm for increased BNF in low soil N +/- inoculants in HC field trials.
- (18 mo) Greenhouse screening trials initiated on selected lines for BNF response.
- (24 mo) Screened germplasm for increased BNF in low soil N +/- inoculants in HC field trials
- (30 mo) RILs advanced to F3.
- (33 mo) Advanced characterization of G X E for increased/stable BNF of selected lines completed

2b. Phenotype existing mapping populations for BNF response, populate with molecular markers, and conduct QTL analysis.

- (6 mo) Increased seed of existing mapping populations for QTL analysis
- (12 mo) Initial phenotyping for divergent response of BNF in greenhouse completed
- (18 mo) Parental lines and selected populations tested for BNF in the field (US and HC sites)
- (24 mo) Correlative response of BNF in field and GH trials established
- (30 mo) Parental lines and selected populations tested for BNF in the field (US and HC sites)
- (30 mo) RIL populations phenotyped for BNF response and populated with SSR markers
- (33 mo) Initial analysis of potential new QTLs completed.
- (33 mo+) Available CAP, SCAR, SSR, SRAP, RAPD, TRAP markers used to populate newly generated genomic maps.

Fo

For the Specific Aim to dissemination new knowledge and technologies:

3a. Improve farmer awareness of inoculation technologies

- (18 mo) Conducted farmer evaluations of knowledge and benefits of inoculation and BNF
- (24 mo) Training materials created to disseminate through PELUM farmer network
- (30 mo) PELUM meetings on new technologies in Rwanda, Tanzania, Uganda, and Kenya completed.
- (33 mo) Positive program results disseminated to 200+ PELUM partners in SSA.

3b. Conduct on-farm demonstrations comparing inoculant strategies

- (12 mo) Format for field demonstrations of inoculant technology at HC research stations established.
- (18 mo) Field days conducted in each HC to present research results.
- (24 mo) On-farm trials initiated with selected farmer cooperators.
- (30 mo) Field days conducted in each HC to present research results.
- (33 mo) Results of field trials analyzed for profitability and disseminated to PELUM network.

3c. Strengthen farmers' collective capabilities to purchase inoculants and incorporate them into a profitable and sustainable system for small landholders.

- (18 mo) Field Extension Agronomists at HC institutions trained in benefits of BNF and inoculant use.
- (24 mo) Advocacy meetings between farmer groups and agribusiness interests conducted
- (30 mo) Meetings with policy makers and agribusiness on seed/inoculant quality issues conducted
- (33 mo) Incorporated participatory research results into extension training programs, farmer advocacy meetings, and PELUM network website
- (33 mo) Determined potential for engaging Lutheran World Relief, World Bank, the N-for-Africa program, and other international funding agencies to expand current technology transfer efforts to increase BNF via biological inoculation on small landholder farms.

5. Host Country Institutional Capacity Building

Building and Promoting Partnerships with Relevant Research Scientists

The multidisciplinary team of scientists involved in this CRSP 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.

Outcomes of our CRSP project will inform ongoing variety development programs in the U.S. and host countries about specific improvements in BNF and seed composition needed to realize enhanced yield, nutritional value, and marketability of dry beans and other pulses. We anticipate our direct interaction with these programs will expand the impact of current CRSP-funded variety development programs in the US. Dr. Phil Miklas has ongoing research activities with the bean breeding program at the Sokoine University of Agriculture. This connection will provide direct linkage between US and Tanzanian scientists using molecular genetics tools to select for improved bean germplasm. Prof. Jim Kelly at Michigan State University has ongoing germplasm development projects with colleagues at the Institit des Sciences Agronomiques du Rwanda/ISAR in Rwanda. Our research team has ongoing collaboration with bean breeders at the Rwanda through PABRA (CIAT and ECABREN) in the area of exchange of germplasm, esp. snap beans, climbing beans and root rot resistant bean lines.

Dr. Michael Ugen and colleagues at NaCRRI in Uganda work in collaboration with CIAT and ECABREN (East and Central Africa Bean Research Network) under PABRA (Pan African Bean Research Alliance) for 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.

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.

Through VEDCOs leadership in the PELUM network, we will work with farmers groups and associations and agribusiness concerns in Rwanda, Tanzania, Uganda, and Kenya 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. Involving local leadership is a key component of this approach to mobilization of farmers and local agricultural concerns.

CSRL uses 'Learning Forums' regularly to interact with various institutions and service providers (governmental and non-governmental), private sector traders, agricultural processors and distributors etc., to gain and maintain appropriately broad perspectives on key issues in production, the value chain, benefit from their special expertise, and build new collaborative relationships for high levels of success.

Periodic planning and review meetings involving all partners will be implemented to discuss and resolve any challenges and constraints, and to develop a consensus on strategies to deal with them. This will also facilitate broad involvement in research design, data collection instruments and processes, and data analysis.

The program coordinator will actively seek out and involve other developmental partners with similar interests for take advantage of synergies and facilitate dissemination of results to other areas within the country and to other countries in the region.

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

Funding for this CRSP project will support training of seven (7) Host Country graduate students seeking M.Sc. degrees in agriculturally related fields. Two graduate students will be trained in the Soil Science Department at Makerere University. They will be responsible for field and laboratory evaluation of plant responses to inoculation as well as analyzing interactions between environmental conditions and plant BNF. Two graduate students will be trained at Sokoine University of Agriculture in genetics and soil microbiology and be responsible for evaluating genotype x inoculant x environment interactions. One graduate student will be trained at Washington State University and be responsible for molecular genetic analysis of common bean germplasm for variation in biological nitrogen fixation. One graduate student will be trained at Iowa State University and be responsible for detailed phenotypic analysis of the US and HC germplasm selected for molecular analysis. And one graduate student will trained at Michigan State University and be responsible for conducting field evaluation of variety x inoculant interactions and selecting superior combinations using molecular breeding techniques. These students will be responsible for evaluating experimental germplasm for biological nitrogen fixation and quantifying genetic and environmental variation in response to rhizobia inoculation.

All graduate students will develop detailed proposals in their specific disciplines, collect and analyze data and produce reports with the guidance of supervisors. They also will disseminate their findings in scientific workshops, and through scientific publications. Graduate and undergraduate student will be involved in all phases of research design, data collection and data analysis to develop relevant research skills. Inter-Institution collaborative linkages strengthen local, regionally, and international capacities and broaden student opportunities for career development. It is also expected that HC students training in the US will spend some time conducting practical field work in their home country. The student enrolled at Michigan State University in Crop and Soil Sciences, for example, will conduct in depth studies on promising lines indentified in Rwanda field trials and will develop linkage maps of a recombinant inbred line population to conduct QTL analysis of BNF capacity. Once the student has completed his or her coursework at MSU, he or she will spend an estimated 4 months in Rwanda gathering data on BNF variability in the RIL population. The student will then return to MSU to complete degree requirements. It also is expected that HC students trained at US institutions will return to their home countries to engage in research in their chosen field.

We anticipate our graduate students and interns will be highly sought after by academia and industry in their host counties. The program also will support four interns each year to gain practical experience in participatory agricultural research, and advocacy with VEDCO and NaCRRI. Experience has shown that many of these interns go on to pursue advanced graduate degrees.

Innovative approaches to training

Graduate students at Iowa State University will be encouraged to enroll in the 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.

Students will also 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. This program typically invites a number of international students to attend. CSRL anticipates supporting several graduate students and interns at this important meeting.

The proposal also includes a request for funding to support Mr. Tindwa's training visit to WSU under the direction of Dr. Lynne Carpenter-Boggs. This will provide Mr. Tindwa an opportunity to learn of modern molecular and biochemical techniques used to identify and quantify soil microflora, and participate in the been germplasm evaluation being conducted at WSU by Dr. Miklas and Dr, Carpernter-Boggs.

6.Contribution to USAID Objectives and Initiatives

UGANDA: Expand sustainable economic opportunities for rural sector growth.

Work in this project is closely aligned with USAID's goals of increasing agricultural production, enhancing the sustainable use of natural resources, reduce threats to biodiversity, and improve food security. USAID assistance seeks to increase and diversify commercial agricultural production and increase Uganda's competitiveness in local and international markets. This project will contribute to USAID's mission of strengthening producer organizations by working with individual farmers and farmer groups. Through VEDCO's participatory train the trainers approach, this program will disseminate new knowledge about sustainable agricultural technologies and build capacity of farmer groups and associations. 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. This program also contributes directly to the US Presidential Initiative to End Hunger In Africa, which is designed to help Africa countries reduce hunger in half by 2015. In particular, the CRSP project explores the benefits of modern agricultural (micro-biological) technology to increase agricultural productivity and income to small landholder farmers. A letter of support for this CRSP project from the USAID Uganda Mission is appended to this proposal.

RWANDA: Economic Growth, Agriculture and Trade

The landlocked mountainous country of Rwanda is the most densely populated country on the African continent. The majority of people live in rural areas, engaged in subsistence agriculture, and almost two thirds of the population lives below the poverty line (FAO – 2009). Increasing access to improved technologies and productivity increasing inputs – especially fertilizers and seed varieties – is critical to raising performance in the agricultural sector. On average, only 7% of farm households report using purchased inputs, either due to lack of knowledge about their effective use or lack of funds. Chemical fertilizers are only used by an estimated 5% of Rwandan farmers. Biological inoculants can be a very effective and cost effective overcome this constraint on legume production. Outcomes of this CRSP program directly support the USAID Rwanda Mission program for economic growth and expanded opportunities in rural areas, increase household incomes, employment, and corresponding rural financial services for targeted communities. The central Mission goal of increasing agricultural productivity is promoted by developing sustainable production practices to increase legume yields through training and access to modern agricultural inputs. Knowledge and experiences gained through VEDCO's dissemination activities in Uganda provide an excellent model for disseminating information to farmer groups in rural communities in Rwanda.

Tanzania: Health and Economic Growth

The major objectives of the USAID Mission in Tanzania is to stabilize population growth, prevent the spread of HIV/AIDS, arrest environmental degradation and promote democracy, human rights and broad-based national and regional economic growth. As in Uganda and Rwanda, the outcomes of this CRSP program will contribute to improved health and nutrition of small landholder farm families. This is especially critical in families dealing with HIV/AIDS and for persons particularly vulnerable to malnutrition (orphaned infants, elderly, widows). CRSP activities Tanzania will contribute to USAID's mission of strengthening producer organizations by working with individual farmers and farmer groups. Through VEDCO's participatory train the trainers approach, this program will disseminate new knowledge about sustainable agricultural technologies and build capacity of farmer groups and associations. This program also contributes directly to the US Presidential Initiative to End Hunger In Africa, which is designed to help Africa countries reduce hunger in half by 2015. In particular, the CRSP project explores the benefits of modern agricultural (micro-biological) technology to increase agricultural productivity and income to small landholder farmers. A letter of support for this CRSP project from the USAID Tanzania Mission is appended to this proposal.

7. Strategies for Achieving Developmental Impacts

A participatory approach: The partnership CSRL and VEDCO have established working with farmers and farmer groups is based on participatory interaction throughout program development, implementation, and assessment. This means all stakeholders involved especially the main beneficiaries - small land holder farmers -- are involved at all stages. This approach ensures ownership of the project by the people who should benefit most from the outcome of the research. Importantly, farmers also participate in the evaluation of trials (on-farm evaluation with farmers) for early adoption of the results. Other partners such as extension agents, university researchers, NGOs/CBOs can be involved in on-farm evaluation of the trials for early understanding of the results and passing information to the end-users and accelerated adoption.

Real partnerships: Formation of active and dependent partnerships where all stakeholders involved regularly meet to review project implementation and progress enables linkages to evolve beyond temporary collaborations. CSRL's long-term commitment to the east Africa will bring many partners/stakeholders together such as nutrition experts, extension agents, NGOs/CBOs, policy makers, local and opinion leaders, processors, researchers and marketers to confront the issues of rural hunger and poverty in the region. The partnerships and linkages developed between VEDCO extension workers, NaCRRI scientists, and CSRL faculty provide a model for success that can be applied throughout the region for organizations that have a similar vision for improving livelihoods of rural communities.

Gender equity: Much of the agricultural sector is fueled by the productive capacity of women. Yet gender discrimination is still pervasive. To achieve sustainable economic growth, gender discrimination must be addressed. Imbalances in traditional gender relations make it more difficult for women to have access and control over such assets as fertilizer, seed, pesticides, credit, and extension services. As of 2008, women headed 34% percent of all Rwandan households. Of these households, widows head 80%. Female-headed households are the first hit when incomes decline. On average, female-headed households have access to 30% less land than male-headed households and own 50% less livestock. This CRSP program will follow the guidelines established by CSRL and implemented rigorously by VEDCO throughout its training and advocacy programs to ensure women farmers benefit from the new knowledge and interventions brought to rural communities (see www.srl.ag.iastate.edu for numerous examples). Gender balance also will be achieved in selecting graduate students, interns and hourly students for this program.

Innovative outreach approaches: Numerous innovative and effective approaches to disseminate new information are being used in Uganda by our NGO and NARO partners. These include: *On-farm demonstrations* where farmers are more involved in demonstrating new approaches to the communities. A good demonstration portrays its effect much more clearly than explanation of words especially when well labeled and placed in strategic places where more audience are likely to see the demons and feel the effects. *Mass media* utilizing the many FM radio stations scattered all over the country. This has become a much easier way of reaching people in the rural areas. Likewise the use of *cellular phone technology and Internet* is spreading rapidly. Surprisingly, many rural farmers have cell phones and use them to obtain up-to-date marketing information. Internet kiosks are opening in many small towns. In addition, most of the information or results available could be packaged in print forms such as brochures, leaflets, pamphlets, booklets, posters, etc *translated into local languages* in order to reach most beneficiaries and the rural communities. *Farmer field schools* are an effective way of demonstrating in details the benefit of a technology and also giving a more in-depth description of the technology to the participating farmers. It gives the farmers opportunities to know more about the technologies, become experts who could also help other farmers understand the technology better. This improves on technology dissemination and adoption. Those who successfully complete the training in the school can be awarded certificates as this increases people's morale to participate in the field school activities. *Local community forums* such as Church meetings, social meetings, political meetings are all important in dissemination of information and technologies to the communities.

Monitoring and evaluation: In accordance with CSRL protocols, there will be a well prepared Participatory Monitoring and Evaluation procedure for the project where all stakeholders are involved in the development of the monitoring and evaluation tools. All stakeholders should understand the tools and be in position to apply them. This allows for evaluation of progress, early correction of mistakes and planning feature research activities. Participatory monitoring and evaluation has been 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. An M&E Assistant Project Officer is directly responsible for district level activities. A key outcome of the M&E activity is careful evaluation of opportunities to expand the program to other locations in the region.

A robust model for expansion: Developing a robust working model has been the goal of CSRL's work with its partner organizations in Uganda since 2004. Consistent program (re)evaluation has enabled CSRL to modify its intervention strategy and implementation periodically, leading to enhanced program success. This is an ongoing process to identify both the potential for and pathways leading to transfer and scaling up of the approach. Key elements of this model are: Training of Rural Development Extensionists (RDEs), developing farmer associations, workshops and publicity for innovations, widespread dissemination of information through VEDCO's network in eight districts and association with other development organizations, willingness to partner with similarly interested and dedicated organizations.

Ensuring benefits to U.S. Agriculture:
Numerous outcomes of this project will benefit US Agriculture.

- Evaluation and marker data will enable QTL analysis to identify markers associated with BNF. If reliable markers are found, they will eventually be examined for utility in marker-assisted selection of enhanced BNF trait. This technology will be useful for US bean breeding programs.
- The project will engender closer collaborative ties between US scientists and well-respected and successful African scientists.
- The project involves two USDA-ARS laboratories directly engaged in bean germplasm improvement. There will be opportunity for sharing germplasm and generating new recombinant inbred lines with potential for improved performance in the US, as well as sub-Saharan Africa.
- Involvement of a US-based company whose agricultural products enhance BNF has potential to decrease N-fertilizer in the US as well as globally, without sacrificing productivity. .

Annexes

- **CVs of key US and HC partners (attached)**
- **Letters of willingness to collaborate (attached)**
- **Letters from USAID Missions (attached)**
- **Leveraging additional resources from HC and US partners**

US Institutions have committed $152,872 in 'in-kind' dollars towards the successful completion of the projects outlined in this proposal. Our industrial partner, Becker Underwood, Inc (BU) is contributing about 43% of this amount. This level of commitment from an industry partner is significant and clearly indicative of the potential for leveraging additional industry funds to expand the program. Through its collaboration with the Lutheran World Relief, Becker Underwood is currently supporting the expansion of Inoculant Technology in Burkina Faso, Niger, Tanzania, Kenya, and Mali. This activity involves local seed companies and is designed to minimize dependence on inorganic N fertilizer. While this project initially depends upon inoculants developed by BU and shipped to research collaborators, opportunities to involve HC industries for inoculant production and distribution will be pursued.

While a formal commitment of funds from the CSRL program is not possible, many of the management, development, and research activities conducted by the Center with our partners in Sub Saharan Africa Uganda support the research and development activities outlined in this proposal. Natural synergies will be leveraged to provide cost savings and efficiencies for achieving the CRSP program objectives.

- **Literature Cited**

Anderson, J.M., and Ingram, J.S.I. 1989. Tropical soil biology and fertility (TSBF): a handbook of method. CAB International. 171 p.

Africa Research Bulletin. 2007. Environment: Deadly Floods Sweep Across Africa. Economic, Financial and Technical Services 44 (8): 17512B-17512C.

Barron, J.E., Pasini, R.S., Davis, D.W., Stuthman, D.D., and Graham, P.H. 1999. Response to selection for seed yield and nitrogen (N_2) fixation in common bean (*Phaseolus vulgaris* L.). Field Crops Research 62: 119-128.

Bationo, A. 2004. Managing Nutrient Cycles to Sustain Soil Fertility in Sub- Saharan Africa. *TSBF-CIAT.* Academy Science Publishers, Nairobi

Bliss, F.A., Pereira, P.A.A., Araujo, R.S., Henson, R.A., Kmiecik, K.A., McFerson, J.R., Teixeira, M.G., and daSilva, C.C. 1989. Registration of five high nitrogen fixation common bean germplasm lines. Crop Sci. 29: 240-241.

Bliss, F.A., 1993. Breeding common bean for improved nitrogen fixation. Plant and Soil 152: 71-79.

Butler, L.M., and Mazur, R. E. 2007. "Principles and Processes for Enhancing Sustainable RuralLivelihoods: Collaborative Learning in Uganda" International Journal of Sustainable Development & World Ecology 14:1-14.

CIAT 2002. Soil fertility degradation in sub-Saharan Africa: Levering lasting solutions to a long lasting problem. Rockefeller Bellagio Study. www.ciat.cgiar.org/news/pdf/tsbf_bellagio.pdf

Diouf, A., Abdoulaye Diop, T., and Gueye, M. 2008. Nodulation in situ of common bean (Phaseolus vulgaris L.) and field outcome of an elite symbiotic association in Senegal. Res. J. Agric. Biol. Sci. 4: 810-818.

Ehui, S, and Pender, J. 2005. Resource Degradation, Low agricultural Productivity, and Poverty in sub-Saharan Africa: Pathways out of the Spiral. Agricultural Economics 32: 225-242.

Ellis F. 2000. Rural Livelihoods and Diversity in Developing Countries. Oxford: Oxford University Press.

Ellis, F., and Bahiigwa, G. 2003. Livelihoods and rural poverty reduction in Uganda. World Development. 31(6): 997-1013.

FAO 2006. The State of Food Insecurity in the World. Rome, Italy: Food and Agriculture Organization.

FAO 2009: http://faostat.fao.org/site/339/default.aspx

Giller, K.E. 2001 Nitrogen fixation in tropical cropping systems. 2nd Ed. CAB Intl., 423 p

Graham, P.H. 1981. Some problems of nodulation and symbiotic nitrogen fixation in Phaseolus vulgaris L.: A Review. Field Crops Research 4: 93-112

Graham, P.H. 2003. Addressing edaphic constraints. Field Crop Research 82:179-192.

Helmore, K., and Singh, N. 2001. Sustainable Livelihoods: Building on the Wealth of the Poor. Bloomfield, CT: Kumarian Press.

KDA 2004. Kamuli District Annual Report. Kamuli, Uganda: Kamuli District Administration.

Martinez-Romero, E. 2003. Diversity of Rhizobium-Phaseolus vulgaris symbiosis: overview and perspectives. Plant and Soil 252: 11-23.

Mazur, R.E., Masinde, D.M., and Butler, L.M. 2006. "Effective Partnerships for Sustainable Rural Livelihoods: A Critical Review and a Way Forward" in Proceedings of the 18th Symposium and Global Learning Opportunity of the International Farming Systems Association. Rome, Italy Oct. 30-Nov. 4.

Melnikova, N.N., and Omelchuk, S.V. 2009. Effect of legume seed exudates on the formation of Rhizobium-legume symbiosis. Appl. Biochem. Microbiol. 45:297-302.

Miklas, P. N., Kelly, J. D., Beebe, S. E., and Blair, M.W. 2006. Common bean breeding for resistance against biotic and abiotic stresses: from classical to MAS breeding. Euphytica 147:105-131.

Musdandu, A.A.O., and Joshua, O.O. 2001. Response of common bean to rhizobium inoculation and fertilizers. J. Food Tech. Africa 6:121-125.
NAP. 2008. Emerging Technologies to Benefit Farmers in Sub-Saharan Africa and South Asia. National Academies Press. Washington DC.
Ndakidemi, P.A., and Dakora, F.D. 2003. Legume seed flavonoids and nitrogenous metabolites as signals and protectants in early seedling development. Funct. Plant Biol. 30:729-745.
Ndakidemi, P.A. , Dakora, F.D. , Nkonya, C. , Ringo, D., and Mansoor, D. 2006. Yield and economic benefits of common bean (Phaseolus vulgaris) and soybean (Glycine max) inoculation in northern Tanzania. Aust. J. Exp. Agric. 46(4) 571–577.
Nkwiine, C. 1999. Increase of crop yields by beneficial organisms: a case of rhizobia use in Uganda. Proc. Soil Sci. Soc. East Africa. 17th Conf. p 174-6.
Nkonya, E., Pender, J., Jagger, P., Sserunkuuma, D., Kaizzi, C. and Ssali, H. 2004. Strategies forSustainable Land Management and Poverty Reduction in Uganda. Research Report # 133. Washington DC: International Food Policy Research Institute.
Opio, F., Ugen, M.A., Kyamanywa, S., Davis, S., and M. Mugisha-Mutetikka. 2001. Beans. In: (Eds. Mukiibi J. K. et al). pp 162-191. Agriculture in Uganda, Volume II. National Agricultural Research Organization (NARO).
Schulze, J. 2004. How are nitrogen fixation rates regulated in legumes? J. Plant Nutr. Soil Sci. 167:125-137.
Selener, D. 1997, Participatory action research and social change. Cornell Participatory Action Research Network. Ithaca, NY: Cornell University.
Silver, M.C.R., and Nkwiine, C. 2007. A review of work on rhizosphere microbiota in Uganda. African J. Ecol.. 45(2):20-26.
Sseguya, H. 2007. Annual Evaluation Report for the Sustainable Rural Livelihoods in Kamuli District, Uganda. Center for Sustainable Rural Livelihoods, Iowa State University, USA.
Vadez, V., Lasso, J.H., Beck, D.P., and Drevon, J.J. 1999. Variability of N_2-fixation in common bean (*Phaseolus vulgaris* L.) under P deficiency is related to P use efficiency: N_2-fixation tolerant to P deficiency. Euphytica 106: 231-242.
Volunteer Efforts for Development Concerns (VEDCO). 2007. Annual Report 2006. Kampala.
Xavery, P., Kalyebara R., Kasambala, S., and Ngulu, F., 2006. The Impact of Improved Bean Production Technologies in Northern and North Western Tanzania. Occasional Publication Series No. 43, Pan African Bean Res. Alliance, CIAT Africa Region, Kampala, Uganda and Selian Agric. Res. Inst., Arusha, Tanzania

Cost application

Title: Enhancing biological nitrogen fixation (BNF) of leguminous crops grown on degraded soils in Uganda, Rwanda, and Tanzania

Budget tables
(see attached files)

Budget narrative
A total of $985,471 is requested to support the three program strategic aims for 33 months from 1 January 2010 to 28 Sept. 2012. Cost share by US institutions is $154,236 which is 25% of total funds to US Institutions, as required by USAID. BeckerUnderwood cost share is $22,000/yr, of which $12,000 is to provide guidance and technical support by BU personnel, $8,000/yr for BU inoculant products, and $2000/yr for delivering inoculant to HC collaborators. Approximately 52% of direct costs will be allocated to host countries (HC); $370,500 to be subcontracted directly to HC institutions. More than 45% of requested funds are attributable to HC capacity building.

a. Personnel Cost
Approximately 34% of the total requested funding ($334,752 in direct costs) is allocated for financial support of the project personnel directly involved in the research and training activities. This includes HC graduate students to be trained at US and HC institutions, lab and field technicians, as well as summer salary for one US PI. All project personnel are selected based on their demonstrated interest in developing expertise in sustainable natural resource use and research.

Graduate Research Assistants:
Approximately 52% of direct costs for personnel ($181,468) are allocated to support graduate students. These funds will support seven (7) MS level GRA positions at 50% effort (20 hours per week). Two graduate students will be trained in the Soil Science Department at Makerere University. They will be responsible for field and laboratory evaluation of plant responses to inoculation as well as analyzing interactions between environmental conditions and plant BNF. Two graduate students will be trained at Sokoine University of Agriculture in genetics and soil microbiology and be responsible for evaluating genotype x inoculant x environment interactions. One graduate student will be trained at Washington State University and be responsible for molecular genetic analysis of common bean germplasm for variation in biological nitrogen fixation. One graduate student will be trained at Iowa State University and be responsible for detailed phenotypic analysis of the US and HC germplasm selected for molecular analysis. And one graduate student will trained at Michigan State University and be responsible for conducting field evaluation of variety x inoculant interactions and selecting superior combinations using molecular breeding techniques. These students will be responsible for evaluating experimental germplasm for biological nitrogen fixation and quantifying genetic and environmental variation in response to rhizobia inoculation. All graduate students will develop detailed proposals in their specific disciplines, collect and analyze data and produce reports with the guidance of supervisors. They also will disseminate their findings in scientific workshops, and through scientific publications. Fees requested for graduate student stipends, fringe benefits, and tuition are in accordance with graduate college policy for Iowa State University, Washington State University, Michigan State University, Makerere University, and Sokoine University of Agriculture.

Field/Lab technicians:
The majority of remaining funds requested for personnel are allocated to HC field and lab technicians working at the Rwanda, Tanzania, and Uganda field research stations. In addition, $50,000 is requested for a 25% time lab technician and 1-month summer salary per year for Dr. Lynne Carpenter-Boggs, the U.S. soil microbiologist on our CSRP team.

Undergraduate Research Assistants - interns
Funds are requested to support training of five (5) undergraduate students ($12,300). Two students will be trained with VEDCO staff as interns during the field operations. They will be responsible for assisting field staff with data collection, demonstration site preparation, preliminary data analysis, and conducting farmer meetings. Three Rwandan students will be assigned to assist at the three ISAR field sites and will be trained in field techniques and germplasm evaluation.

Fringe Benefits
Fringe benefits are requested in accordance with Iowa State University, USDA-Agricultural Research Service, Michigan State University, and Washington State University policies. No fringe benefits are requested for HC personnel. *Graduate Research Assistants:* ISU (13.2%); MSU (10.7%); WSU (13.2%). *Lab Technicians:* WSU (32%). *Faculty:* WSU (31%).

b. Travel
Approximately 20% ($197,020) of the funds requested will be expended for program related travel. This includes travel by the US PI and Co-PIs to Uganda, Rwanda, and Tanzania, travel for the HC Co-PIs to the other HC sites, travel by HC graduate students to US institutions for training, and in-country travel expenses for conducting field operations. International airfare costs are estimated at $2,250 to $2,800 per person depending on starting location and destination. Total costs for HC co-PIs to travel between Uganda, Rwanda, and Tanzania to evaluate in-field protocols and results is estimated at $2,725 per person per year. For all international airfares, the cost per ticket is based on coach class travel on a U.S. flag carrier.

Per diem rates and anticipated lodging expenses budgeted for each country are based on experiential costs during previous travels to the host countries by the PI and co-PIs and are well below the rates allowed by the U.S. Department of State. The per diem rates range from $30 to $50 per day depending whether travel is anticipated within country, limited by university policy, or travel between host countries. Ground travel includes travel via train, bus, taxi and/or private transport services based on prior experience in the countries. Visa charges, costs for required vaccinations, and emergency medical insurance for US travels are also included in the budget.

c. Equipment
No major instrumentation is requested in this proposal. Funds are requested, however, to purchase a motorcycle ($6,500) for VEDCO staff working on this project. Transportation to remote field sites is essential to reach as many farmers and farmer groups as possible. Small motorcycles are the least expensive means to accomplish this.

d. Supplies
Approximately 12% of the funding request ($121,700) will be used to purchase expendable supplies needed to conduct the field and laboratory experiments. Expendable supplies used by graduate student research at ISU, MSU and WSU include laboratory chemicals for DNA extraction, PCR and SSR marker analyses, plant tissue analyses, and microbial cultures. Standard breeding supplies for conducting seed increases, making crosses, and harvesting seed will be purchased as needed. Research supplies for HC institutions include planting and harvesting materials, soil survey instruments, rain gauges, thermometers, soil moisture gauges and other accessories required for analysis of plant and soil samples, and monitoring test site conditions. Expendable laboratory supplies include routine glassware, petri dishes, and media for microbial studies, as well as lab supplies needed to analyze yield, yield components, and seed composition.

e. Training
Degree training includes formal education for seven (7) MS level graduate students from host countries. Two graduate students will be trained in the Soil Science Department at Makerere University under the direction

of Dr. Mateete Bekunda, Professor of Soil Science. Two graduate students will be trained at Sokoine University of Agriculture under the direction of Dr. Susan Mchimbi, Associate Professor of Plant Breeding and Genetics. One HC graduate student will be trained at Washington State University under the co-direction of Dr. Lynn Carpenter-Boggs, Assistant Professor of Soil Microbiology and Biochemistry, and Dr. Phillip Miklas, Legume Research Geneticist with USDA-ARS. One HC graduate student will be trained at Iowa State University under the direction of the program PI, Dr. Mark Westgate, Professor of Crop Production and Physiology. And one HC graduate student will be trained at Michigan State University under the co-direction of Dr. Jim Kelly, Professor of Crop Breeding and Genetics, and Dr. Karen Cichy, Research Geneticist with USDA-ARS. Dr. Lynne Carpenter-Boggs also will serve as the coordinator for Mr. Tindwa's training visit to WSU.

It is expected that HC students training in the US will spend some time conducting practical field work in their home country. The student enrolled at Michigan State University in Crop and Soil Sciences, for example, will conduct in depth studies on promising lines indentified in Rwanda field trials and will develop linkage maps of a recombinant inbred line population to conduct QTL analysis of BNF capacity. Once the student has completed his or her coursework at MSU, he or she will spend an estimated 4 months in Rwanda gathering data on BNF variability in the RIL population. The student will then return to MSU to complete degree requirements. It also is expected that HC students trained at US institutions will return to their home countries to engage in research in their chosen field.

Fees requested for graduate student stipends, fringe benefits, and tuition are in accordance with graduate college policy for Iowa State University, Washington State University, Michigan State University, and Makerere University. Approximately 7% of direct costs ($70,261) are allocated to train these HC students.

Non-degree

Funds requested for non-degree training ($20,600) will support formal internships for five (5) undergraduate students ($12,300) and training of HC laboratory technicians, field agronomists and extension staff on use and agricultural benefits of seed inoculants. These latter activities are incorporated into 'contractual services' and 'other expenses' in the VEDCO sub-contract, and funds allocated specifically for this purpose cannot be quantified exactly. Expenses related to the HC microbiologist training in the US are included in the travel line item for Sokoine University of Agriculture.

f. Other

Additional funding of $29,650 is requested to cover general expenses anticipated for communications (telephone, publications, etc), mass media, field rental, and contractual services. A large component of this request ($8,300) is for VEDCO's program to disseminate project information through the PELUM network (Participatory Ecological Land Use Management) in Eastern, Central and Southern Africa involving local media, written documents, and meetings with policy makers and other agricultural concerns.

g. Total direct costs

Total direct costs to all participating institutions for this 33-month project is $780,483. Of these funds, approximately 44% ($355,870) are direct costs allocated to host country institutions. When direct costs to the lead US institution for HCs also are taken into account, approximately 53% ($416,995) of direct costs are allocated HC partners, which is well above the 50% requirement for pulse-CRSP proposals.

h. Indirect costs for ISU

Indirect costs are calculated according to the pulse-CRSP, Iowa State University, and USDA-Agricultural Research requirements. Total Indirect costs for ISU ($24,121) are calculated at 26% of direct costs of $92,774 ($102,075 minus equipment, tuition, all subs.)

i. Indirect costs on subcontracts

Indirect costs are calculated at 26% of the first $25,000 for each sub-contract. Total for the three-year project is $58,499 on total sub-contracts of $800,774.

j. Total indirect costs

A total indirect cost for this project is $204,988. This includes indirect charged by the lead institution, ISU ($82,620) plus indirect costs charged in subcontracts by USDA-ARS (11% = $17,054), VEDCO (15% = $10,541), NaCRRi (10% = $7,095), Makerere University (10% = $6,150), Michigan State University (52% = $33,355), and Washington State University (49.8% = $48,173). These rates are in accordance with negotiated indirect rates at these institutions.

Dry Grain Pulses CRSP : BUDGET SUMMARY

Enhancing biological nitrogen fixation of leguminous crops grown on degraded soils in Uganda, Rwanda and Tanzania

1/1/10 - 09/30/12

	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	HC or U.S. Institution (5)	HC or U.S. Institution (6)	HC or U.S. Institution (7)	HC or U.S. Institution (8)	HC or U.S. Institution (9)	
Institution Name	ISU		MSU/Kelly	ARS/Cichy	WSU/Boggs	ARS/Miklas	Makerere U	VEDCO	NaCCRI	ISAR, Rwanda	Sokoine Univ	
a. Personnel Cost												
Salaries	$0.00	$39,818.00	$34,981.00	$0.00	$50,000.00	$51,280.00	$19,800.00	$22,800.00	$16,500.00	$24,750.00	$43,200.00	**$303,129.00**
Fringe Benefit	$0.00	$5,256.00	$3,764.00	$0.00	$15,834.00	$6,769.00	$0.00	$0.00	$0.00	$0.00	$0.00	**$31,623.00**
b. Travel	$25,950.00	$6,750.00	$18,600.00	$12,600.00	$11,700.00	$22,500.00	$21,900.00	$7,720.00	$38,235.00	$7,395.00	$23,670.00	**$197,020.00**
c. Equipment ($5000 Plus)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$6,500.00	$0.00	$0.00	$0.00	**$6,500.00**
d. Supplies	$11,200.00	$0.00	$5,000.00	$15,000.00	$15,000.00	$15,000.00	$12,750.00	$17,850.00	$11,900.00	$9,000.00	$9,000.00	**$121,700.00**
e. Training												
Degree	$0.00	.$9,301.00	$19,159.00	$0.00	$0.00	$27,951.00	$4,150.00	$0.00	$0.00	$0.00	$9,700.00	**$70,261.00**
Non-Degree	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$10,700.00	$0.00	$9,900.00	$0.00	**$20,600.00**
f. Other	$3,800.00	$0.00	$1,800.00	$0.00	$4,200.00	$2,400.00	$2,900.00	$4,700.00	$4,300.00	$3,900.00	$1,650.00	**$29,650.00**
g. Total Direct Cost	**$40,950.00**	**$61,125.00**	**$83,304.00**	**$27,600.00**	**$96,734.00**	**$125,900.00**	**$61,500.00**	**$70,270.00**	**$70,935.00**	**$54,945.00**	**$87,220.00**	**$780,483.00**
h. Indirect Cost	$24,121.00	$0.00	$33,355.00	$3,066.00	$48,173.00	$13,988.00	$6,150.00	$10,541.00	$7,095.00	$0.00	$0.00	**$146,489.00**
i. Indirect Cost on Subcontracts (First $25000)	$58,499.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
j. Total Indirect Cost	$82,620.00	$0.00	$33,355.00	$3,066.00	$48,173.00	$13,988.00	$6,150.00	$10,541.00	$7,095.00	$0.00	$0.00	**$204,988.00**
Total	**$123,570.00**	**$61,125.00**	**$116,659.00**	**$30,666.00**	**$144,907.00**	**$139,888.00**	**$67,650.00**	**$80,811.00**	**$78,030.00**	**$54,945.00**	**$87,220.00**	
Grand Total						**$985,471.00**						

	Amount	Percentage
Total direct cost budgeted for U.S. institution(s)	$374,488.00	47.98%
Total direct cost budgeted for H.C institution(s)	$405,995.00	52.02%

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	HC or U.S. Institution (5)	HC or U.S. Institution (6)	HC or U.S. Institution (7)	HC or U.S. Institution (8)	HC or U.S. Institution (9)	Total
In-kind	$127,313.00		$17,191.00	$0.00	$9,732.00	$0.00						$154,236.00
Cash												$0.00
Total	$ 127,313.00	$ -	$ 17,191.00	$ -	$ 9,732.00	$ -	$ -	$ -			$ -	$ 154,236.00
Attribution to Capacity Building												
Percentage of effort	0.00%	100.00%	54.78%	0.00%	0.00%	69.20%	56.32%	53.82%	33.83%	79.44%	83.95%	45.33%
Amount corresponding to effort	$0.00	$61,125.00	$63,905.80	$0.00	$0.00	$96,802.50	$38,100.48	$43,492.48	$26,397.55	$43,648.31	$73,221.19	$446,693.30

Enhancing biological nitrogen fixation of leguminous crops grown on degraded soils in Uganda, Rwanda and Tanzania

Name of Authorized Lead U.S Institutional Representative:

Email (Inst. Rep.): grants@iastate.edu		Phone No. (Inst. Rep.) 515-294-5225
Signature (Inst. Rep.): Suzanne Schuknecht		Date: 1/29/10

Dry Grain Pulses CRSP : BUDGET SUMMARY

Enhancing biological nitrogen fixation of leguminous crops grown on degraded soils in Uganda, Rwanda and Tanzania

	1/1/10 - 09/30/12											
	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	HC or U.S. Institution (5)	HC or U.S. Institution (6)	HC or U.S. Institution (7)	HC or U.S. Institution (8)	HC or U.S. Institution (9)	
Institution Name	**ISU**		**MSU/Kelly**	**ARS/Cichy**	**WSU/Boggs**	**ARS/Miklas**	**Makerere U**	**VEDCO**	**NaCCRI**	**ISAR, Rwanda**	**Sokoine Univ**	
a. Personnel Cost												
Salaries	$0.00	$39,818.00	$34,981.00	$0.00	$50,000.00	$51,280.00	$19,800.00	$22,800.00	$16,500.00	$24,750.00	$43,200.00	**$303,129.00**
Fringe Benefit	$0.00	$5,256.00	$3,764.00	$0.00	$15,834.00	$6,769.00	$0.00	$0.00	$0.00	$0.00	$0.00	**$31,623.00**
b. Travel	$25,950.00	$6,750.00	$18,600.00	$12,600.00	$11,700.00	$22,500.00	$21,900.00	$7,720.00	$38,235.00	$7,395.00	$23,670.00	**$197,020.00**
c. Equipment ($5000 Plus)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$6,500.00	$0.00	$0.00	$0.00	**$6,500.00**
d. Supplies	$11,200.00	$0.00	$5,000.00	$15,000.00	$15,000.00	$15,000.00	$12,750.00	$17,850.00	$11,900.00	$9,000.00	$9,000.00	**$121,700.00**
e. Training												
Degree	$0.00	$9,301.00	$19,159.00	$0.00	$0.00	$27,951.00	$4,150.00	$0.00	$0.00	$0.00	$9,700.00	**$70,261.00**
Non-Degree	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$10,700.00	$0.00	$9,900.00	$0.00	**$20,600.00**
f. Other	$3,800.00	$0.00	$1,800.00	$0.00	$4,200.00	$2,400.00	$2,900.00	$4,700.00	$4,300.00	$3,900.00	$1,650.00	**$29,650.00**
g. Total Direct Cost	**$40,950.00**	**$61,125.00**	**$83,304.00**	**$27,600.00**	**$96,734.00**	**$125,900.00**	**$61,500.00**	**$70,270.00**	**$70,935.00**	**$54,945.00**	**$87,220.00**	**$780,483.00**
h. Indirect Cost	$24,121.00	$0.00	$33,355.00	$3,066.00	$48,173.00	$13,988.00	$6,150.00	$10,541.00	$7,095.00	$0.00	$0.00	**$146,489.00**
i. Indirect Cost on Subcontracts (First $25000)	$58,499.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
j. Total Indirect Cost	$82,620.00	$0.00	$33,355.00	$3,066.00	$48,173.00	$13,988.00	$6,150.00	$10,541.00	$7,095.00	$0.00	$0.00	**$204,988.00**
Total	**$123,570.00**	**$61,125.00**	**$116,659.00**	**$30,666.00**	**$144,907.00**	**$139,888.00**	**$67,650.00**	**$80,811.00**	**$78,030.00**	**$54,945.00**	**$87,220.00**	
Grand Total	**$985,471.00**											

	Amount	Percentage
Total direct cost budgeted for U.S. institution(s)	**$374,488.00**	**47.98%**
Total direct cost budgeted for H.C institution(s)	**$405,995.00**	**52.02%**

Cost Share	U.S. Institution	U.S. for Host Country	HC or U.S. Institution (1)	HC or U.S. Institution (2)	HC or U.S. Institution (3)	HC or U.S. Institution (4)	HC or U.S. Institution (5)	HC or U.S. Institution (6)	HC or U.S. Institution (7)	HC or U.S. Institution (8)	HC or U.S. Institution (9)	Total
In-kind	$127,313.00		$17,191.00	$0.00	$9,732.00	$0.00						$154,236.00
Cash												$0.00
Total	$ 127,313.00	$ -	$ 17,191.00	$ -	$ 9,732.00	$ -	$ -	$ -			$ -	$ 154,236.00

Attribution to Capacity Building												
Percentage of effort	0.00%	100.00%	54.78%	0.00%	0.00%	69.20%	56.32%	53.82%	33.83%	79.44%	83.95%	45.33%
Amount corresponding to effort	$0.00	$61,125.00	$63,905.80	$0.00	$0.00	$96,802.50	$38,100.48	$43,492.48	$26,397.55	$43,648.31	$73,221.19	$446,693.30

Enhancing biological nitrogen fixation of leguminous crops grown on degraded soils in Uganda, Rwanda and Tanzania	
Name of Authorized Lead U.S Institutional Representative:	
Email (Inst. Rep.):	Phone No. (Inst. Rep.)
Signature (Inst. Rep.) :	Date:

Dry Grain Pulses CRSP : FIRST PERIOD

Enhancing biological nitrogen fixation of leguminous crops grown on degraded soils in Uganda, Rwanda and Tanzania

	1/1/10 - 09/30/10										
	U.S. Institution	**U.S. for Host Country**	**HC or U.S. Institution (1)**	**HC or U.S. Institution (2)**	**HC or U.S. Institution (3)**	**HC or U.S. Institution (4)**	**HC or U.S. Institution (5)**	**HC or U.S. Institution (6)**	**HC or U.S. Institution (7)**	**HC or U.S. Institution (8)**	**HC or U.S. Institution (9)**
Institution Name	**ISU**		**MSU/Kelly**	**ARS/Cichy**	**WSU/Boggs**	**ARS/Miklas**	**Makerere U**	**VEDCO**	**NaCCRI**	**ISAR, Rwanda**	**Sokoine Univ**
a. Personnel Cost											
Salaries	$0.00	$0.00	$0.00	$0.00	$13,200.00	$13,538.00	$5,400.00	$0.00	$4,500.00	$6,750.00	$12,000.00
Fringe Benefit	$0.00	$0.00	$0.00	$0.00	$4,180.00	$1,787.00	$0.00	$0.00	$0.00	$0.00	$0.00
b. Travel	$8,400.00	$0.00	$4,200.00	$4,200.00	$3,900.00	$6,600.00	$7,000.00	$0.00	$11,945.00	$2,465.00	$10,640.00
c. Equipment ($5000 Plus)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
d. Supplies	$0.00	$0.00	$1,000.00	$5,000.00	$5,000.00	$5,000.00	$8,250.00	$0.00	$5,300.00	$3,000.00	$3,000.00
e. Training											
Degree	$0.00	$0.00	$0.00	$0.00	$0.00	$7,379.00	$1,150.00	$0.00	$0.00	$0.00	$2,500.00
Non-Degree	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$2,700.00	$0.00
f. Other	$500.00	$0.00	$0.00	$0.00	$800.00	$800.00	$300.00	$0.00	$1,300.00	$1,300.00	$550.00
g. Total Direct Cost	**$8,900.00**	**$0.00**	**$5,200.00**	**$9,200.00**	**$27,080.00**	**$35,104.00**	**$22,100.00**	**$0.00**	**$23,045.00**	**$16,215.00**	**$28,690.00**
h. Indirect Cost	$2,314.00	$0.00	$2,704.00	$1,022.00	$13,486.00	$3,900.00	$2,210.00	$0.00	$2,305.00	$0.00	$0.00
i. Indirect Cost on Subcontracts (First $25000)	$41,249.00										
j. Total Indirect Cost	$43,563.00	$0.00	$2,704.00	$1,022.00	$13,486.00	$3,900.00	$2,210.00	$0.00	$2,305.00	$0.00	$0.00
Total	**$52,463.00**	**$0.00**	**$7,904.00**	**$10,222.00**	**$40,566.00**	**$39,004.00**	**$24,310.00**	**$0.00**	**$25,350.00**	**$16,215.00**	**$28,690.00**
Grand Total	**$244,724.00**										

	Amount	Percentage
Total direct cost budgeted for U.S. institution(s)	**$85,484.00**	**48.70%**
Total direct cost budgeted for H.C institution(s)	**$90,050.00**	**51.30%**

Cost Share	**U.S. Institution**	**U.S. for Host Country**	**HC or U.S. Institution (1)**	**HC or U.S. Institution (2)**	**HC or U.S. Institution (3)**	**HC or U.S. Institution (4)**	**HC or U.S. Institution (5)**	**HC or U.S. Institution (6)**	**HC or U.S. Institution (7)**	**HC or U.S. Institution (8)**	**HC or U.S. Institution (9)**	**Total**
In-kind	$38,417.00		$4,638.00	$0.00	$2,630.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$45,685.00
Cash												$ -
Total	$ 38,417.00	$ -	$ 4,638.00	$ -	$ 2,630.00	$ -	$ -	$ -	$ -	$ -	$ -	$ 45,685.00

Attribution to Capacity Building												
Percentage of effort	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Amount corresponding to effort	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Enhancing biological nitrogen fixation of leguminous crops grown on degraded soils in Uganda, Rwanda and Tanzania

Dry Grain Pulses CRSP : SECOND PERIOD

Enhancing biological nitrogen fixation of leguminous crops grown on degraded soils in Uganda, Rwanda and Tanzania

	10/01/10 - 09/30/11										
	U.S. Institution	**U.S. for Host Country**	**HC or U.S. Institution (1)**	**HC or U.S. Institution (2)**	**HC or U.S. Institution (3)**	**HC or U.S. Institution (4)**	**HC or U.S. Institution (5)**	**HC or U.S. Institution (6)**	**HC or U.S. Institution (7)**	**HC or U.S. Institution (8)**	**HC or U.S. Institution (9)**
Institution Name	**ISU**		**MSU/Kelly**	**ARS/Cichy**	**WSU/Boggs**	**ARS/Miklas**	**Makerere U**	**VEDCO**	**NaCCRI**	**ISAR, Rwanda**	**Sokoine Univ**
a. Personnel Cost											
Salaries	$0.00	$19,615.00	$17,232.00	$0.00	$18,128.00	$18,592.00	$7,200.00	$8,400.00	$6,000.00	$9,000.00	$15,600.00
Fringe Benefit	$0.00	$2,589.00	$1,854.00	$0.00	$5,741.00	$2,454.00	$0.00	$0.00	$0.00	$0.00	$0.00
b. Travel	$8,650.00	$2,700.00	$7,200.00	$4,200.00	$3,900.00	$7,950.00	$7,450.00	$3,860.00	$13,145.00	$2,465.00	$6,515.00
c. Equipment ($5000 Plus)	$0.00		$0.00	$0.00	$0.00	$0.00	$0.00	$6,500.00	$0.00	$0.00	$0.00
d. Supplies	$6,200.00	$0.00	$2,000.00	$5,000.00	$5,000.00	$5,000.00	$2,250.00	$9,050.00	$3,300.00	$3,000.00	$3,000.00
e. Training											
Degree	$0.00	$4,582.00	$9,438.00	$0.00	$0.00	$10,134.00	$1,500.00	$0.00	$0.00	$0.00	$3,600.00
Non-Degree	$0.00		$0.00	$0.00	$0.00	$0.00	$0.00	$1,200.00	$0.00	$3,600.00	$0.00
f. Other	$1,350.00		$600.00	$0.00	$1,400.00	$800.00	$1,300.00	$1,800.00	$1,500.00	$1,300.00	$550.00
g. Total Direct Cost	**$16,200.00**	**$29,486.00**	**$38,324.00**	**$9,200.00**	**$34,169.00**	**$44,930.00**	**$19,700.00**	**$30,810.00**	**$23,945.00**	**$19,365.00**	**$29,265.00**
h. Indirect Cost	$10,687.00		$15,021.00	$1,022.00	$17,016.00	$4,992.00	$1,970.00	$4,622.00	$2,395.00	$0.00	$0.00
i. Indirect Cost on Subcontracts (First $25000)	$16,066.00										
j. Total Indirect Cost	$26,753.00	$0.00	$15,021.00	$1,022.00	$17,016.00	$4,992.00	$1,970.00	$4,622.00	$2,395.00	$0.00	$0.00
Total	**$42,953.00**	**$29,486.00**	**$53,345.00**	**$10,222.00**	**$51,185.00**	**$49,922.00**	**$21,670.00**	**$35,432.00**	**$26,340.00**	**$19,365.00**	**$29,265.00**
Grand Total	**$369.185.00**										

	Amount	**Percentage**
Total direct cost budgeted for U.S. institution(s)	**$142,823.00**	**48.35%**
Total direct cost budgeted for H.C institution(s)	**$152,571.00**	**51.65%**

Cost Share	**U.S. Institution**	**U.S. for Host Country**	**HC or U.S. Institution (1)**	**HC or U.S. Institution (2)**	**HC or U.S. Institution (3)**	**HC or U.S. Institution (4)**	**HC or U.S. Institution (5)**	**HC or U.S. Institution (6)**	**HC or U.S. Institution (7)**	**HC or U.S. Institution (8)**	**HC or U.S. Institution (9)**	**Total**
In-kind	$43,890.00		$6,184.00	$0.00	$3,507.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$53,581.00
Cash												$ -
Total	$ 43,890.00	$ -	$ 6,184.00	$ -	$ 3,507.00	$ -	$ -	$ -	$ -	$ -	$ -	$ 53,581.00

Attribution to Capacity Building												
Percentage of effort	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Amount corresponding to effort	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Enhancing biological nitrogen fixation of leguminous crops grown on degraded soils in Uganda, Rwanda and Tanzania

Dry Grain Pulses CRSP : THIRD PERIOD

Enhancing biological nitrogen fixation of leguminous crops grown on degraded soils in Uganda, Rwanda and Tanzania

	10/01/11 - 09/30/12										
	U.S. Institution	**U.S. for Host Country**	**HC or U.S. Institution (1)**	**HC or U.S. Institution (2)**	**HC or U.S. Institution (3)**	**HC or U.S. Institution (4)**	**HC or U.S. Institution (5)**	**HC or U.S. Institution (6)**	**HC or U.S. Institution (7)**	**HC or U.S. Institution (8)**	**HC or U.S. Institution (9)**
Institution Name	**ISU**		**MSU/Kelly**	**ARS/Cichy**	**WSU/Boggs**	**ARS/Miklas**	**Makerere U**	**VEDCO**	**NaCCRI**	**ISAR, Rwanda**	**Sokoine Univ**
a. Personnel Cost											
Salaries	$0.00	$20,203.00	$17,749.00	$0.00	$18,672.00	$19,150.00	$7,200.00	$14,400.00	$6,000.00	$9,000.00	$15,600.00
Fringe Benefit	$0.00	$2,667.00	$1,910.00	$0.00	$5,913.00	$2,528.00	$0.00	$0.00	$0.00	$0.00	$0.00
b. Travel	$8,900.00	$4,050.00	$7,200.00	$4,200.00	$3,900.00	$7,950.00	$7,450.00	$3,860.00	$13,145.00	$2,465.00	$6,515.00
c. Equipment ($5000 Plus)	$0.00		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
d. Supplies	$5,000.00		$2,000.00	$5,000.00	$5,000.00	$5,000.00	$2,250.00	$8,800.00	$3,300.00	$3,000.00	$3,000.00
e. Training											
Degree	$0.00	$4,719.00	$9,721.00	$0.00	$0.00	$10,438.00	$1,500.00	$0.00	$0.00	$0.00	$3,600.00
Non-Degree	$0.00		$0.00	$0.00	$0.00	$0.00	$0.00	$9,500.00	$0.00	$3,600.00	$0.00
f. Other	$1,950.00		$1,200.00	$0.00	$2,000.00	$800.00	$1,300.00	$2,900.00	$1,500.00	$1,300.00	$550.00
g. Total Direct Cost	**$15,850.00**	**$31,639.00**	**$39,780.00**	**$9,200.00**	**$35,485.00**	**$45,866.00**	**$19,700.00**	**$39,460.00**	**$23,945.00**	**$19,365.00**	**$29,265.00**
h. Indirect Cost	$11,120.00		$15,630.00	$1,022.00	$17,671.00	$5,096.00	$1,970.00	$5,919.00	$2,395.00	$0.00	$0.00
i. Indirect Cost on Subcontracts (First $25000)	$1,184.00										
j. Total Indirect Cost	$12,304.00	$0.00	$15,630.00	$1,022.00	$17,671.00	$5,096.00	$1,970.00	$5,919.00	$2,395.00	$0.00	$0.00
Total	**$28,154.00**	**$31,639.00**	**$55,410.00**	**$10,222.00**	**$53,156.00**	**$50,962.00**	**$21,670.00**	**$45,379.00**	**$26,340.00**	**$19,365.00**	**$29,265.00**
Grand Total	**$371.562.00**										

	Amount	Percentage
Total direct cost budgeted for U.S. institution(s)	**$146,181.00**	**47.22%**
Total direct cost budgeted for H.C institution(s)	**$163,374.00**	**52.78%**

Cost Share	**U.S. Institution**	**U.S. for Host Country**	**HC or U.S. Institution (1)**	**HC or U.S. Institution (2)**	**HC or U.S. Institution (3)**	**HC or U.S. Institution (4)**	**HC or U.S. Institution (5)**	**HC or U.S. Institution (6)**	**HC or U.S. Institution (7)**	**HC or U.S. Institution (8)**	**HC or U.S. Institution (9)**	**Total**
In-kind	$45,006.00		$6,369.00	$0.00	$3,595.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$54,970.00
Cash												$ -
Total	$ 45,006.00	$ -	$ 6,369.00	$ -	$ 3,595.00	$ -	$ -	$ -	$ -	$ -	$ -	$ 54,970.00

Attribution to Capacity Building												
Percentage of effort	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Amount corresponding to effort	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Enhancing biological nitrogen fixation of leguminous crops grown on degraded soils in Uganda, Rwanda and Tanzania

PULSE CRSP	Year 1	Year 2	Year 3	3-Year totals				
Iowa State University	9 months	12 months	12 months	33 months				
Personnel					Total Costs	Total Costs	**HC capacity building**	
Graduate Research Asst.,MS-AGRON					to Lead Inst	**to US Inst**	**US**	**HC**
1/2 time Stipend	$0	$19,615	$20,203	$39,818	$39,818	$39,818	$39,818	
Subtotal Personnel	**$0**	**$19,615**	**$20,203**	**$39,818**				
Fringe Benefits								
Grad student stipend (13.2%)	$0	$2,589	$2,667	$5,256	$5,256	$5,256	$5,256	
Subtotal Fringe Benefits	**$0**	**$2,589**	**$2,667**	**$5,256**				
Travel (International)								
PI (2 trips per year)								
Airfare (international, to Uganda, Rwanda, Tanzania)	$5,000	$5,250	$5,500	$15,750				
Lodging ($85 * 18 days)	$1,530	$1,530	$1,530	$4,590				
Meal Per Diem ($40 * 18 days)	$720	$720	$720	$2,160				
Vaccinations & Medical / Evac. Insurance	$600	$600	$600	$1,800				
Ground Transportation	$350	$350	$350	$1,050				
Visas/Fees (2 countries)	$200	$200	$200	$600				
Graduate Research Assistant to/from U.S.								
Airfare	$0	$2,500	$2,500	$5,000				
Lodging & Meals Per Diem ($50/d * 21 days)	$0	$0	$1,050	$1,050				
Ground Transportation	$0	$0	$300	$300				
Visas/Fees	$0	$200	$200	$400			$6,750	
Subtotal Travel	**$8,400**	**$11,350**	**$12,950**	**$32,700**	$32,700	$32,700		
Equipment								
Equipment	***$0***	***$0***	***$0***	**$0**				
Material and Supplies								
Computer (notebook)	$0	$1,200	$0	$1,200				
Research Supplies	$0	$5,000	$5,000	$10,000				
Subtotal Material & Supplies	***$0***	***$6,200***	***$5,000***	**$11,200**	*$11,200*	*$11,200*		
Host Country Subawards								
Makerere Subcontract	$24,310	$21,670	$21,670	$67,650				$38,100
NaCRRI Subcontract	$25,350	$26,340	$26,340	$78,029				$26,394
VEDCO Subcontract	$0	$35,432	$45,379	$80,811				$43,491
MSU/Kelly Subcontract	$7,904	$53,345	$55,410	$116,659		$116,659	$63,904	$0
ARS/Cichy Subcontract	$10,222	$10,222	$10,222	$30,666		$30,666		$0
ISAR Rwanda Subcontract	$16,215	$19,365	$19,365	$54,945				$43,650
ARS/Miklas Subcontact	$39,004	$49,922	$50,961	$139,887		$139,887	$96,800	
WSU/Boggs Subcontract	$40,566	$51,185	$53,156	$144,907		$144,907	$0	
Sokoine Subcontract	$28,690	$29,265	$29,265	$87,220				$73,225
Subtotal Host Country Subaward	***$192,261***	***$296,745***	***$311,768***	**$800,774**				
Tuition								
Research Asst., MS - AGRON								
Tuition (50%)	$0	$4,582	$4,719	$9,301				
Subtotal Tuition	***$0***	***$4,582***	***$4,719***	**$9,301**	$9,301	$9,301	$9,301	
Other Direct Costs								
Publication Costs	$0	$600	$1,200	$1,800				
Communication (long distance, fax, DHL, etc.)	$500	$750	$750	$2,000				
Subtotal Other Direct Costs	***$500***	***$1,350***	***$1,950***	**$3,800**	$3,800	$3,800		
Subtotal ISU Direct Costs	***$201,161***	***$342,431***	***$359,258***	***$902,850***				
Indirect Costs								
Overhead 26% (excl. equipment, tuition, all subs)	$2,314	$10,687	$11,120	$24,121	$24,121	$24,121		
ISAR, WSU, Sok) subs	$41,249	$16,066	$1,184	$58,499	$58,499	$58,499		
Subtotal Indirect Costs	**$43,563**	**$26,753**	**$12,305**	**$82,621**				
Total ISU (1 Jan 2010 - 28 Sept. 2012)	***$244,724***	***$369,184***	***$371,563***	***$985,470***	***$184,697***	***$616,816***	***$221,829***	***$224,859***
Cost Share					***41% of direct costs to HC***			
Salary					***49% of direct costs to HC capacity***			
ISU - M. Westgate, PI (15% CY)	$13,956	$18,608	$19,166	$51,730	***45% of total costs for HC capacity***			
ISU - Clerical Staff CSRL (4.75% CY)	$2,461	$3,282	$3,840	$9,583	***36% of US costs for HC capacity***			
WSU - L. Boggs, PI (5% CY)	$2,630	$3,507	$3,595	$9,732	***33% of ISU costs for HC capacity***			
MSU - Kelly (4.5% CY)	$4,638	$6,184	$6,369	$17,191				
Subtotal Salary	***$23,685***	***$31,581***	***$32,970***	***$88,236***				
Becker Underwood Cost Share	**$22,000**	**$22,000**	**$22,000**	**$66,000**				
Total US Cost Share	***$45,685***	***$53,581***	***$54,970***	**$154,236**	**25.0%**	Cost share as % of US costs		

total to US institutions:	$616,816	
required cost share US	$154,204	25%

PULSE CRSP	Year 1	Year 2	Year 3	3-Year totals	
Uganda - Makerere University	9 months	12 months	12 months	33 months	HC capacity building
Personnel					
Research Asst., M.Sc. - Soil Science					
Stipend ($200 * 12 months x 2)	$3,600	$4,800	$4,800	$13,200	
Laboratory Technician - Soil Science					
Part-time, Salary ($100/month)	$900	$1,200	$1,200	$3,300	
Student supervision ($50/student/mo)	$900	$1,200	$1,200	$3,300	
Subtotal Personnel	***$5,400***	***$7,200***	***$7,200***	***$19,800***	$19,800
Fringe N/A					
Travel					
Co-PI to Rwanda and Tanzania					
Airfare (EBB to DAR, KGL)	$1,500	$1,500	$1,500	$4,500	
Lodging ($85 * 7 nights)	$595	$595	$595	$1,785	
Meals ($40 * 7 days)	$280	$280	$280	$840	
Vaccinations & Medical / Evac. Insurance	$250	$250	$250	$750	
Ground Transportation	$100	$100	$100	$300	
Research Asst. # 1 (M.Sc. - Soil Science)					
Field Research Per Diem ($30 * 20 days)	$600	$600	$600	$1,800	
Transportation ($15 * 5 trips)	$75	$75	$75	$225	
Principal Investigator (work at research site)					
Per Diem ($50 * 3 days/mo)	$1,350	$1,800	$1,800	$4,950	
Travel to Research Sites					
Mileage ($.5/km * 4500km/year)	$2,250	$2,250	$2,250	$6,750	
Fuel for in-town research travel	$250	$300	$300	$850	
Subtotal Travel	***$7,000***	***$7,450***	***$7,450***	***$21,900***	
Equipment					
	$0	***$0***	***$0***	***$0***	
Material and Supplies					
Research Materials/Supplies - Soil Science	$2,250	$2,250	$2,250	$6,750	
Computers (3)	$6,000	$0	$0	$6,000	$6,000
Subtotal Materials & Supplies	***$8,250***	***$2,250***	***$2,250***	***$12,750***	
Contractual Services N/A					
Tuition					
Research Asst., M.Sc. -Soil Science					
Tuition and fees	$1,150	$1,500	$1,500	$4,150	
Subtotal Tuition	***$1,150***	***$1,500***	***$1,500***	***$4,150***	$4,150
Other Direct Costs					
Communication (long distance, fax, DHL, etc.)	$300	$300	$300	$900	
Annual Workshops		$1,000	$1,000	$2,000	$2,000
Subtotal Direct Cost	***$300***	***$1,300***	***$1,300***	***$2,900***	
Subtotal Makerere University	***$22,100***	***$19,700***	***$19,700***	***$61,500***	
Indirect Costs					
10%	$2,210	$1,970	$1,970	***$6,150***	$6,150
Cost Share					
N/A	$0	$0	$0	$0	
Total Makerere University	***$24,310***	***$21,670***	***$21,670***	***$67,650***	**$38,100**

designated for capacity building at Makerere

Total (1 Jan 2010 - 28 Sept. 2012) **$67,650**

56.32%

PULSE CRSP	Year 1	Year 2	Year 3	3-Year totals	
Uganda - NaCRRI	9 months	12 months	12 months	33 months	capacity building activities
Personnel					
Research Technician - Agronomy					
Salary ($250 * 12 months)	$2,250	$3,000	$3,000	$8,250	
Research Technicial - Laboratory					
Salary ($250 * 12 months)	$2,250	$3,000	$3,000	$8,250	
Subtotal Personnel	***$4,500***	***$6,000***	***$6,000***	***$16,500***	$16,500
Fringe N/A					
Travel					
Co-PI to Rwanda and Tanzania					
Airfare (international)	$1,500	$1,500	$1,500	$4,500	
Lodging ($85 *7 nights)	$595	$595	$595	$1,785	
Meals ($50 day * 7 days)	$350	$350	$350	$1,050	
Taxis	$200	$200	$200	$600	
Research Technician - Agronomy					
Per Diem ($30 * 40 days*2 technichians)	$2,400	$2,400	$2,400	$7,200	
Transportation ($45 * 30 trips)	$1,350	$1,350	$1,350	$4,050	
Co-PI (work at research site)					
Per Diem ($50 * 3 days/mo)	$1,350	$1,800	$1,800	$4,950	
Travel to Research Sites					
Vehicle maintenance (repair and services)	$750	$1,500	$1,500	$3,750	
Driver's lodging ($30 * 40 nights)	$1,200	$1,200	$1,200	$3,600	
Fuel Cost ($.50 km * 4500 km /year)	$2,250	$2,250	$2,250	$6,750	
Subtotal Travel	***$11,945***	***$13,145***	***$13,145***	***$38,235***	
Equipment					
Equipment	***$0***	***$0***	***$0***	***$0***	$0
Material and Supplies					
Agronomy inputs including soil analysis	$1,500	$1,800	$1,800	$5,100	
Research Materials & Supplies, Agronomy	$1,000	$1,500	$1,500	$4,000	
Computer, monitor, printer, UPS	$2,800	$0	$0	$2,800	$2,800
Subtotal Materials & Supplies	***$5,300***	***$3,300***	***$3,300***	***$11,900***	
Contractual Services N/A					
Contracted labour for production of foundation seeds	$850	$950	$950	$2,750	
Other Direct Costs					
Communication (long distance, fax, DHL, etc.)	$450	$550	$550	$1,550	
Subtotal Other Direct Costs	***$450***	***$550***	***$550***	**$1,550**	
Subtotal NaCRRI	***$23,045***	***$23,945***	***$23,945***	***$70,935***	
Indirect Costs					
Overhead 10%	$2,305	$2,395	$2,395	$7,094	$7,094
Cost Share					
N/A	$0	$0	$0	$0	
Total NaCRRI	***$25,350***	***$26,340***	***$26,340***	***$78,029***	**$26,394**
					designated for capacity building at NaCRRI
Total (1 Jan 2010 - 28 Sept. 2012)		**$78,029**			**33.83%**
					for NaCRRI capacity building

Pulse CRSP	**Year 1**	**Year 2**	**Year 3**	**TOTALS**	**for HC capacity building**
Uganda - VEDCO	9 months	12 months	12 months	33 months	
Personnel					
Field agronomist ($700/mo * 12 mo)		$8,400	$8,400	$16,800	
Advocacy facilitator($500*12 mo)		$0	$6,000	$6,000	
Interns (2) - salary ($50/m each * 12 mo.)		$1,200	$1,200	$2,400	
Subtotal Personnel	**$0**	**$9,600**	**$15,600**	**$25,200**	$25,200
Travel					
In-country Travel					
Field travel per diem ($30 * 40 days)		$1,200	$1,200	$2,400	
Collaboration Rwanda		$500	$500	$1,000	
vehicle maintenance and repair		$960	$960	$1,920	
drivers lodging ($30 * 20 nights)		$600	$600	$1,200	
fuel costs ($.50 km * 1200 km /year)		$600	$600	$1,200	
Subtotal In-Country Travel	**$0**	**$3,860**	**$3,860**	**$7,720**	
Equipment					
Motorcycle		$6,500	$0	$6,500	
Subtotal Equipment	**$0**	**$6,500**	**$0**	**$6,500**	$6,500
Material and Supplies					
Motorcycle fuel & maintenance		$1,800	$1,800	$3,600	
Training, Equip., Materials, Demonstrations		$6,000	$7,000	$13,000	
Computer		$1,250	$0	$1,250	$1,250
Subtotal Materials and Supplies	**$0**	**$9,050**	**$8,800**	**$17,850**	
Contractual Services					
Information dissemination, campaign and advocacy					
launching the bean campaign		$0	$5,000	$5,000	
Policy makers engagements and dialog		$0	$2,000	$2,000	
Production of documents and dissemination		$0	$1,300	$1,300	
Sub-total Contractual Services	**$0**	**$0**	**$8,300**	**$8,300**	
Other Direct Costs					
Communication (internet, long distance, fax, DHL)		$800	$900	$1,700	
Monitoring and evaluation		$1,000	$1,000	$2,000	
Radio air time		$0	$1,000	$1,000	
sub-total other direct costs	**$0**	**$1,800**	**$2,900**	**$4,700**	
Subtotal VEDCO Direct Costs	**$0**	**$30,810**	**$39,460**	**$70,270**	
Indirect Costs					
15% (VEDCO rate)	$0	$4,622	$5,919	$10,541	$10,541
Total - VEDCO	**$0**	**$35,432**	**$45,379**	**$80,811**	**$43,491**

for VEDCO capacity building

53.82%

Total (1 Jan 2010 - 28 Sept. 2012) **$80,811**

PULSE CRSP	**Year 1**	**Year 2**	**Year 3**	**3-Year totals**	**US cost**	for HC capacity building
MSU/Kelly	9 months	12 months	12 months	33 months		
Personnel						
Graduate Research Asst.,MS						
1/2 time stipend	$0	$17,232	$17,749	**$34,981**		
Subtotal Personnel	**$0**	**$17,232**	**$17,749**	**$34,981**		$34,981
Fringe Benefits						
Grad student stipend (10.7%)	**$0**	**$1,854**	**$1,910**	**$3,764**		$3,764
Travel (International)						
Co-PI (1 trip per year)						
Airfare (international, to Rwanda)	$2,800	$2,800	$2,800	$8,400		
Lodging ($85 * 7 days)	$595	$595	$595	$1,785		
Meal Per Diem ($40 * 7 days)	$280	$280	$280	$840		
Vaccinations & Medical / Evac. Insurance	$300	$300	$300	$900		
Ground Transportation	$125	$125	$125	$375		
Visas/Fees	$100	$100	$100	$300	$12,600	
Graduate Assistant Travel						
Airfare	$0	$2,800	$2,800	$5,600		
Visas/Fees	$0	$200	$200	$400		$6,000
Subtotal Travel	***$4,200***	***$7,200***	***$7,200***	**$18,600**		
Equipment						
Equipment	***$0***	***$0***	***$0***	***$0***		
Material and Supplies						
Subtotal Material & Supplies	***$1,000***	***$2,000***	***$2,000***	**$5,000**	$5,000	
Tuition						
Research Asst., MS						
Tuition	$0	$9,438	$9,721	$19,159		
Subtotal Tuition	***$0***	***$9,438***	***$9,721***	**$19,159**		$19,159
Other Direct Costs						
Publication Cost	$0	$600	$1,200	$1,800		
Subtotal Other Direct Costs	***$0***	***$600***	***$1,200***	**$1,800**	$1,800	
SubtotalDirect Costs	***$5,200***	***$38,324***	***$39,780***	**$83,304**		
Indirect Costs						
Overhead MSU (52% exclude equip and tuition)	$2,704	$15,021	$15,630	**$33,355**	$33,355	
Total MSU/Kelly	***$7,904***	***$53,345***	***$55,410***	**$116,659**		
Total (1 Jan 2010 - 28 Sept. 2012)		$116,659			**$52,755**	**$63,904**

54.78% of total to HC capacity building

45% US costs

PULSE CRSP	Year 1	Year 2	Year 3	3-Year totals	US cost	for HC capacity building
ARS/Cichy	9 months	12 months	12 months	33 months		
Personnel	**$0**	**$0**	**$0**	**$0**		$0
Travel (International)						
Co-PI (1 trip per year)						
Airfare (international, to Rwanda)	$2,800	$2,800	$2,800	$8,400		
Lodging ($85 * 7 days)	$595	$595	$595	$1,785		
Meal Per Diem ($40 * 7 days)	$280	$280	$280	$840		
Vaccinations & Medical / Evac. Insurance	$300	$300	$300	$900		
Ground Transportation	$125	$125	$125	$375		
Visas/Fees	$100	$100	$100	$300	$12,600	
Subtotal Travel	***$4,200***	***$4,200***	***$4,200***	**$12,600**		
Equipment						
Equipment	***$0***	***$0***	***$0***	***$0***		
Material and Supplies						
Subtotal Material & Supplies	***$5,000***	***$5,000***	***$5,000***	**$15,000**	$15,000	
Other Direct Costs						
Subtotal Other Direct Costs	***$0***	***$0***	***$0***	**$0**	$0	
SubtotalDirect Costs	***$9,200***	***$9,200***	***$9,200***	***$27,600***		
Indirect Costs						
Overhead ARS (11.11%)	$1,022	$1,022	$1,022	**$3,066**	$3,066	
Total ARS/Cichy	***$10,222***	***$10,222***	***$10,222***	**$30,666**		
Total (1 Jan 2010 - 28 Sept. 2012)		**$30,666**			**$30,666**	**$0**

0% of total to HC capacity building

100% US costs

PULSE CRSP	Year 1	Year 2	Year 3	3-Year totals	US cost	for HC capacity building
ISAR/Rwanda	9 months	12 months	12 months	33 months		
Personnel						
Field Staff ($250/mo*3)	$6,750	$9,000	$9,000	$24,750		$24,750
Undergraduate research asst. ($100/mo *3)	$2,700	$3,600	$3,600	$9,900		$9,900
Subtotal personnel	***$9,450***	***$12,600***	***$12,600***	***$34,650***		
Travel (International)						
Travel						
Co-PI to Uganda and Tanzania						
Airfare (KGL to EBB, DAR)	$1,500	$1,500	$1,500	$4,500		
Lodging ($85 * 7 nights)	$585	$585	$585	$1,755		
Meals ($40 day * 7 days)	$280	$280	$280	$840		
Taxis	$100	$100	$100	$300		
Subtotal Travel	***$2,465***	***$2,465***	***$2,465***	***$7,395***		
Equipment						
Equipment	***$0***	***$0***	***$0***	***$0***		
Material and Supplies						
Subtotal Material & Supplies	***$3,000***	***$3,000***	***$3,000***	**$9,000**		$9,000
Other Direct Costs						
Communication (long distance, fax, DHL, etc.)	$300	$300	$300	$900		
Field preparation/maintenance	$1,000	$1,000	$1,000	$3,000		
Subtotal Other Direct Costs	***$1,300***	***$1,300***	***$1,300***	***$3,900***	$3,900	
SubtotalDirect Costs	***$16,215***	***$19,365***	***$19,365***	***$54,945***		
Indirect Costs						
N/A	$0	$0	$0	**$0**	$0	$0
Total ISAR/Rwanda	***$16,215***	***$19,365***	***$19,365***	**$54,945**		
Total (1 Jan 2010 - 28 Sept. 2012)		$54,945			**$3,900**	**$43,650**

79.44% of total to HC capacity building

7% US costs

PULSE CRSP	Year 1	Year 2	Year 3	3-Year totals	US cost	US for HC capacity building
ARS/Miklas	9 months	12 months	12 months	33 months		
Personnel						
Graduate Research Asst., MS-WSU (50% time)						
Stipend	$13,538	$18,592	$19,150	**$51,280**		$51,280
Fringe Benefits						
Grad. Research Asst. (13.2%)	$1,787	$2,454	$2,528	**$6,769**		$6,769
Travel (International)						
Co-PI (1 trip per year)						
Airfare (international, to Uganda, Rwanda, Tanzania)	$2,500	$2,500	$2,500	$7,500		
Lodging ($85 * 7 days)	$595	$595	$595	$1,785		
Meal Per Diem ($40 * 7 days)	$280	$280	$280	$840		
Vaccinations & Medical / Evac. Insurance	$300	$300	$300	$900		
Ground Transportation	$125	$125	$125	$375		
Visas/Fees (2 countries)	$100	$100	$100	$300	$11,700	
Graduate Research Assistant to/from U.S.						
Airfare	$2,500	$2,500	$2,500	$7,500		
Lodging & Meals Per Diem ($50/d * 21 days)	$0	$1,050	$1,050	$2,100		
Ground Transportation	$0	$300	$300	$600		
Visas/Fees	$200	$200	$200	$600		$10,800
Subtotal Travel	***$6,600***	***$7,950***	***$7,950***	**$22,500**		
Equipment						
Equipment	***$0***	***$0***	***$0***	**$0**		
Material and Supplies						
Research supplies	$5,000	$5,000	$5,000	$15,000		
Subtotal Material & Supplies	***$5,000***	***$5,000***	***$5,000***	**$15,000**	$15,000	
Tuition						
Research Asst.,MS-WSU						
Tuition (non-resident)	$7,379	$10,134	$10,438	**$27,951**		$27,951
Other Direct Costs						
Communication (long distance, fax, DHL, etc.)	$300	$300	$300	$900		
Field space rental	$500	$500	$500	$1,500		
Subtotal Other Direct Costs	***$800***	***$800***	***$800***	**$2,400**	$2,400	
Subtotal ISU Direct Costs	***$35,104***	***$44,930***	***$45,866***	**$125,900**		
Indirect Costs						
ARS overhead (11.11%)	$3,900	$4,992	$5,096	$13,987	$13,987	
Total ARS/Miklas	***$39,004***	***$49,922***	***$50,961***	***$139,887***	**$43,087**	**$96,800**
Grand Total (1 Jan 2010 - 29 Sept. 2012)		**$139,887**			**31%**	**69.20%**
					US costs	US to HC capacity building

PULSE CRSP	Year 1	Year 2	Year 3	3-Year totals	US cost	US for HC capacity building
WSU/Boggs	9 months	12 months	12 months	33 months		
Personnel						
1 mo faculty salary	$4,384	$6,021	$6,201	**$16,606**	$16,606	
Technician (25%FTE)	$8,816	$12,107	$12,471	**$33,394**	$33,394	
Subtotal Personnel	**$13,200**	**$18,128**	**$18,672**	**$50,000**		
Fringe Benefits						
Faculty (31%)	$1,359	$1,866	$1,922	**$5,148**	$5,148	
Technician (32%)	$2,821	$3,874	$3,991	**$10,686**	$10,686	
Subtotal Fringe Benefits	**$4,180**	**$5,741**	**$5,913**	**$15,834**		
Travel (International)						
Co-PI (1 trip per year)						
Airfare (international, to Uganda, Rwanda, Tanzania)	$2,500	$2,500	$2,500	$7,500		
Lodging ($85 * 7 days)	$595	$595	$595	$1,785		
Meal Per Diem ($40 * 7 days)	$280	$280	$280	$840		
Vaccinations & Medical / Evac. Insurance	$300	$300	$300	$900		
Ground Transportation	$125	$125	$125	$375		
Visas/Fees (2 countries)	$100	$100	$100	$300	$11,700	
Subtotal Travel	***$3,900***	***$3,900***	***$3,900***	**$11,700**		
Equipment						
Equipment	***$0***	***$0***	***$0***	**$0**		
Material and Supplies						
Research supplies	$5,000	$5,000	$5,000	$15,000		
Subtotal Material & Supplies	***$5,000***	***$5,000***	***$5,000***	**$15,000**	$15,000	
Other Direct Costs						
Communication (long distance, fax, DHL, etc.)	$300	$300	$300	$900		
Publication Costs	$0	$600	$1,200	$1,800		
Field space rental	$500	$500	$500	$1,500		
Subtotal Other Direct Costs	***$800***	***$1,400***	***$2,000***	**$4,200**	$4,200	
Subtotal ISU Direct Costs	***$27,080***	***$34,169***	***$35,485***	***$96,734***		
Indirect Costs						
WSU overhead (49.8%, exclude equip,tuition)	$13,486	$17,016	$17,671	$48,173	$48,173	
Total WSU/Boggs	***$40,566***	***$51,185***	***$53,156***	***$144,907***	**$144,907**	**$0**
Total (1 Jan 2010 - 28 Sept. 2012)		**$144,907**			**100%**	**0%**
					US costs	US to HC capacity building

PULSE CRSP	Year 1	Year 2	Year 3	3-Year totals	US cost	for HC capacity building
Sokoine/Tanzania	9 months	12 months	12 months	33 months		
Personnel						
Research Asst., M.Sc.						$0
Stipend ($400/mo * 2)	$7,200	$9,600	$9,600	$26,400		$26,400
Field Technicians						
Salary ($250/mo * 2)	$4,800	$6,000	$6,000	$16,800		$16,800
Subtotal Personnel	***$12,000***	***$15,600***	***$15,600***	***$43,200***		
Travel						
Co-PI to Uganda and Rwanda						
Airfare (DAR to EBB, KGL)	$1,500	$1,500	$1,500	$4,500		
Lodging ($85 * 7 nights)	$585	$585	$585	$1,755		
Meals ($40 day * 7 days)	$280	$280	$280	$840		
Taxis	$100	$100	$100	$300		
Microbiologist training in U.S.						
Airfare (international)	$2,500	$0	$0	$2,500		
Lodging ($85 * 15 nights)	$1,275	$0	$0	$1,275		
Meals ($40 day * 15 days)	$600	$0	$0	$600		
Ground transportation	$100	$0	$0	$100		
Visas/Fees	$100	$0	$0	$100		$4,575
Co-PI (work at research site)						
Per Diem ($50 * 3 days/mo)	$1,350	$1,800	$1,800	$4,950		
Travel to Research Sites						
Fuel Cost ($.50 km * 4500 km /year)	$2,250	$2,250	$2,250	$6,750		$6,750
Subtotal Travel	***$10,640***	***$6,515***	***$6,515***	***$23,670***		
Equipment						
Equipment	***$0***	***$0***	***$0***	***$0***		
Material and Supplies						
Research Materials/Supplies	$3,000	$3,000	$3,000	$9,000		
Subtotal Material & Supplies	***$3,000***	***$3,000***	***$3,000***	***$9,000***		$9,000
Tuition						
Research Asst., M.Sc.						
Tuition and fees	$2,500	$3,600	$3,600	$9,700		
Subtotal Tuition	***$2,500***	***$3,600***	***$3,600***	***$9,700***		$9,700
Other Direct Costs						
Communication (long distance, fax, DHL, etc.)	$300	$300	$300	$900		
Field space rental	$250	$250	$250	$750		
Subtotal Other Direct Costs	***$550***	***$550***	***$550***	***$1,650***	$1,650	
SubtotalDirect Costs	***$28,690***	***$29,265***	***$29,265***	***$78,220***		
Indirect Costs						
N/A	$0	$0	$0	**$0**	$0	$0
Total Sokoine/Tanzania	***$28,690***	***$29,265***	***$29,265***	***$87,220***		
Total (1 Jan 2010 - 28 Sept. 2012)		**$87,220**			**$1,650**	**$73,225**

83.95% of total to HC capacity building

2% US costs

DRY GRAIN PULSES CRSP WORKPLAN FORMAT

(FY 10)

Project Title:

Enhancing biological nitrogen fixation (BNF) of leguminous crops grown on degraded soils in Uganda, Rwanda, and Tanzania

Lead U.S. Principal Investigator and University:

Mark E. Westgate
Director, Center for Sustainable Rural Livelihoods
Iowa State University
110 Curtiss Hall
Ames, IA 50011
515-294-9106
westgate@iastate.edu

Collaborating Host Country and U.S. PIs and Institutions:

Mateete Bekunda: Makerere University Department of Soil Science, Kampala, Uganda. ph: +256-414-542-277, Fax: +256-414-531-641, mateete@agric.mak.au.ug

Lynne Carpenter-Boggs: Washington State University, Director Center for Sustaining Agriculture and Natural Resources, Dept. Crop and Soil Sciences, (509) 335-1553. lcboggs@wsu.edu

Karen Cichy: USDA-ARS, Sugarbeet and Bean Research Unit, East Lansing, MI, 48824-1325 ph: 517- 353-9262 ext. 4, Fax: 517- 337-6782, karen.cichy@ars.usda.gov

James D. Kelly: Michigan State University, Department of Crop & Soil Sciences, East Lansing, MI 48824-13254. Ph: 517-355-0271 x 1181, Fax: 517-353-5174. kellyj@msu.edu

Phillip Miklas: USDA-ARS, Vegetable and Forage Crop Research, Prosser, WA 99350 ph: 509-786-9258; cell: 509-786-8492; Fax: 509-786-9277; phil.miklas@ars.usda.gov

Henry Kizito Musoke: Volunteer Efforts for Developmental Concerns, Kampala, Uganda. ph: +256-414-270-598, henrykizito@vedco.or.ug

Susan Mchimbi-Msolla: Crop Science and Production, Sokoine University of Agriculture, Morogoro, Tanzania, nchimbi@giant.suanet.ac.tz

Augustine Musoni: Institit des Sciences Agronomiques du Rwanda (ISAR), Nygatare Research Station, fmusoni@yahoo.com

Eda Reinot: Becker Underwood, Inc. P.O. Box 667, Ames, IA, 50010, USA ph: 800-232-5907, Fax: 515-232-5961, eda.reinot@BeckerUnderwood.com

Hamisi Tindwa: Department of Soil Science, Sokoine University of Agriculture, P. O. Box 3008, Morogoro, Tanzania, tindwa@yahoo.com

Michael Ugen: National Crops Research Institute, Namulonge, Uganda. ph: +256-414-573-016, Fax: +256-752-726-554, michaelugen@yahoo.com

Peg Armstrong-Gustafson: (collaborator) amson technology l.c., 4010 University Avenue, Des Moines, IA 50311. Ph: 515-279-7767, Fax: 515-255-6101, peg@tmgmanagement.com

I. Project Problem Statement and Justification: *(Please describe constraint to be addressed, its importance, and status of research progress to date) Maximum 4000 characters*

Common beans are the most important legume crop in Uganda, Rwanda and Tanzania occupying a very large proportion of land devoted to legumes. For example, over 45% of the protein intake by Ugandans comes from beans providing 25% of dietary calories. Likewise, over 75% of rural households in Tanzania depend on beans for daily subsistence. Common bean is an important source of protein for low-income families in rural and urban areas providing about 38% of utilizable protein and 12-16% of daily caloric requirements. Improved bean production in Uganda, Rwanda, and Tanzania offers unique opportunities to address the deteriorating food security situation there and elsewhere in sub-Saharan Africa.

Loss of soil fertility is recognized as the most important constraint to food security in sub-Saharan Africa. Low levels of nitrogen and phosphorous are the primary fertility constraints. Because soils are increasingly becoming degraded, an affordable means of improving soil fertility and productivity of nitrogen-accumulating crops is critical. Properly nodulated legumes can leave up to 350 kg nitrogen per hectare in the soil, depending on effectiveness of the nitrogen fixation process, type of legume, length of time the legume is grown, soil nutrient levels and nitrogen already available. Because inoculum is much cheaper than inorganic fertilizer, use of inoculants can provide an affordable and sustainable way to improve production of nitrogen fixing legumes.

Numerous studies have shown the potential of improving legume productivity by enhancing nodulation through proper use of a biological inoculant. Yet field trials in sub-Saharan Africa have provided mixed results. Likely causes for variable response include poor quality control of inoculant formulation, failure to compete with local rhizobia, inhibition by indigenous microbial flora, or failure of the inoculant species to survive in low pH and/or droughty soils. Modern inoculant formulations designed to deliver a synergistic suite of biological and chemical enhancements for biological nitrogen fixation under stressful soil conditions have
been made available to our collaborative research project by Becker Underwood, Inc. Becker Underwood's **BioStacked®** inoculant technologies for legume crops consist of well stabilized *Rhizobium* bacteria, a biological fungicide, plant growth promoting rhizobacteria, and other biologically derived proprietary biostimulant technologies which promote plant growth and overall plant health. These stacked inoculants have been shown to decrease chemical fertilizer use in crop rotations, increase legume yields, suppress root diseases, and improve rhizosphere conditions for root growth. We anticipate they will be particularly effective under degraded soil conditions encountered on small-landholder farms in Uganda, Rwanda, and Tanzania.

To optimize BNF, it also is essential to identify germplasm with greatest capacity for this trait. Although common bean has the potential for BNF, it is reported to have the lowest percent N_2 derived from N fixation among legumes. Genetic variation for BNF has been reported within the primary gene pool, and lines with superior BNF have been identified. Superior BNF lines such as Puebla 152 and BAT 477 have been used as parents in crosses to generate populations for genetic studies and to examine selection and breeding for improved BNF. Few breeding lines with improved BNF, however, have been developed. The optimal selection environment for BNF is under low soil N since application of nitrogen fertilizer reduces N fixation capacity. Marker-assisted selection (MAS) under such conditions is highly sought after as a means to facilitate breeding for traits like BNF with low to moderate heritability.

Molecular mapping in combination with germplasm screening and MAS would be a powerful way to improve locally adapted germplasm for BNF in a host country. Recombinant inbred populations currently available are ideal for tagging and mapping genes that influence quantitative traits (QTLs). Few QTLs associated with BNF, however, have been identified to date, and those identified have not been validated. Identifying and validating QTL-conditioning enhanced BNF would be a major contribution to the scientific community, and represent a major step toward effective marker-assisted selection for BNF.

Our BNF-CRSP program objectives address the need to identify production systems that enhance BNF, develop germplasm that benefits most from symbiotic inoculation, and aggressively share this new information with small landholder farmers in sub-Saharan Africa whose health and well being depend heavily on legume production.

II. Planned Project Activities in the Workplan Period (January 1 to September 28, 2010)

Objective 1:

The ***first strategic aim*** is to improve BNF and seed yields of common beans significantly using superior seed inoculants such as Becker Underwood's BioStacked® inoculant through farmer-based experimentation and adoption of innovative production techniques.

Sub-Objective1a: *To evaluate effectiveness of biologically stacked inoculants on local and improved germplasm.* We expect to identify the genotypes, inoculants, and research demonstration sites at HC institutions. Complete two cropping seasons to quantify the yield advantage of inoculation, and initiate the analysis of plant/soil/weather information to identify unique G x E responses.

Sub-Objective 1b: *To quantify genotype by environment interactions and constraints to enhancing BNF of inoculated plants.* We expect to complete the soils physical and chemical characterization for all test sites, established field sampling and laboratory procedures to quantify BNF, and initiate the soil DNA extraction and analysis for indigenous rhizobia strains.

Collaborators:

Becker Underwood, Inc. (BU) is an international developer of bio-agronomic and specialty products. The company is the leading global producer of inoculants, beneficial nematodes, and a wide range of agricultural and horticultural products. BU will produce the **Bio-stacked**® legume inoculants (see http://www.beckerunderwood.com/en/newsreleases/100104) for distribution to HC and US researchers in this CRSP project. BU has worked with numerous universities around the world and has implemented quality assurance programs and technical support to ensure proper formulation and field application.

Approaches and Methods:

In Rwanda, Tanzania, and Uganda multiple sites will be used to evaluate popular cultivars of both determinate bush and indeterminate vine growth habit types for response to different rhizobia-inoculum treatments. Site selection will be defined by where beans are already grown and consumed, and will encompass the range of soil types and weather conditions documented at each site (1c). Four cultivars will be chosen representing different market types, evolutionary origin, in addition to the different plant types. For example in Tanzania popular cultivars (genotypes) representing the major speckled purple-Kablanketi (Type III, Andean), yellow-Njano (Type I, Andean), Red Kidney (Type I, Andean), and Carioca (Type II, MA) market types would be tested. Adapted non-nodulating genotype(s) (~BAT477, DOR364 from CIAT) will be useful for this and subsequent BNF trials as checks. Rhizobia inoculum treatments will include **Bio-stacked**®, other commercially available inoculants (e.g. Bio-N-Fix), and no inoculum. The **Bio-stacked®** inoculum from Becker-Underwood, Inc. is formulated for enhanced BNF under stressful soil conditions (see product note from Becker Underwood, Inc.). A RCBD with four replications, and moderately large plot size will be used (4 to 6 rows wide by 5 to 7 m length), Established research station sites will be used initially and expanded to on farm and community co-op trials using select genotypes which exhibit greatest BNF response. It is envisioned by year 2 that HC Extension personnel, NGO, or other business partners will be identified to help develop and implement strategies for technology dissemination to numerous farmers (Strategic Aim 3). A low N treatment will be targeted the first few years and expanded to include low and high N in subsequent years as HC and US project participants gain training and experience with experimental protocols and procedures.

Standard agronomic practices will be employed in the controlled location studies (Opio et al 2001). Incidence and severity of disease and pest damage will be recorded to determine their indirect impact on N-fixation, plant performance and response to inoculant treatments. Agronomic data collected for each treatment includes: 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, and economic return on investment in the inoculant technology. The latter will be assessed by careful record keeping of agronomic input costs and grain sales. Thermometers, rain gauges, and soil moisture sensors will be positioned on site for recording local weather conditions. Plant N (multiple subsamples per plot), seed N (multiple subsamples per plot), biomass, and seed yield at harvest maturity on a plot basis will be used to measure BNF response of the different genotypes and treatments. These measurements are the most affordable in terms of cost and labor and correlate well with seasonal BNF. Select genotypes or treatments with large or interesting BNF responses, could be further characterized by evaluation of root biomass, nodulation number and mass, isotope assays, or post crop response. Data collection will be coordinated by HC scientists and students.

Objective 2:

The ***second strategic aim*** is to examine the inheritance of genetic and environmental variation in BNF in common bean, and to identify molecular markers associated with QTL conditioning for enhanced BNF.

Sub-Objective 2a: *To identify parental materials for inheritance studies of BNF.* We expect to obtain the experimental and adapted common bean germplasm from national and international bean breeding programs, complete the parental crosses to generate mapping populations, complete initial screening of bean germplasm for increased BNF in low soil N +/- inoculants in HC field trials, and initiate greenhouse screening trials on selected lines for BNF response to inoculant.

Sub-Objective 2b: *To phenotype existing mapping populations for BNF response, populate with molecular markers, and conduct QTL analysis.* We expect to increase seed of selected mapping populations for QTL analysis, complete the initial phenotyping for divergent response of BNF in greenhouse, and plant parental lines and selected populations for BNF in the field at both US and HC institutions.

Collaborators:

Host country field managers at NaCRRI, ISAR, and SUA and experiment station managers at ISU, MSU, and WSU in the US.

Approaches and Methods:

We will collect and increase seed of representative commercial market types and advanced breeding lines from host countries Rwanda, Uganda, Tanzania and the US; lines known to differ for BNF (BAT 477, Pueblo 152, CAL 143, RIZ lines, etc.); super-nodulating and non-nodulating; and select parents of existing mapping populations; in total about 50 materials. These materials will be tested for BNF response under low N conditions in the field (single locations in Rwanda, Tanzania, and Uganda) and greenhouse (US-WSU). The materials will be split into groups of 30 genotypes each. The plan is to test half the lines in Rwanda and the other half in Tanzania in Year 1, and vice versa in Year 2. The plots will be smaller (single row, 3 m length) and with fewer reps (2 to 3).

The materials will also be tested in the greenhouse in the US (WSU and ISU). Single plants will be sown in 1 liter pots containing 50% sand/potting soil mixture, N-deficient fertilizer solution, and arranged in RCBD with 5 replications, and at least two treatments – non-inoculated and inoculated (with mixture of rhizobia strains). The materials will be similarly grouped (20 to 30 materials each group) for the GH experiments conducted over a period of two years. BNF response will be measured by plant N (multiple subsamples per plot), seed N (multiple subsamples per plot), biomass, and seed yield at harvest maturity for field studies. For greenhouse studies, plant biomass on shoot/root basis, nodulation score, and plant N concentration at 12 wks after planting will be used to measure BNF response.

Crosses will be conducted between parents with contrasting BNF response (low vs. high) to initiate generation of genetic mapping populations (recombinant inbred line – RIL populations). It takes three years to obtain mapping populations and increase seed for F5 or later derived RILs for replicated multi-site testing. Four populations will be developed (two by ARS-Prosser and two by ARS-East Lansing) consisting of approximately 150 lines each. Efforts will be made to cross high X low parents that are adapted for each country (Rwanda, Tanzania, Uganda, and US). Basic agronomic information will be collected, e.g. biomass at flowering, biomass at harvest, shoot N at harvest, seed yield, seed N, HI and NHI. From these RIL populations we expect to obtain advanced breeding lines with good BNF, good agronomic performance, and identify acceptable HC market types.

Given the three year time frame necessary to generate new mapping populations, existing mapping populations with promise for mapping QTL conditioning BNF response will be tested in HC and US. Two existing mapping populations will be phenotyped for BNF response (EP=Eagle/Pueblo 158, 78 F8 RILs, 357 markers; RC=Rojo/CAL 143, 147 F5 RILs, no markers). Seed of the RILs will be increased (January-May, Year 1, EP by ARS, East Lansing and RC by ARS-Prosser). The parents for EP, RC, and a few other bi-parental populations will be tested in the GH to confirm divergent phenotypic response for BNF (January – Year 1, WSU). Given divergent response for the parents the EP population will be tested at two sites (ARS-Prosser and -East Lansing) under low N, using 1-2 row plots and 3-4 reps as determined by seed availability, using a RCBD design (summer Year 1).

Objective 3:

The ***third strategic aim*** is to improve the productivity, profitability, and sustainability of agricultural systems on degraded soils through effective dissemination of new information and technologies to small-landholder farmers.

Collaborators:

PELUM is an a network of 207 civil society organizations in Eastern, Central and Southern Africa working towards poverty eradication, food security, and sustainable community development (see http://www.pelumrd.org/).

Approaches and Methods:

Although no funds are allocated specifically for information dissemination in this funding period, we recognize that training, demonstrations, and advocacy efforts must be conducted essentially on a continual basis.

We will disseminate information about the application of inoculant technologies directly to small landholder farmers through our partner connections in PELUM. PELUM's work focuses on enhancing farmers' livelihoods through sustainable agriculture, seed and food security. PELUM has active networks in 10 countries: Botswana, Kenya Lesotho, Malawi, Rwanda, South Africa, Tanzania, Uganda, Zambia and Zimbabwe. As a network their strength lies in efficient and effective collaboration and communication.

For this funding period, outreach activities will include training VEDCO/SUA/ISAR staff on the use and potential benefits of inoculation technology, selecting farmers to participate in on-farm trials, sensitizing farmers and farmer groups about inoculant technology, identify local bean varieties to include in the field trials, training farmers on proper methods for conducting on-farm trials, data management, economic returns, and supporting data collection for site characterization. This will be completed through on-farm demonstrations, mass media, field schools, and local forums that the PELUM network has established in the region.

Sub-objective 3a: *To improve farmer awareness of inoculation technologies*, we expect to have the activities listed above underway, and to have completed farmer evaluations of knowledge and benefits of inoculation and BNF.

Sub-objective 3b: *To conduct on-farm demonstrations comparing inoculant strategies,* we expect to have the design and format field demonstrations of inoculant technology at HC research stations established.

Sub-objective 3c: *To strengthen farmers' collective capabilities to purchase inoculants and incorporate them into a profitable and sustainable system for small landholders,* we expect to have Field Extension Agronomists at HC institutions trained in benefits of BNF and inoculant use.

Objective 4: *"Increase the capacity, effectiveness and sustainability of agriculture research institutions which serve the bean and cowpea sectors in developing countries"*

Capacity building in terms of degree training includes formal education for seven (7) MS level graduate students and five (5) undergraduate students from host countries. Two graduate students will be trained in the Soil Science Department at Makerere University under the direction of Dr. Mateete

Bekunda, Professor of Soil Science. Two graduate students will be trained at Sokoine University of Agriculture under the direction of Dr. Susan Mchimbi, Associate Professor of Plant Breeding and Genetics. One HC graduate student will be trained at Washington State University under the co-direction of Dr. Lynn Carpenter-Boggs, Assistant Professor of Soil Microbiology and Biochemistry, and Dr. Phillip Miklas, Legume Research Geneticist with USDA-ARS. One HC graduate student will be trained at Iowa State University under the direction of the program PI, Dr. Mark Westgate, Professor of Crop Production and Physiology. And one HC graduate student will be trained at Michigan State University under the co-direction of Dr. Jim Kelly, Professor of Crop Breeding and Genetics, and Dr. Karen Cichy, Research Geneticist with USDA-ARS.

It is expected that HC students training in the US will spend some time conducting practical field work in their home country. The student enrolled at Michigan State University in Crop and Soil Sciences, for example, will conduct in depth studies on promising lines indentified in Rwanda field trials and will develop linkage maps of a recombinant inbred line population to conduct QTL analysis of BNF capacity. Once the student has completed his or her coursework at MSU, he or she will spend an estimated 4 months in Rwanda gathering data on BNF variability in the RIL population. The student will then return to MSU to complete degree requirements. It also is expected that HC students trained at US institutions will return to their home countries to engage in research in their chosen field.

Capacity building in terms of non-degree training include formal internships for five (5) undergraduate students and training of HC laboratory technicians, field agronomists and extension staff on use and agricultural benefits of seed inoculants. In the first year, three undergraduate students will be assigned to the three field sites in Rwanda to assist in germplasm evaluation. These students will be supervised by Dr. Augustine Musoni, and interact directly with US PIs during their visits to the field sites. Two undergraduate intern will be assigned to work with VEDCO staff on information dissemination in Year 2 and 3.

An additional short-term training activity is planned for SUA microbiologist Mr. Hamisi Tindwa in the microbiology lab of Dr. Lynne Carpenter-Boggs at Washington State University. The intent of this training activity is for Mr. Tindwa to learn about modern molecular and biochemical methods to identify and quantify soil microflora.

Training/Capacity Building Workplan Format (January 1 to September 28, 2010)

Degree Training:

First and Other Given Names	TBD
Last Name	
Citizenship	Uganda
Gender	
Training Institution	Makerere University
Supervising CRSP PI	Bekunda
Degree Program for training	M.S.
Program Areas or Discipline	Soil Science
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID?	YES
Host Country Institution to Benefit from Training	Makerere University
Thesis Title/Research Area	TBD
Start Date	Summer 2010

Projected Completion Date	Summer 2012
Training status (Active, completed, pending, discontinued or delayed)	pending
Type of CRSP Support (full, partial or indirect) for training activity	full

First and Other Given Names	TBD
Last Name	
Citizenship	Uganda
Gender	
Training Institution	Makerere University
Supervising CRSP PI	Bekunda
Degree Program for training	M.S.
Program Areas or Discipline	Soil Science

If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? YES

Host Country Institution to Benefit from Training	Makerere University
Thesis Title/Research Area	TBD
Start Date	Summer 2010
Projected Completion Date	Summer 2012
Training status (Active, completed, pending, discontinued or delayed)	pending
Type of CRSP Support (full, partial or indirect) for training activity	full

First and Other Given Names	TBD
Last Name	
Citizenship	Tanzania/Rwanda/Uganda
Gender	
Training Institution	Washington State University
Supervising CRSP PI	Carpenter-Boggs, Miklas
Degree Program for training	M.S.
Program Areas or Discipline	Soil Microbiology/Biochemistry

If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? YES

Host Country Institution to Benefit from Training	Sokoine University Agriculture
Thesis Title/Research Area	TBD
Start Date	Summer 2010
Projected Completion Date	Summer 2012
Training status (Active, completed, pending, discontinued or delayed)	pending
Type of CRSP Support (full, partial or indirect) for training activity	full

First and Other Given Names	TBD
Last Name	
Citizenship	Tanzania
Gender	
Training Institution	Sokoine University Agriculture
Supervising CRSP PI	Mchimbi, Tindwa
Degree Program for training	M.S.
Program Areas or Discipline	Breeding and Genetics

If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? YES	
Host Country Institution to Benefit from Training	Sokoine University Agriculture
Thesis Title/Research Area	TBD
Start Date	Summer 2010
Projected Completion Date	Summer 2012
Training status (Active, completed, pending, discontinued or delayed)	pending
Type of CRSP Support (full, partial or indirect) for training activity	full

First and Other Given Names	TBD
Last Name	
Citizenship	Tanzania
Gender	
Training Institution	Sokoine University Agriculture
Supervising CRSP PI	Mchimbi, Tindwa
Degree Program for training	M.S.
Program Areas or Discipline	Breeding and Genetics
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? YES	
Host Country Institution to Benefit from Training	Sokoine University Agriculture
Thesis Title/Research Area	TBD
Start Date	Summer 2010
Projected Completion Date	Summer 2012
Training status (Active, completed, pending, discontinued or delayed)	pending
Type of CRSP Support (full, partial or indirect) for training activity	full

Short-term Training:

Type of training	Visiting Scientist
Description of training activity	Lab and field activities
Location	Washington State University
Duration	14 days
When will it occur?	Summer-fall 2010
Participants/Beneficiaries of Training Activity:	Mr. Hamisi Tindwa
Anticipated numbers of Beneficiaries (male and female)	1
PI/Collaborator responsible for this training activity	Dr. Lynn Carpenter-Boggs
List other funding sources that will be sought (if any)	
Training justification	To coordinate techniques on soil microflora identification and quantification

Type of training	Staff and farmer education on inoculant technologies, management and benefits
Description of training activity	Formal lecture and open discussion
Location	Varied, depending on staff and farmer group locations
Duration	4 hours
When will it occur?	Spring-summer 2010

Participants/Beneficiaries of Training Activity:	Extension staff, farmer groups
Anticipated numbers of Beneficiaries (male and female)	50 male, 50 female
PI/Collaborator responsible for this training activity	Westgate, Musoke
List other funding sources that will be sought (if any)	
Training justification	Adaptation of new technology requires user understanding of appropriate use, management, and pitfalls.

III. Contribution of Project to Target USAID Performance Indicators:

Graduate and undergraduate training is central to this project. Supporting advanced education for HC students with world-class scientist and training field technicians will contribute directly to HC capacity building.

Training of farmers and farmer groups on technologies to improve bean productivity will contribute to income and food security of small landholder farmers.

Improved on-farm productivity will enhance marketing opportunities for farmer associations.

Advancing inoculant technology for legumes will promote agricultural enterprise associated with inoculant production and sales.

IV. Target Outputs:

New knowledge on bean germplasm x inoculant x environment interactions to inform ongoing variety development programs in the U.S. and host countries about specific improvements in BNF needed to realize enhanced yield, nutritional value, and marketability of dry beans and other pulses.

Seven graduate students and (at least) five undergraduate students trained in agricultural research and extension.

Methods and conditions for profitable use of superior legume inoculants determined.

V. Engagement of USAID Field Mission(s)

Work in this project is closely aligned with USAID's goals of increasing agricultural production, enhancing the sustainable use of natural resources, reduce threats to biodiversity, and improve food security. USAID assistance seeks to increase and diversify commercial agricultural production and increase Uganda's competitiveness in local and international markets. This project will contribute to USAID's mission of strengthening producer organizations by working with individual farmers and farmer groups. In particular, the CRSP project explores the benefits of modern agricultural (micro-biological) technology to increase agricultural productivity and income to small landholder farmers.

Outcomes of this CRSP program directly support the USAID Rwanda Mission program for economic growth and expanded opportunities in rural areas, increase household incomes, employment, and corresponding rural financial services for targeted communities. The central Mission goal of increasing agricultural productivity is promoted by developing sustainable production practices to increase legume yields through training and access to modern agricultural inputs. Knowledge and experiences gained through VEDCO's dissemination activities in Uganda provide an excellent model for disseminating information to farmer groups in rural communities in Rwanda.

The major objectives of the USAID Mission in Tanzania is to stabilize population growth, prevent the spread of HIV/AIDS, arrest environmental degradation and promote democracy, human rights and broad-based national and regional economic growth. CRSP activities Tanzania will contribute to USAID's mission of strengthening producer organizations by working with individual farmers and farmer groups. Through our participatory approach, this program will disseminate new knowledge about sustainable agricultural technologies and build capacity of farmer groups and associations. This program also contributes directly to the US Presidential Initiative to End Hunger In Africa, which is designed to help Africa countries reduce hunger in half by 2015.

VI. Networking Activities with Stakeholders:

We anticipate our direct interaction with these programs will expand the impact of current CRSP-funded variety development programs in the US. Dr. Phil Miklas has ongoing research activities with the bean breeding program at the Sokoine University of Agriculture. This connection will provide direct linkage between US and Tanzanian scientists using molecular genetics tools to select for improved bean germplasm. Prof. Jim Kelly at Michigan State University has ongoing germplasm development projects with colleagues at the Institit des Sciences Agronomiques du Rwanda/ISAR in Rwanda. Our research team has ongoing collaboration with bean breeders at the Rwanda through PABRA (CIAT and ECABREN) in the area of exchange of germplasm, esp. snap beans, climbing beans and root rot resistant bean lines.

Dr. Michael Ugen and colleagues at NaCRRI in Uganda work in collaboration with CIAT and ECABREN (East and Central Africa Bean Research Network) under PABRA (Pan African Bean Research Alliance) for 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.

Through VEDCOs leadership in the PELUM network, we will work with farmers groups and associations and agribusiness concerns in Rwanda, Tanzania, Uganda, and Kenya 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. Involving local leadership is a key component of this approach to mobilization of farmers and local agricultural concerns.

CSRL uses 'Learning Forums' regularly to interact with various institutions and service providers (governmental and non-governmental), private sector traders, agricultural processors and distributors etc., to gain and maintain appropriately broad perspectives on key issues in production, the value chain, benefit from their special expertise, and build new collaborative relationships for high levels of success.

VII. Leveraging of CRSP Resources:

US Institutions have committed $154,236 in 'in-kind' dollars towards the successful completion of the projects outlined in this proposal. Our industrial partner, Becker Underwood, Inc (BU) is contributing about 43% of this amount. This level of commitment from an industry partner is significant and clearly indicative of the potential for leveraging additional industry funds to expand the program. Through its collaboration with the Lutheran World Relief, Becker Underwood is currently supporting the expansion of Inoculant Technology in Burkina Faso, Niger, Tanzania, Kenya, and Mali. This activity involves local seed companies and is designed to minimize dependence on inorganic N fertilizer. While a formal commitment of funds from the CSRL program is not possible, many of the management, development, and research activities conducted by the Center with our partners in Sub Saharan Africa Uganda support the research and development activities outlined in this proposal.

VIII. Contribution of Project to Target USAID Performance Indicators:

(At this time—leave this field blank)

IX. Project Benchmarks (semi-annual indicators of progress):

(At this time –leave this field blank)

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

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

Project Title: **Enhancing biological nitrogen fixation (BNF) of leguminous crops grown on degraded soils in Uganda, Rwanda, and Tanzania**
Lead U.S. PI and University: **Mark E. Westgate, Iowa State University**
Host Country(s): **Rwanda, Tanzania, Uganda**

Output Indicators	**2010 Target**	**2010 Actual**
	(October 1 2009-Sept 30, 2010)	
Degree Training: Number of individuals enrolled in degree training		
Number of women	4	
Number of men	4	
Short-term Training: Number of individuals who received short-term training		
Number of women	50	
Number of men	50	
Technologies and Policies		
Number of technologies and management practices under research	3	
Number of technologies and management practices under field testing	3	
Number of technologies and management practices made available for transfer	0	
Number of policy studies undertaken	0	
Beneficiaries:		
Number of rural households benefiting directly	100	
Number of agricultural firms/enterprises benefiting	3	
Number of producer and/or community-based organizations receiving technical assistance	10	
Number of women organizations receiving technical assistance	0	
Number of HC partner organizations/institutions benefiting	5	
Developmental outcomes:		
Number of additional hectares under improved technologies or management practices	0	

SEMI-ANNUAL INDICATORS OF PROGRESS BY INSTITUTIONS AND TIME PERIOD

Project Title: *Enhancing biological nitrogen fixation (BNF) of leguminous crops grown on degraded soils in Uganda, Rwanda, and Tanzania*

	Abbreviated name of institutions															
	ISU		MSU		WSU		VEDCO		NaCCRI		SUA		Makerere		ISAR	
Identify Benchmark Indicators by Objectives	**4/1/10**	**9/30/10**	**4/1/10**	**9/30/10**	**4/1/10**	**9/30/10**	**4/1/10**	**9/30/10**	**4/1/10**	**9/30/10**	**4/1/10**	**9/30/10**	**4/1/10**	**9/30/10**	**4/1/10**	**9/30/10**
Objective 1																
Identify genotypes for field testing			**x**		**x**				**x**		**x**				**x**	
Identify research demonstration sites	x		x		x		x		x		x		x		x	
Trial 1 established	x		x		x				x		x				x	
Quantify yield of inoculation trials season 1		x		x		x				x		x				x
Trial 2 established		x		x		x				x		x				x
Quantify yield of inoculation trials season 2		x		x		x				x		x				x
Initial analysis of soil and weather data										x		x		x		x
Soil physical characteristics quantified										**x**		**x**		**x**		**x**
Soil chemical characteristics quantified										x		x		x		x
Established sampling procedures to quantify BNF	x		x		x				x		x		x		x	
Established lab procedures to quantify BNF	x		x		x				x		x		x		x	
Soil sampled for DNA extraction					x	x			x	x	x	x		x	x	x
Procedures established to analyze for rhizobia					x						x					
Objective 2																
Obtain experimental and adapted germplasm	x		x		x						x				x	
Make crosses to generate mapping populations			x		x											x
Screen for increased BNF in low soil N +/- inoculants				x		x				x		x				
Initiate Greenhouse BNF screening on selected lines						x										
Increase seed of mapping populations for QTL analysis						x										
Initiate phenotyping for divergent response of BNF	x			x		x				x		x				x
Begin field testing of parental lines and selected populations	x			x		x				x		x				x
Objective 3																
train VEDCO/SUA/ISAR staff on use of inoculation technology		x						x		x		x		x		x
select HC farmers to participate in on-farm trials		x						x		x		x				x
sensitize farmers and farmer groups about inoculant technology		x						x		x		x				x
identify local bean varieties to include in field trials							x		x		x				x	
train farmers on proper methods for conducting on-farm trials							x	x	x	x	x	x			x	x
complete farmer KPA evaluations on inoculation and BNF								x				x				x
design and format field demonstrations of inoculant technology		x					x		x		x		x		x	
incorporate BNF/inoculant information in PELUM activities							x									
Name of the PI responsible for reporting on benchmarks	Westgate		Cichy		Miklas		Musoke		Ugen		Mchimbi		Bekunda		Musoni	
Signature/Initials:																
Date:																

Comments and Issues of Concern Regarding Phase III Project Technical and Cost Applications

(December 21, 2009)

Project Title: ***Enhancing biological nitrogen fixation (BNF) of leguminous crops grown on degraded soils in Uganda, Rwanda and Tanzania.***

Project PI and Lead Institution: Dr. Mark Westgate, Iowa State University

TECHNICAL APPLICATION:

1. The Management Office was pleased to see the changes incorporated into the revised Technical and Cost Applications in response to our recommendations. In particular, the inclusion of a microbiologist on the project team, the scheduling of activities so as to make this a 33 month project, and the increased allocation of funding to Host Country institutions in Rwanda and Tanzania should ultimately strengthen this project. I am certain that USAID will also view favorably these changes.

2. The Management Office recognizes that the real cost of a collaborative regional project is inherently high. This is especially true for the proposed BNF project which will involve an multidisciplinary team of scientists from ten U.S. and Host Country institutions, in three Host Countries within Central and Eastern Africa and the U.S., plus a diverse set of activities ranging from molecular genetics to agronomic field research and to technology promotion and dissemination. It is for this reason, that the MO requested two budgets that were higher than the amounts announced in the RFP. The perspective of the MO was that by combining potentially two related projects into one under the leadership of a single U.S. university, there would be an increased likelihood of successful achievement of the Pulse CRSP's global program objectives in the areas of biological nitrogen fixation and sustainability of bean based agricultural systems. Before the MO approves the proposed Phase III project, the MO requests that the following issues regarding the Technical Application be clarified and addressed. As you will recognize, these changes will then have implications on the Cost Application (Budget Spreadsheet and Narrative).

3. <u>Commodity focus</u>: A goal of the First Strategic Aim is to improve yields and nutritional quality of staple leguminous crops including <u>both</u> common beans and cowpeas. The MO questions the justification for giving attention to cowpeas in this project as it is a commodity primarily grown for its leaves rather than for grain in Central and Eastern Africa. Also, we doubt whether it will be possible to achieve the proposed "major gains in yield and quality of cowpea" within Central Africa without making a major investment in research. The MO thus encourages ISU to focus its efforts on common bean, at least in this Phase III project. [As suggested, the revised project will focus only on improving common bean germplasm. All references to cowpea have been deleted.]

4. <u>Intellectual Property Issues</u>: The Dry Grain Pulses CRSP supports the testing of the "Biostacked Inoculants" from Becker Underwood along with the other "locally available inoculants" in Uganda, Rwanda and Tanzania. I know such inoculants have been developed for common bean by the HC partners and are available to farmers in these countries. The MO is concerned however about the following IPR issues, should the Biostacked Inoculants be found to be effective in Central Africa.
   - Is Becker Underwood placing any restrictions on the publication of research data resulting from this collaborative project? [BUI Response-- Becker Underwood would not impose any restrictions on the publication of the research data. Out of professional courtesy, it is hoped that Becker Underwood would receive advance copies of any proposed publication.]
   - Is Becker Underwood willing to license the Biostacked Inoculants technology to NARS or universities in Africa to be produced and distributed for humanitarian purposes? What would be the terms of such a license? [BUI Response-- Becker Underwood has reviewed the CRSP policy handbook as it relates to IP. It is premature to state that Becker Underwood would choose one IP option over the other or to establish terms for a license. Becker Underwood will consider all of the options presented in the handbook for making the Biostacked Inoculants available to NARS or universities in Africa. The terms of any arrangement will not be unreasonable and will take into account the humanitarian nature of the collaboration.]
   - Would the Biostacked Inoculants be available at low cost so that resource poor farmers in Africa could have ready access to this technology? [BUI Response-- Clearly, the specific answer to this question will depend on the outcome of the discussions related to the question above. However, in the spirit of the proposal, Becker Underwood would provide the products and would only seek to cover costs until such time that a commercial market is developed. At that point, market forces will guide the pricing strategy. It should be noted that by Becker Underwood's participation in this project, it already desires that farmers in Africa have access to technology that can improve their productivity and livelihoods.]
   - How will the economic profitability and cost effectiveness analysis of different inoculants be conducted if the cost to farmers of the Biostacked Inoculants technology in Africa is presently unknown? [BUI Response-- The project will measure the benefits of the Biostacked Inoculant technology – this is a pre-requisite. When the benefits are quantified and a commercial market develops the pricing strategy will be reasonable and be based on market forces. In other such market scenarios, it has been the Becker Underwood philosophy to typically price the technology to the farmer at a 4:1 benefit to cost ratio.]

   I want to make you aware of the fact that the Dry Grain Pulses CRSP has established a policy on Intellectual Property to which the MO expects all subcontracted institutions will comply. Please see the section entitled "Fundamental Principles Related to Intellectual Property Generation and Transfer under the Dry Grain Pulses CRSP" (pages 63-64 in the Operations and Policy Manual of the Dry Grain Pulses CRSP).

http://www.pulsecrsp.msu.edu/ResourcesandForms/PulseCRSPOperationsandPolicyManual/tabid/88/Default.aspx

5. Economic Profitability: It is good to see that ISU plans to include "economic profitability" as one the criteria/indicators to compare different treatments against the control (no inoculum). From reading the list of collaborators, it is not clear who will provide this expertise. It is important that proper data are collected throughout the project to ensure that comparability analysis for economic profitability is possible. [An economic analysis of return on investment (ROI) for field and on-farm trials is inherent in all program activities. Since these are relatively simple calculations based on inputs and grain sales, and the team has extensive practical experience with such analyses, it was not deemed necessary to add expertise to the research team for this purpose.]

6. Microbiologist: Although the MO was pleased to see the inclusion of Dr. Lynn Carpenter Boggs as a Co-PI in the BNF project, her role and contribution to achieving the objectives of the project are not clear. Will Dr. Carpenter-Boggs be providing leadership to the work on identifying and quantifying the *Rhizobium* sources colonizing the nodules of bean as described under Strategic Aim 1? Will she have a role in developing the protocols for the evaluation of bean genetic materials for BNF? (Strategic Aim 2?) What will be Dr. Carpenter-Boggs collaborative relationship with Phil Miklas (ARS-Washington), Jim Kelly and/or yourself (Mark Westgate)? With Host Country scientists? It is imperative that Dr. Carpenter-Boggs have a clearly defined role in this project and be fully integrated into the project team as a Co-PI, so as to justify the $145,845 budget line for WSU. [Dr. Carpenter-Boggs will coordinate all rhizobium collection, isolation, characterization in HC, will develop protocols for measuring BNF response in HC and US and provide actual rhizobium and BNF response trait analysis in support of Miklas, Kelly, and Cichey's work. She will also provide leadership and HC training in the quantification, isolation, and identification of rhizobia in HC fields; and selection of strains best suited to HC field conditions (Strategic Aim 1), conduct the molecular analyses of HC rhizobial strains of interest (Strategic Aim 1), conduct greenhouse phenotyping of advanced breeding lines for BNF response, necessary for QTL analysis (Strategic Aim 2), collaborate with HC and US researchers in developing protocols for breeding line trials in HC field trials (Strategic Aim 2), and aid PELUM in development of outreach materials regarding use of inoculants (Strategic Aim 3). Dr. Carpenter-Boggs also will serve as the main-campus advisor for the graduate student training at WSU under Phil Miklas (stationed in Prosser, WA), and coordinate Mr. Tindwa training visit to WSU.]

Moreover, the MO had hoped to see involvement by Host Country microbiologists with experience in working with bean *Rhizobium* in the project. Such HC expertise could prove to be highly valuable in achieving your project objectives. We suspect that there is a wealth of knowledge and experience in the Host Countries upon which this project can build. The MO is aware of scientists who have worked on *Rhizobium* in beans in Uganda (Makerere) and Tanzania (SUA). [We are pleased to add Mr. Hamisi Tindwa, soil microbiologist at the Sokoine University of Agriculture, to the project. Mr. Tindwa is trained in soil microbiology and biochemistry and has considerable field experience with Rhizobium technology.]

7. Strategic Aim 3: This is an important aim, however, the lack of certain details raises questions about the likelihood that this aim will be effectively achieved within the time period of the proposed award. Please respond to the following:

a. What will be the content of the "information dissemination" and training efforts under sub-aim 3a, b and c (e.g., training modules for Rural Development Extension Specialists, training for farmers, etc.)?

b. What results (new information or technologies) will be available after 21 or 33 months that can and should be disseminated to small holder farmers within the region? Is the timing of outputs such that the project can demonstrate improved farmer awareness, understanding and recognition of the benefit of inoculation technologies in bean production systems by the completion of the project at 33 months? The MO questions whether the project will be in a position by Year 2 to establish on-farm demonstration plots to demonstrate varietal differences in bean response to inoculants in soils varying in fertility. Previous research indicates that major genotype by environment interactions for BNF and yield will exist in beans. Proceeding to on-farm demonstrations (sub-aim 3b) so soon into the project (in Year 2) suggests that the PIs do not fully appreciate the challenge of understanding the complexity of these interactions. Moreover, there is concern about proceeding with the promotion and dissemination of technologies (i.e., bean varieties with superior BNF and yield potential, inoculants that contribute to enhanced BNF, etc.) to farmers before adequate research has been conducted and the technologies and knowledge have been developed. [The research team fully acknowledges prior studies showing the challenges associated with using inoculants profitably. That is why the predominant research focus is on understanding the genotype x soil environment x inoculant interactions, and making field evaluations at multiple locations in three SSA countries. We agree it is unlikely we'll discover the optimum combination of variety and inoculant for each location to demonstrate to farmers within two years. We do anticipate, however, being able to where primary limitations to improving N2 fixation exist and if superior formulations can help overcome these limitations. Our team's experience working closely with farmers and farmer groups over 20+ years clearly indicates that field demonstrations are only part of the effort needed to convince farmers to adopt new farming practices. The outreach component of this project includes training, demonstrations, and advocacy efforts that are conducted essentially on a continual basis. Specific Aim 3 has been edited extensively to describe these ongoing activities.]

c. Isn't it premature to assume that Becker Underwood's current technology will be superior to locally available inoculants, since the research under Strategic Aim 1 has yet to be conducted? If locally produced inoculates are found to contribute to highest bean yields and profitability, will Strategic Aim 3 c still seek to "increase the availability of high quality (local) inoculants in the three HCs"? [The experimental design includes BU's stacked inoculants along with others commercially available. We are open to the possibility that a locally available inoculant x environment x variety combination could be superior to BU's product(s). The ultimate goal of this project is to improve BFN of common beans on small-landholder farms, not promote BU's products. We enlisted BU as a partner, however, because they are recognized internationally as a source of superior inoculants both in terms of their formulation quality and technical support. No local supplier of inoculants in SSA can make this claim.]

8. Lead PI's Commitment to Project: The MO is concerned that the Lead U.S. PI will not be dedicating sufficient time to this project, as reflected by Westgate's commitment of only 5% time for cost share. This amount of time is considered grossly inadequate for a Lead PI who will be providing intellectual and administrative leadership to a $750,000 to a $1,000,000 CRSP project involving multiple U.S. and Host Country collaborators and institutions (total of 9 sub-subcontracts). Please clarify. [The time allocation for the lead PI under 'US Cost Share ' has been increased to 15% time, which more realistically reflects the effort need to manage this multi-institutional project.]

COST APPLICATION:

1. Funding Periods for 33 Month Phase III Project:

   The Management Office wishes to clarify that a fiscal year in the Dry Grain Pulses CRSP is from October 1 through September 30 of the following year. Assuming that the proposed Phase III project will start January 1, 2010, the "workplan" and funding "obligation" periods will be as follows.

   Year 1 (Fiscal Year 2010) - January 1, 2010 through September 30, 2010 (9 months)
   Year 2 (Fiscal Year 2011) - October 1, 2010 through September 30, 2011 (12 months)
   Year 3 (Fiscal Year 2012) - October 1, 2011 through September 28, 2012 (12 months)

   The Management Office apologizes if this was not made clear in earlier communications. It is important that the Budget and Cost Applications be revised to reflect the actual Fiscal Years and obligation periods of the Dry Grain Pulses CRSP. [The budget structure has been modified to align with the CRSP fiscal year.]

2. Budget for Personnel:
   The budgets for personnel costs are extremely high. Please respond to the following concerns with appropriate changes in the budget and/or narrative.

a. The policy of the Dry Grain Pulses CRSP is to NOT pay honorarium to PIs on CRSP projects. If a PI is employed full time by an institution, the effort and time that a PI dedicates and invests in a CRSP project is considered evidence of institutional commitment. Payment of 'honorarium' only contributes to unsustainability of CRSP projects and creates a culture within Host Country institutions that CRSP projects are add-ons to existing academic, research and outreach programs of the institution. Thus, the MO does not approve of payment of honorarium to HC PIs at Makerere, NaCCRI and VEDCO in Uganda. Please adjust the budgets appropriately. [Honoraria have been deleted from the budget]

b. Support for "field staff" is a major contributor to the high cost of personnel. Although the MO recognizes that labor are certainly required to complete research and outreach commitments, the budget narrative doesn't provide (1) a clear justification for the number of field staff budgeted, (2) nor an indication of the established institutional rate of compensation for field staff (e.g., $450 per month). The budget lines for field staff at ISAR-Rwanda and Sokoine University-Tanzania are particularly troubling, where four full time staff proposed at a total cost of $59,400 for each institution over the 33 month period. It was also noted that under the $750K budget scenario, the personnel line for ISAR and SUA goes down by approximately $30,000 for each institution without an apparent corresponding reduction in activity. [We have limited technical support to one technical staff per location at ISAR and SUA, and established a uniform level of compensation per month across locations. A large portion of the funds previously allocated to technical staff is now re-allocated to support training of graduate students (2 at SUA) and undergraduate interns (3 at ISAR). Funds previously allocated for undergraduate students at ISU have been re-allocated to ISAR for this purpose.]

c. 3. Cost Share:

Please respond to the following questions/concerns:

a. Cost Share by ARS for Drs. Phil Miklas and Karen Cichy- The Management Office questions whether the cost share proposed for Drs. Miklas and Cichy will stand up under audit. What is the source of funding for the laboratories? We remind ISU that federal funds cannot be used as in-kind contributions on USAID awards. How will ISU monitor and document this cost share commitment? [These items have been deleted from the budget.]

b. Cost Share by WSU for Dr. Carpenter-Boggs- How will WSU be providing and documenting cost share for laboratory use? Please be reminded that WSU will be charging full indirect (49.8%). Universities use indirect to cover expenses associated with utilities and maintenance of laboratories. [This item has been deleted from the budget.]

c. Cost Share by Becker Underwood- It is our understanding that ISU will NOT have any legally binding sub-agreement with BU. Thus the question we have is--How will ISU monitor and document the Cost Share by BU?

Please be reminded that according to the sub-agreement that MSU will have with ISU for this project, ISU will have a legally binding commitment to provide auditable cost share that is equal to at least 25% of total funds budgeted under all the U.S. institutions (this includes ISU, MSU, WSU and USDA-ARS). Thus, it will be ISU's responsibility to monitor and document all the cost-share it reports to MSU (either on its own behalf or on behalf of other U.S. institutions) that will meet the USAID cost-share guidelines and audit requirements. [ISU conducts annual audits of all extramural funding that can be provided for this project upon request. Total cost share is limited to 25% of total funds to all US Institutions.]

3. Training:
   a. A HC trainee is budgeted under USDA/ARS/Miklas column and the IDC for this training cost is charged at the USDA rate of 11%. However, the trainee will be enrolled at WSU in an M.S. degree program. It is not clear what arrangement exists between USDA/ARS and WSU regarding payment of tuition, stipend and other training costs while the student is enrolled at WSU. Does this arrangement have any implications on IDC, considering the fact that WSU's IDC rate is substantially higher than that of the USD-ARS? [Per communications with PI Miklas, the indirect rate charged by the USDA is appropriate regarding student training at WSU]

   b. Undergraduate Research Assistants- It is assumed that the undergraduate research assistantships are being awarded to U.S. study abroad students who complete an international internship in Uganda. Although the MO recognizes that such an experience will be transformative for domestic students, the practice of CRSPs has been to not give priority to supporting domestic undergraduate training (due in large part to their greater ability to pay). In a resource limiting environment, the MO would recommend that these funds be used to support additional short term training in Africa or for graduate degree training which leads to a clear research output consistent with the workplans. [This item has been deleted from the previous budget. Funds have been re-allocated to support undergraduate interns at ISAR, and travel to the US for the SUA microbiologist to work with PI Boggs. Training is a major allocation of funds to HC institutions in this project.]

4. VEDCO Expenses:
   a. Because of the concerns presented regarding Strategic Aim 3 (see comments above under Technical Application), please justify the budget proposed for VEDCO in Year 2 of the project. [A much more detailed listing of activities is provided in the revised technical application, work plan, and cost application.]

b. The concern regarding the CRSP's policy on payment of "honorarium" also applies to VEDCO staff. The CRSP does not pay honorarium which compensates full time staff for activities which are considered part of their normal responsibilities. If on the other hand, ISU desires to buy-out time of VEDCO staff so that they provide training to farmer organizations, etc., such compensation is allowed and should be viewed as "Salary". Please provide information of the monthly salaries of the Supervisor and Extension Specialist and an indication of the amount of time they will need to dedicate to the project each month. [Honoraria have been deleted from the budget.]

c. Explain why the CRSP should cover Audit and Evaluation expenses of an NGO? [This item has been deleted from the VEDCO budget].

5. Travel Expenses:
Please note that travel expenses budgeted for project PIs to attend the Global Program Meetings of the Pulse CRSP in April 2010 and in late 2011 are not necessary since these will be covered by the Management Office. [This item has been deleted from the ISU budget]

6. Equipment:
The Cost Application states that "NO major equipment is requested." However, it is noted that $6,350 has been budgeted under "equipment" for VEDCO in the budget spreadsheet for Year 2. If indeed there will not be any items purchased which cost over $5,000, this amount should go under "Supplies". [This oversight has been corrected in the revised Cost Application. Transportation to remote field sites is essential to reach farmers and farmer groups in Uganda. Small motorcycles are the least expensive means to accomplish this.]

7. Rectification of Cost Application Narrative with Budget Spreadsheets:
The total amounts for many lines presented in the Cost Application Narratives for the $750K and $1,000K budgets do not agree with the Budget Spreadsheet totals. For example, the Total Direct Cost for the $750K budget proposal was stated to be $672,201 in the Cost Application Narrative, however, the amount in the Budget Spreadsheet totaled only $608,942. A second example of inconsistencies between the Cost Application Narrative and the Budget Spreadsheet is in the percentage of direct cost split between the U.S. and Host Country institutions. This discrepancy was noted for both the $750K and the $1,000K budgets. [We apologize for failing to rectify last minute changes in the budget with the Cost Application. The figures presented in the revised Cost Application have been reviewed carefully to correspond with the revised budget figures.]

The Management Office requests that all numbers and percentages in the Cost Application Narratives be cross checked against the Budget Spreadsheets for accuracy.