

## Using Improved Pulse Crop Productivity to Reinvigorate Smallholder Mixed Farming Systems in Western Kenya

### Principle Investigators

Julie Lauren, Cornell University, USA

John Ojiem, KARI, Kenya

### Collaborating Scientists

Beth Medvecky, Cornell, USA

Alice Pell, Cornell, USA

John Duxbury, Cornell, USA

Peter Hobbs, Cornell, USA

Rebecca Stoltzfus, Cornell, USA

Christopher Barrett, Cornell, USA

Martins Odendo, KARI, Kenya

Samuel Mwonga, Egerton, Kenya

John Okalebo, MOI, Kenya

John Nderitu, UNairobi, Kenya

James Muthomi, UNairobi, Kenya

Robin Buruchara, CIAT, Uganda

---

### Project Problem Statement and Justification

Many rural households in the East African highlands are no longer self-sufficient in beans, a critical source of food and income. Farmers' inability to afford fertilizer inputs, coupled with continuous cropping on ever shrinking land holdings, has led to degraded and infertile soils and a concomitant decline in crop vigor, pest and disease tolerance and overall system productivity.

Low bean and maize productivity in Western Kenya is related to both soil fertility and biological constraints. Legumes can be important options for rebuilding soil fertility but poor utilization of applied P fertilizers, conflicts between soil renewal and immediate food and income needs and low fixed nitrogen returns from many grain legumes have limited expected returns. Additional production constraints and risks for beans in Western Kenya are presented by diseases and pests. Angular leaf spot and anthracnose are major bean foliar diseases, and root rots, bean stem maggot, nematodes and root-feeding insects are particularly serious problems in intensively cultivated, degraded soils. Bean root rot can become so severe that the amount of seed harvested becomes less than the amount planted, causing farmers to abandon bean cropping altogether. We hypothesize that vigorous establishment of pulse crops leads to increased pest/disease resistance, improved N fixation, and nutrient accumulation, which ultimately reduces risk, benefits system productivity, food security and human nutrition. Practices promoting early plant vigor and growth encourage bigger and deeper root systems which can explore larger volumes of soil for limiting nutrients and compete more effectively with soil borne pathogens.

Consumption of pulses is essential for addressing iron deficiency, anemia and stunting caused by inadequate intakes of zinc. Knowledge about the mineral nutrient content of staple food products, including iron and zinc, is needed to inform selection of appropriate cultivars that will benefit consumer's health and to assist policy makers in meeting desired national health outcomes. Recent national or regional level food composition data are often unavailable forcing researchers and policy makers to rely on international databases that do not adequately represent local environmental conditions, varieties, etc. Mineral nutrient contents of major foods grown under a representative range of smallholder farmer conditions are needed to develop local food composition tables and to determine food system nutrient outputs.

Determining how to effectively increase productivity of seriously degraded soils and to maintain the fertility of still productive lands is of paramount importance to all farmers living in the East African Highlands. To achieve this outcome, farmers and scientists need to form genuine partnerships, combining farmers' highly sophisticated and nuanced understanding of local conditions with scientists' insight into underlying processes and the powerful problem-solving ability of their scientific methods. Providing opportunities for current and future scientific leaders to gain experience and expertise with participatory research and development approaches needs to be an essential part of the education process. These experiences will help students understand that adoptable and sustainable technologies are those that reduce risk and effectively address farmer constraints and resource levels.

### **Planned Project Activities for April 1, 2008 - September 30, 2009**

**Objective 1:** To develop and assess farmer capacity for improving vigor and growth of pulse crops on nutrient accumulation, pest/disease resistance and system productivity across a soil degradation gradient.

#### **Collaborators:**

Beth Medvecky, Cornell University, USA  
 Alice Pell, Cornell University, USA  
 Chris Barrett, Cornell University, USA  
 Martins Odendo, KARI, Kenya  
 Crispus Njeru, KARI, Kenya

David Mbakaya, KARI, Kenya  
 Noel Makete, KARI, Kenya  
 Isabella Ememwa, KARI, Kenya  
 Ruben Otsyula, KARI, Kenya  
 Robin Buruchara, CIAT

#### **Approaches and Methods:**

1. *In Community Farmers Workshops* - KARI will organize and conduct in-community workshops for selected farmers, local extension and NGO personnel with input from the rest of the research team. Farmers invited to the workshop will be selected from an existing characterized group of farmers who had participated in a former Cornell project of the National Science Foundation Biocomplexity Initiative. These farmers' plots fall along a soil degradation gradient of steadily decreasing levels of soil C, N, P, K, Ca, Mg. Participatory approaches will be used to engage participants and facilitate the exchange of farmer and scientific knowledge as well as the rationale behind vigor-enhancing practices (root rot tolerant bean germplasm, seed priming, boma compost, combining/ concentrating organic & inorganic fertilizers, multipurpose pulse crops lablab and cowpea). Farmers will share their own knowledge and may propose additional vigor-enhancing practices to be tested by the group.

2. *On Farm Verification Trials* - Specific strategies that farmers wish to evaluate on their own farms will be facilitated and supported by the project. Given the extremely limited resources of the farmers, it will be necessary for the project to supply sufficient quantities of seed and fertilizers to plant the verification plots. KARI personnel will provide technical backstopping and follow up with the farmers. The vigor enhancing practices will be tested with beans during the long rainy season when farmers plant their main maize/bean intercrop. The drought tolerant indigenous pulses, lablab or cowpea, will be evaluated during the more erratic short rainy season.

**Objective 2:** To disseminate and evaluate through participatory approaches simple, low cost strategies for vigorous establishment/growth of pulse crops leading to increased system productivity and sustainability.

**Collaborators:**

Beth Medvecky, Cornell University, USA  
 Alice Pell, Cornell University, USA  
 Chris Barrett, Cornell University, USA  
 John Duxbury, Cornell University, USA  
 Peter Hobbs, Cornell University, USA  
 Rebecca Stoltzfus, Cornell University, USA  
 NGO and Female Farm Groups to be identified

Martins Odendo, KARI, Kenya  
 Crispus Njeru, KARI, Kenya  
 David Mbakaya, KARI, Kenya  
 Noel Makete, KARI, Kenya  
 Isabella Ememwa, KARI, Kenya  
 Ruben Otsyula, KARI, Kenya

**Approaches and Methods:**

1. *Create awareness and identify additional NGO and female farmer groups for collaboration and dissemination of vigor enhancing strategies* - Contacts will be made with NGO groups and the many informal farmer groups which exist within the target area in order to expand the impact of the project to a wider audience beyond the initial pool of selected farmers.

2. *Crop performance evaluation and in season exchange visits* - Farmers will collect crop establishment data (germination and 4 wks post-germination) and volumetric yield data (for maize, beans, and lablab or cowpea) from their verification trial plots in each cropping season. In addition, farmers will be shown how to assess and record the incidence and severity of pests and diseases (root rot, bean fly, others) with easily observed characteristic signs or symptoms. Results will be shared with the project. Each cropping season farmer-to-farmer exchange visits and visits to the replicated researcher-managed experiments will be supported to provide other opportunities for facilitating experiential learning and exchanges about successes and failures. Participant feedback after each group event will be solicited and reported.

3. *Initiate socioeconomic surveys of farmers* - A survey will be undertaken at the end of the long rains in 2009 (one full short rains-long rains cycle) to document farmer reaction to the tested strategies. Perceived benefits and constraints, changes in management approaches and labor requirements, farmer to farmer knowledge dissemination and likelihood of adoption will be assessed. Impacts on livelihood indicators also will be collected as available, such as cost-benefit analysis of the chosen strategy, status of household food self-sufficiency, as well as crop sales and disposition of cash. Input on the survey instrument will be sought from all project collaborators (KARI, Cornell, Universities, CIAT) and incorporated prior to field testing. Socioeconomic data gathered from the NSF Biocomplexity project will serve as baseline information.

Additional baseline information on bean cultivation practices not available from NSF dataset will be collected prior to the In-Community Farmer Workshops.

**Objective 3:** To research factors (nutrients, pest/diseases and their interactions) affecting pulse productivity across a soil degradation gradient.

**Collaborators:**

Beth Medvecky, Cornell University, USA  
 Alice Pell, Cornell University, USA  
 Chris Barrett, Cornell University, USA  
 John Duxbury, Cornell University, USA  
 Peter Hobbs, Cornell University, USA  
 Rebecca Stoltzfus, Cornell University, USA  
 Martins Odendo, KARI, Kenya  
 David Mbakaya, KARI, Kenya

Noel Makete, KARI, Kenya  
 Isabella Ememwa, KARI, Kenya  
 Ruben Otsyula, KARI, Kenya  
 Robin Buruchara, CIAT, Uganda  
 Samuel Mwonga, Egerton University, Kenya  
 Robert Okalebo, Moi University, Kenya  
 James Muthomi, University of Nairobi, Kenya  
 John Nderitu, University of Nairobi, Kenya

**Approaches and Methods:**

1. *Project Initiation Workshop* - Complex experimental designs will be used to test responses to the full complement of vigor enhancing strategies and to tease apart interactions among management practices, soils, crops and pests/diseases. All project collaborators (KARI, Cornell, Universities, CIAT) will convene to develop and detail the specific research questions, experimental design and data to be collected from the replicated trials. Research questions will likely emphasize incidence and severity of pests and diseases, characterization of soil chemical characteristics and agronomic evaluations of system productivity

2. *Implement replicated experimental trials* - KARI will establish and oversee the management of the replicated experiments on representative maize and bean fields at 4 sites across the soil degradation gradient. Farmer collaborators from each represented gradient zone will help to identify the most appropriate site within that zone and the farmer who owns the field will be fully compensated in cash and kind. These replicated experiments will be carried out over the life of the project.

3. *Data collection and evaluation* - Data from the replicated experiments as identified during the Project Initiation Workshop will be collected by KARI staff. At the end of the short rains 2008 and long rains 2009 cropping seasons, results will be collected and shared among all collaborators.

4. *In-season field visits and annual meeting review of results* - Each cropping season site visits will be made to the replicated trials by project collaborators during early crop growth to assess the effectiveness and impacts of the tested vigor enhancing strategies. Observations and comments will be reported. Project collaborators will meet after one full short rains-long rains cycle to review and synthesize results from farmer and replicated experiments. Successful and unsuccessful features of the vigor enhancing strategies and impacts will be identified. Areas needing additional attention or modification will be identified.

5. *Collection and nutrient analysis of grain and edible leaf samples* - KARI staff will gather grain sub-samples from farmer and replicated trials. Samples will be sent to Cornell University for mineral nutrient analysis (Ca, Mg, P, K, S, Zn, Cu, Mn) and calculation of cropping system yields and nutrient outputs.

6. *Pursue opportunities for germplasm testing and exchange* - Phosphorus efficient bean germplasm (2-3 lines) will be obtained from the Pennsylvania State University (PSU) project and tested during the long rains season in observational plots across the soil degradation gradient. Commonly adopted root rot tolerant bean varieties from the target area will be sent to PSU for P efficiency trait testing. Likewise early and late maturity cowpea cultivars will be obtained from University of California Riverside (UCR) and tested during the short rains for biomass and grain production.

**Objective 4:** To facilitate and support on-farm participatory research opportunities for Kenyan agricultural scientists and graduate students.

**Collaborators:**

Beth Medvecky, Cornell University, USA  
 Alice Pell, Cornell University, USA  
 Chris Barrett, Cornell University, USA  
 John Duxbury, Cornell University, USA  
 Peter Hobbs, Cornell University, USA  
 Rebecca Stoltzfus, Cornell University, USA

Francis Muyekho, KARI, Kenya  
 David Mbakaya, KARI, Kenya  
 Samuel Mwonga, Egerton University, Kenya  
 Robert Okalebo, Moi University, Kenya  
 James Muthomi, University of Nairobi, Kenya  
 John Nderitu, University of Nairobi, Kenya

**Approaches and Methods:**

1. *Coursework in selected fields* - One student from each of the three Kenyan Universities will receive support to undertake a 2-year Masters Degree program in the areas of soil science (Egerton Univ.), plant

protection (Univ. Nairobi) or agronomy (Moi Univ.). Staff from KARI, the Ministry of Agriculture and NGOs will be actively sought as students, thereby benefiting these institutions directly when the students complete their degrees and return to work. One staff member from KARI-Kakamega has already been nominated to work with Dr. Okalebo at Moi University. Once selected the students will be enrolled and undertake Master's level coursework during the first year of the project.

*2. Develop and implementation of student research projects* - Each student will prepare a student research proposal guided by the discussions during the Project Initiation Workshop and in consultation with their faculty advisor. The proposals will be shared with project collaborators for inputs and comments prior to initiation of the research. The researcher-managed and/or the farmer-managed trials will form the backbone of the students' thesis research. As needed students will establish additional satellite trials. For example, missing element experiments may be set up to assess the role of other limiting nutrients in these soils.

*3. Sharing of results in annual meetings* - Students will present results (as available) from their research projects during the project annual meeting for discussion and suggestions. Results will be incorporated into the project annual report as they become available.

## Target Outputs

- Enhanced vigor strategies for pulse productivity tested by farmers and benefits documented – increased food security, livelihood and income generation opportunities for vulnerable groups (smallholder farmer and female farmers); gender equity
- Facilitating farmer-to-farmer exchanges for knowledge exchange with emphasis on females – human capacity building; gender equity
- Linking farmer learning and experimentation with the science-based research will initiate an understanding about the effects of vigor enhancing strategies on pulse and system productivity as well as interactions with soils, pests and diseases - accelerate access to research findings; increase prospects for scaling up
- Course work and initiation of Masters degree research for mid-career institutional scientists – capacity building
- Multidisciplinary development and research relationship between 2 international institutions (Cornell, CIAT) and Kenyan institutions (KARI, Egerton, Moi, Univ. Nairobi) – global partnerships, capacity building

## Engagement of USAID Field Mission(s)

- Invite Agriculture Officer for Project Initiation Workshop and project site visits-May, October 2008; April 2009
- Courtesy visits to Agriculture Office –May, October 2008; April 2009

## Networking Activities with Stakeholders

- Local NGO and female farmer groups will be contacted in order to create awareness, facilitate and backstop knowledge dissemination about the improved pulse productivity strategies.
- Stockists (local input suppliers) will be invited to attend the In-Community Farmer Workshops to create awareness and exchange ideas about vigor enhancing strategies, thereby stimulating opportunities for increased sales and expanded inventory in response to farmers demands.

## **Leveraging of CRSP Resources**

Four existing projects lead by co-PIs of this project will allow us to leverage travel funds during the project period. The projects are the Biocomplexity Initiative (Sponsor: NSF, through August 2008); SANREM CRSP (Sponsor: USAID, through Sept 2009); Global Livestock CRSP (Sponsor: USAID, through Dec 2011); and Pilot Project on Building Farmer's Capacity and Marketing Skills (Sponsor: Anonymous, through April 2009).

<b>Dry Grain Pulses CRSP Budget Summary</b>						
Using Improved Pulse Crop Productivity to Reinvigorate Smallholder Mixed Farming Systems in Western Kenya						
Budget Summary 04/01/08 - 09/30/09						
	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)
Institution Name	Cornell	0	KARI	0	0	0
<b>a. Personnel Cost</b>						
Salaries	\$ 34,435.68		\$ 5,761.28			
Fringe Benefit	\$ 16,391.38		\$ -			
	\$ -		\$ -			
<b>b. Travel</b>	\$ 25,203.53		\$ 35,383.00			
<b>c. Equipment (\$5000 Plus)</b>	\$ -		\$ -			
	\$ -		\$ -			
<b>d. Supplies</b>	\$ 625.00		\$ 18,623.39			
<b>e. Training</b>						
Degree	\$ -		\$ 47,830.76			
Non-Degree	\$ -		\$ -			
<b>f. Other</b>	\$ 5,120.00		\$ -			
<b>g. Total Direct Cost</b>	<b>\$81,775.59</b>	<b>\$0.00</b>	<b>\$107,598.43</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>
<b>h. Indirect Cost</b>	\$ 44,112.11		\$ 10,759.85			
<b>i. Indirect Cost on Subcontracts (First \$25000)</b>	\$ 13,375.00		\$ -			
<b>j. Total Indirect Cost</b>	\$ 57,487.11	\$ -	\$ 10,759.85	\$ -	\$ -	\$ -
<b>Total</b>	<b>\$ 139,262.70</b>	<b>\$ -</b>	<b>\$ 118,358.28</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>
<b>Grand Total</b>	<b>\$257,621</b>					

	Amount	Percentage
Percentage of U.S. Budget	\$ 81,775.59	43.18%
Percentage of Host Countries Budget	\$ 107,598.43	56.82%

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)	Total
In-kind	\$ -		\$ 33,510.00	\$ -	\$ -	\$ -	\$ 33,510.00
Cash	\$ 42,757.00		\$ 15,951.00	\$ -	\$ -	\$ -	\$ 58,708.00
<b>Total</b>	\$ 42,757.00	\$ -	\$ 49,461.00	\$ -	\$ -	\$ -	\$ 92,218.00
<b>Attribution to IEHA Objectives</b>							
Percentage of effort							52.42%
Amount corresponding to effort	\$ 83,557.62	\$ -	\$ 51,490.65	\$ -	\$ -	\$ -	\$135,048.27
<b>Attribution to Capacity Building (Theme "D")</b>							
Percentage of effort	\$ 0.80	\$ -	\$ 1.12	\$ -	\$ -	\$ -	47.58%
Amount corresponding to effort	\$ 55,705.08	\$ -	\$ 66,867.64	\$ -	\$ -	\$ -	\$122,572.72

## Capacity Building Activities

### Degree Training:

#### **Student #1**

First and Other Given Names: Crispus Mugambi  
 Last Name: Njeru  
 Citizenship: Kenyan  
 Gender: Male  
 Degree: M.S.  
 Discipline: Soil Science  
 Host Country Institution  
 to Benefit from Training: Kenya Agricultural Research Institute Kakamega  
 Training Location: Moi University  
 Supervising CRSP PI: Okalebo, John  
 Start Date: 02/08  
 Project Completion Date: 02/10  
 Training Status: Active  
 Type of CRSP Support  
 (full, partial or indirect): Full (Category 2a)

#### **Student #2**

First and Other Given Names: Belinda Akinyi  
 Last Name: Weya  
 Citizenship: Kenyan  
 Gender: Female  
 Degree: M.S.  
 Discipline: Soil Science  
 Host Country Institution  
 to Benefit from Training: Kenya Ministry of Agriculture Extension – Kisii  
 Training Location: Egerton University  
 Supervising CRSP PI: Mwonga, Samuel  
 Start Date: 08/08  
 Project Completion Date: 08/10  
 Training Status: Active  
 Type of CRSP Support  
 (full, partial or indirect): Full (Category 2a)



**Student #3**

First and Other Given Names: Jane Francisca  
Last Name: Lusweti  
Citizenship: Kenyan  
Gender: Female  
Degree: M.S.  
Discipline: Plant Protection  
Host Country Institution  
to Benefit from Training: Kenyan Ministry of Agriculture Extension  
Training Location: University of Nairobi  
Supervising CRSP PI: Muthomi, James  
Start Date: 10/07  
Project Completion Date: 10/09  
Training Status: Active  
Type of CRSP Support  
(full, partial or indirect): Partial (Category 2b)