

**Annual Report**

**Feed the Future Innovation Lab  
for the Reduction of Post-Harvest Loss**

**January - August 2014**

**Submitted by:**

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Oklahoma State University  
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International Rice Research Institute**

**Submitted on:**

**September 12, 2014**

The Internal Steering and Evaluation Committee (ISEC) consist of:

- Dr. Venkat Reddy – Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss Managing Technical Director; KSU IGP Institute (grain foods and processing)
- Dr. Dirk Maier – Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss Administrative Director; KSU IGP Institute Director (co-PI; PHL engineering/technology)
- Dr. Prasanta Kalita - UIUC ADM Institute Director (co-PI; Bangladesh project co-leader)
- Dr. Steve Sonka - UIUC ADM Institute Research Professor (Economics Coordinator; supply chain assessment)
- Dr. Subramanyam Bhadriraju - Kansas State University (Ethiopia project co-leader; Research/ Environmental Issues Coordinator)
- Dr. Shannon Washburn - Kansas State University (Engagement Coordinator)
- Dr. Nina Lilja - Kansas State University (Gender Coordinator)
- Dr. Mary Meck Higgins – Kansas State University (Nutrition Coordinator)
- Dr. Carlos Campabadal – Kansas State University (Guatemala project co-leader; grain drying, storage facilities and equipment)
- Dr. George Opit - Oklahoma State University (Ghana project co-leader; stored product insects and pests)
- Dr. Sam McNeill - University of Kentucky (Ghana project co-leader; grain drying, storage facilities and equipment)
- Dr. Rizana Mahroof - South Carolina State University (Ethiopia project co-leader; stored product pest management)
- Dr. George Mbata - Ft. Valley State University (monitoring of pest populations, PHL assessment)
- Dr. Andreia Bianchini - University of Nebraska (Guatemala project co-leader; mycotoxin contamination prevention)
- Al Schmidley – International Rice Research Institute (Bangladesh project co-leader; supply chain assessment)
- Dr. Floyd Dowell - USDA-ARS Center for Grain & Animal Health Research, Engineering Research Unit Leader
- Dr. Beth Mitcham - University of California-Davis, Postharvest Technology Center Director

## Focus Countries

- Bangladesh
- Ethiopia
- Ghana
- Guatemala



## **Alliance Collaborators**

### **Companies**

Archer Daniels Midland Company (ADM) (USA)  
Agri Commercial Service Ltd. (Ghana)  
Hiwot Agricultural Mechanization P.L.C. (Ethiopia)  
John Deere (USA)  
Pens Food Bank Enterprise (Ghana)  
Romer Labs (Austria)  
Vestergaard Frandsen (Switzerland)  
Woods End Labs (USA)

### **International Agencies**

CGIAR's International Center for Agricultural Research in the Dry Areas (ICARDA)  
CGIAR's International Maize and Wheat Improvement Center (CIMMYT) (invited)  
CGIAR's International Rice Research Institute (IRRI)  
United Nations Food and Agriculture Organization (FAO)

### **Universities**

Bahir Dar University (Ethiopia)  
Bangladesh Agriculture University (Bangladesh)  
Fort Valley State University (USA)  
Hawassa University (Ethiopia)  
Kansas State University, IGP Institute (USA)  
Kwame Nkrumah University of Science and Technology (KNUST) (Ghana)  
Mekelle University (Ethiopia)  
Oklahoma State University, Entomology and Plant Pathology (USA)  
South Carolina State University, Department of Biological and Physical Sciences (USA)  
Universidad del Valle (Guatemala)  
University of California, Davis; Hort CRSP (USA)  
University of Energy and Natural Resources, Sunyani (Ghana)  
University of Hohenheim, Institute for Agricultural Engineering, Tropics, and Subtropics Group (Germany)  
University of Kentucky, College of Agriculture (USA)  
University of Nebraska, Food Science and Technology Department (USA)

### **Government Agencies**

Feed the Future (USA)  
US Agency for International Development (USAID)  
USDA-ARS Center for Grain and Animal Health Research (USA)

### **Non-Profits**

ADM Institute for the Prevention of Postharvest Loss at the University of Illinois (USA)  
Compatible Technologies International (USA)  
Institute of Food Technologists (IFT) (USA)  
Partners in Food Solutions (USA)  
Practical Action (Bangladesh)  
SHARE Guatemala (Guatemala)  
Savanna Agricultural Research Institute/Council for Scientific Research

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**Annual Report**  
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**for the Reduction of Post-Harvest Loss**  
**January - August 2014**

**I. Executive Summary**

The Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss (also referred to as the PHL Innovation Lab) is a strategic and applied research and education program aimed at providing global leadership in food security by reducing post-harvest loss (PHL) and food waste of durable staple crops (grains, oilseeds, legumes, root crops, seeds) and their processed value-added products. Interventions under this project will integrate smallholder farmers (male and female), producer cooperatives, and agribusiness enterprises with market-based value chains with an initial focus on four Feed the Future countries (Bangladesh, Ethiopia, Ghana, and Guatemala). This will be achieved by:

- Enhancing capacity to improve drying, conditioning, handling, storage, pest management, transportation, grading, standardization, and marketing of their crops, and thus improving the quantity and quality of crops.
- Expanding access to Post-Harvest Service Centers utilizing "Warehouse Receipt Systems" (WRS) as this "banking" tool (credit for inventory or products in storage) increases the market power of smallholders by enabling them to choose at what point in the price cycle to sell their crops.
- Pilot testing of promising "on the shelf" and "in the field elsewhere" best practices and technologies that need further refinements and input from end-users in order to ensure country-specific scale-up and commercial uptake, while minimizing negative environmental impacts of the recommended practices.
- Investigating cultural, social and economic factors, with specific attention to gender issues, that affect local stakeholders and their interactions with post-harvest practices/technologies and utilizing this information to structure recommended changes/technologies to help ensure their adoption.
- Using local artisans, business people, and workers to create and develop, where possible, locally-produced tools and technology to aid in the sustainability of resources and practices.
- Employing advanced information technology-based systems to more rapidly evaluate and disseminate promising PHL innovations for application where needed in Feed the Future countries.
- Increasing the quantity and quality of stored food staples and dietary diversity, along with country-specific nutrition education, thus increasing access to nutritious food and reducing under-nutrition and food insecurity.

**II. Program Activities and Highlights**

- Country teams traveled to the four focus countries during the following dates
  - Bangladesh
    - June 3 (Schmidley held an inception meeting in Bangladesh)
    - July 5-10 (Kalita, Reddy and Schmidley visited the Bangladesh Agricultural University and met with USAID Mission Office.)

- Ethiopia
  - April 18-May 4 (Bhadriraju, Reddy and Mahroof met with Ministry of Agriculture, International Seed Sector Development, GrainPro, Agricultural Transformation Agency, Sesame Business Network, Mekelle University and visited small farm holder. They also met with USAID Mission Office.)
  - July 18-31 (Subramanyam, Reddy, Mahroof, Ambrose and Washburn visited Amhara and Tigray Agricultural Bureaus, Chickpea Research Center in Oromiya, Bako Agricultural Research Center, Mekelle University and Bahir Dar University to meet with scientists on PHL research and engineers on solar dryers.)
- Ghana
  - May 17-31 (Opit, McNeil, Armstrong, Arthur, Campbell, Mbata, Washburn and Reddy conducted the first assessment and presented it to the USAID office.)
- Guatemala
  - March 16-21 (Campabadal, Bianchini and Reddy visited the Huehuetenango region to observe postharvest practices, met with SHARE, Universidad del Valle and USAID Mission Office.)
  - May 26-30 (Campabadal and Bianchini met with SHARE, Universidad del Valle and USAID Mission Office on survey and assessment and mycotoxin testing.)
  - August 17-28 (Campabadal, Bianchini, Reddy, Ellis and Sabillon worked with SHARE and Universidad del Valle to develop training for mycotoxin kits and PHL assessment survey. They also met with USAID Mission Office.)
- In-country counterparts and subcontracts executed (See III. Key Accomplishments)
- Dr. Maier received invitations to speak about the Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss at the following events:
  - College of Agriculture Leadership Team Meeting, January 24, 2014, Manhattan, Kansas
  - FDSCI 302 Introduction to Food Science, Guest Lecture, February 5, 2014, Manhattan, Kansas
  - NC-213 Technical Meeting, February 26, 2014, Omaha, Nebraska
  - Food and Nutrition Security: K-State Perspectives, Campus Forum, May 5, 2014, Manhattan, Kansas
  - Conference on Food Security & Hermetic Storage, May 6, 2014, Washington, DC
  - Post-harvest Loss Metrics, Measurement and Mitigation: Resolving the Unmet Needs, Gates Foundation Workshop, May 12-13, 2014, Washington, DC
  - International Collaborative Projects – Development, Execution and Impact, Special Session, July 14, 2014, ASABE Annual Meeting, Montreal, Canada
  - Global Engagement Day, July 15, 2014, ASABE Annual Meeting, Montreal, Canada

- Food Processing Innovation Lab Inaugural Meeting, August 16-18, 2014, Dakar, Senegal
- Dr. Reddy attended the Rockefeller Foundation Food Loss Quest to India, May 18-23, 2014.
- Members of the Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss were invited to participate in the following events, meetings and workshops:
  - Global Knowledge Initiative/Rockefeller Foundation Food Waste and Spoilage Workshop, January 9, 2014, Michigan State University, East Lansing, Michigan (Maier)
  - Conference on Food Security & Hermetic Storage, May 6, 2014, Washington, DC (Maier, Reddy)
  - Gates Foundation Workshop on Post-harvest Loss Metrics, Measurement and Mitigation, May 12-13, 2014, Washington, DC (Maier)
- Members of the Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss have the following abstracts accepted as oral or poster presentations at the 11<sup>th</sup> International Working Conference on Stored Product Protection, Chiang Mai, Thailand, November 24-28, 2014:
  - Addressing Food Security and Post-Harvest Loss Reduction Through Stored Product Protection, Maier, D., Reddy V. (oral)
  - Reducing losses and improving actor incomes in Bangladesh's postharvest rice value chains: Initial assessment results and recommendations for the future, Schmidley, A. (oral)
  - Improving food security and food safety of small holder farmers in the Western Highlands of Guatemala through reduction of post-harvest losses in corn, Bianchini-Huebner, A., Campabadal, C. (oral)
  - Assessment of maize post-harvest losses on the middle belt of Ghana, Opit, G. (oral)
  - Enhancing food security in Ethiopia through reduction of post-harvest losses and food waste, Bhadriraju, S., Maroof, R. (oral)

### **III. Key Accomplishments**

- All in-country partners identified and subcontracts are in place.
  - KSU-UNL            April 11, 2014
  - KSU-OSU            May 5, 2014
  - KSU-SCSU            May 30, 2014
  - KSU-Mekelle        June 18, 2014
  - KSU-UIUC            July 17, 2014
  - UIUC-IRRI            August 13, 2014
  - KSU-SHARE          August 19, 2014
- The Performance Monitoring Plan was established and the following Feed the Future indicators have been chosen and approved.
  - 4.5.2-6 Number of individuals who have received USG supported long-term agricultural sector productivity or food security training
  - 4.5.2-7 Number of individuals who have received USG supported short-term agricultural sector productivity or food security training

- 4.5.2-12 Number of public-private partnerships formed as a result of Feed the Future assistance
- 4.5.2-39 Number of technologies or management practices in one of the following phases of development
  - Phase I: under research as a result of USG assistance
  - Phase II: under field testing as a result of USG assistance
  - Phase III: made available for transfer as a result of USG assistance
- All country project team members identified
  - Bangladesh
 

**Team Leaders:** Al Schmidley (IRRI); Dr. Prasanta Kalita (University of Illinois)

**Team Members:** Dr. Mobarak Hossain Khan Choudhury (IRRI, Project Coordinator and Senior Postharvest Specialist); Latiful Bari (IRRI, Postharvest Engineer); Dr. Md. Abdul Awal (Bangladesh Agricultural University); Dr. Md. Monjurul Alan (Bangladesh Agricultural University); Dr. Jason Ellis (Kansas State University)
  - Ethiopia
 

**Team Leaders:** Dr. Subramanyam Bhadriraju (Kansas State University); Dr. Rizana Mahroof (South Carolina State University)

**Team Members:** Dr. Fetien Abay (Mekelle University); Dr. Ibrahim Fitwy; Dr. Kiros Meles Aymut (Mekelle University); Dr. Amsalu Ayana (Integrated Seed Sector Development); Dr. Dereje Ayalew (Bahir Dar University); Mr. Muez Berhe Gebremedhin (Sesame Business Network Support Programme); Dr. Yibrah Beyene (Hawassa University); Dr. Tadesse Dessalegn (Wheat Regional Center of Excellence, Ethiopian Institute of Agricultural Research [EIAR]); Dr. Kingsly Ambrose (Kansas State University); Dr. Shannon Washburn (Kansas State University)
  - Ghana
 

**Team Leaders:** Dr. George Opit (Oklahoma State University), Dr. Samuel McNeill (University of Kentucky, Princeton, KY)

**Team Members:** Dr. Enoch Osekre (Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana.); Drs. James Campbell, Frank Arthur, Dr. Paul Armstrong (USDA-ARS Center for Grain and Animal Health Research (CGAHR), Manhattan, KS); Dr. George Mbata (Fort Valley State University, Fort Valley, GA); Dr. Shannon Washburn (Kansas State University); Dr. Oana Baban and Mr. Isaac Ola Ayobami (Vestergaard Frandsen SA, Lausanne, Switzerland); Mr. Evans Nsiah (Pens Food Bank Enterprise, Ejura, Ghana.); and Mr. Kwabena Adu-Gyamfi (Agri Commercial Services, Wenchi, Ghana)
  - Guatemala
 

**Team Leaders:** Dr. Carlos Campabadal (Kansas State University); Dr. Andreia Bianchini (University of Nebraska)

**Team Members:** Dr. Jason Ellis (Engagement Team Leader, Kansas State University), Luis Sabillon (Research Associate, University of Nebraska), Rodrigo Mendoza (Research Assistant, University of Nebraska), Dr. Heather Hallen-Adams (University of Nebraska), Dr. Sam McNeil (Grain Drying Specialist, University of Kentucky), Sam Cook (Research Assistant, Kansas State University), Jennifer Frederick (Research Associate, Kansas State University), David Arrivillaga (CEO of SHARE Guatemala), Guillermo González (Coordinator of Innovation and Collaboration SHARE Guatemala), Walfer Martínez (Production Consultant in Huehuetenango SHARE Guatemala), Msc. Ana Silvia Colmenares (Department Head of Food Science Engineering, Universidad del Valle), Vilma Porres (Researcher at Center for Studies in Agriculture and Food at the Institute of Research, Universidad del Valle), Emerson Herrera (Researcher at Center for Studies in Agriculture and Food at the Institute of Research, Universidad del Valle), Ada Rocina Chavarría (External Consultant for Equal Gender Issues)

#### **IV. Research Program Overview and Structure**

1. **Initial PHL Assessment**—A systems approach has been used to evaluate PHL issues by examining how on-farm activities relate to other entities and operations within the overall food production chain. Technical, social (including specific gender analysis) and economic factors are being assessed utilizing participatory approaches involving key stakeholders, with particular attention to women’s involvement. This analysis forms our research and project development as well as helps us develop post-harvest technologies and business models that not only reduce PHL but that will likely be adopted.

Another key aspect of the initial value chain assessment is to establish a baseline of PHL by examining moisture and nutrient content of the crops studied as well as mycotoxin levels and losses due to insects and other pests. This baseline provides input for assessing critical control points for PHL reduction intervention and the effectiveness of the technologies examined. It also provides a baseline for the Monitoring and Evaluation Plan.

Baseline assessments on value chains are critical for Monitoring and Evaluation activities. Within each of the four initial project countries, an initial rapid assessment was done to define local postharvest value chains and identify actors early on. Some of this information already exists in various forms. That is why the project team explicitly included participation of entities with local knowledge of the value chains assessed. Baseline measurements identify different actors in the value-chain such as different types of farmers (men, women, resource poor, groups, etc.), paddy/grain aggregators, traders, service providers, millers/grain processors, rice/grain wholesalers and retailers. The assessment quantifies baseline data for each of the actors in terms of their current PHL practices so that the interventions can be designed with those actors in mind, and then later the impact (i.e., change in PHL practices) can be measured.

A comprehensive postharvest assessment covers farms and household level processing as well as commercial chain actors and practices. Actors that were included are farmer groups, women self-help groups (approximately 85% of household level processing is done by women), paddy aggregators, entrepreneurs, traders, service providers, millers, rice wholesalers and retailers. We also included the role

of NGOs and public sector research and extension in our assessment. Moreover, our knowledge has extended to include “vertical linkages” with technology suppliers to evaluate the technologies currently available as well as to identify possible channels for sustainably scaling improved options. Approximately 50% of the budgeted effort during Year 1 is devoted to the completion of these assessments by all four in-country project teams.

We have identified promising in-country, “on-the-shelf” and “in the field elsewhere” technologies/best practices that will be incorporated into and evaluated through stakeholder participation as part of our research strategy. These technologies and best practices that will be pilot-tested and evaluated by the end-users, with the expectation for refinement to ensure country-specific scaling and commercial uptake, storage (Purdue Improved Crop Storage (PICS) triple bagging technology; GrainPro Superbags/cocoons; hermetic metal drums/bins), drying (Hohenheim solar dryer), moisture measurement (USDA-ARS moisture sensor), mycotoxin assessment (Romer Lab test strips), storability prediction (Woods End Lab CO2 kits), insect pest control (diatomaceous earth dusts, silica nanoparticles, approved insecticides, Vestergaard Frandsen insecticide impregnated bags), and market access (USAID Warehouse Receipt Systems).

**2. Project Development**—Projects will be based on the gaps identified through value chain assessment analysis, previous experience gained in each country, and input from USAID Missions. Assessment of the critical control points within the value chain are being made and appropriate grain harvesting, drying, storage, handling and marketing methods examined for each region to determine: 1) the key points within the value chain to concentrate our initial projects, and 2) what technologies to focus on. While project development in each country will be led by the Country Team Co-Leaders and overseen by the Managing Technical Director, this process will be informed by a crosscutting group of experts in technology and best practices, gender impacts and stakeholder involvement, nutrition, economics, environmental concerns, and engagement to assure that these factors are being taken into account.

**3. Setting Up Pilot Projects**—Initially, projects in each country will be confined to a select group of smallholder farms or storage facilities, particularly in the first year that the projects are established. This pilot approach will be expanded during the second program year. The key objective of this strategy will be to identify, through stakeholder involvement, initial technologies and best practices as well as to assess the technical robustness, economic feasibility and end-use acceptance of these technologies/practices. This approach will also help us understand the best mechanisms for extension and further adoption of tested technologies and practices. We will utilize our in-country collaborators (and USAID Missions) to determine the best sites for pilot testing. SHARE already has sentinel project sites set up in Guatemala where they monitor progress and assess impact on livelihoods, nutrition, food security and economic growth. We will use these sites to assess aflatoxin and fumonisin levels pre- and post-harvest and compare the effects of the intervention techniques and practices examined. Similar pre- and post-project impact assessments will be undertaken in each country.

**4. Scaling Up**—The complex nature of PHL reduction dictates that a two-pronged approach be implemented for scaling up. First, once our “end-user approved” best technologies and practices have been established, we will utilize our engagement strategy to put our research results into practice taking what we learned in our pilot studies to a wider geographic area in the target country. We have been identifying and establishing partners across the value chain and in local regional governments to help us

with this scale up as well as with the appropriate methods and messages for the scale up process. The value chain analysis itself is invaluable in helping us determine which groups to target as well as help us identify the potential bottlenecks we will encounter in the wider adoption of the technologies and best management practices that were developed through the pilot studies.

The success of the PICS project in Western Africa illustrates that education and training at the local village level has been a key factor in driving adoption of triple bagging technology among thousands of farmers at the local and regional level. In fact, adoption of the technology has spread well beyond the original target region over the past ten years. A primary reason adoption has been quite rapid and widespread is that the readily available, inexpensive technology was shown to successfully manage bruchid infestation of cow peas, and the technology is easy to understand and adopt. The GrainPro bags also work but they are more expensive (typically about \$3/bag) and depend on a company-controlled distributor network, and thus are neither affordable nor readily available to most small holder farmers.

In that regard, moisture sensors and mycotoxins test strips face a similar challenge. However, it is a different kind of a challenge. The inclusion of local entrepreneurs to serve as distributors of the technology may help in greater adoption of these technologies. Moisture sensors and test strips are essential technologies because we will need to address the improved handling of wet grains (especially maize in Guatemala and Ghana, and rice in Bangladesh). If wet grains can be harvested earlier because reasonable and reliable drying technology is available (along with the understanding/knowledge on how to utilize it), and the moisture content can be monitored before, during and after drying, then the mycotoxins issue will likely be remediated. (Earlier harvest will avoid mycotoxins development on wet grain sitting in the field, and drying will avoid wet grain being infected by molds and mycotoxins while in storage; and, mycotoxins can be quantified/monitored before and after drying with test strips). The storage of these now-dry grains can then successfully commence with a number of known and proven technologies (triple bagging, plastic barrels, steel silos etc.). For example, in the case of Ghana, education/training and equipping of model farmers and professionals from private sector agricultural institutions (e.g., ABCs) will facilitate increased adoption of the use of moisture sensors and test strips in a sustainable manner. As previously mentioned, each trainee will be provided a portable moisture meter to use or distribute to a producer to use.

The second part of the scale-up process relates to establishing and implementing a knowledge infrastructure that can disseminate these and other findings across broader geographic and commodity boundaries. PHL occurs across the entire agricultural value chain, from the field to the consumer. Causes of loss can vary extensively between commodities, growing seasons, people, and geographies. Thus, it has not been possible to create and disseminate a single template that can be generally applied to reduce PHL. Further, developing countries' inadequate communication systems and limited information/analytical capabilities has severely restrained the transformative steps needed to tailor promising practices and technologies for adaptation in new settings. Therefore, learning from differing projects across time and space historically has been difficult. We will aggressively implement practices and technologies targeted to PHL reduction in key Feed the Future settings and establish technology-enhanced capabilities to directly address the challenges that have severely retarded widespread progress in this area of work. Our effort will employ and enhance an existing technology platform, the Sustainable Development Virtual Knowledge Interface (SusDeViki; [www.susdeviki.illinois.edu](http://www.susdeviki.illinois.edu)), to investigate and establish these

urgently needed learning capabilities. This effort will be further informed by the PHL evidence portal being developed and implemented at the ADM Institute.

**5. Inclusion of the Private Sector and other In-Country Entities**—We have been building collaborative relationships with the private sector and other in-country entities. In Ghana, Pens Food Bank is a storage company that helps connect smallholders with markets. It accepts maize from producers, traders and aggregators for cleaning, drying and storage for a fee. Pens Food Bank is providing its drying, storage and training facilities to help us conduct necessary research and training. The University of Energy and Natural Resources (Sunyani, Ghana), Kwame Nkrumah University of Science and Technology (Kumasi, Ghana) and the Savanna Agricultural Research Institute (Tamale, Ghana) have all agreed to provide faculty and graduate students to help with in-country research of the PHL Innovation Lab. HIWOT Agricultural Mechanization Company (Ethiopia) is willing to help identify people, facilitate collaborations, and provide advice and technical assistance. Practical Action (NGO, Bangladesh) will use its local network to help with pilot projects and disseminate knowledge. SHARE (nonprofit, Guatemala) has developed instruction programs in health, nutrition, agriculture and food production. They have agreed to help the PHL Innovation Lab 1) find private partners that would like to participate in the pilot studies, 2) help us with local and national agreements and MOUs, 3) act as a local information clearinghouse, and 4) serve as an in-country liaison to Guatemala’s USAID Mission office.

**6. Cross-cutting Analyses**—Our approach to cross-cutting analyses is that these considerations are part of each project. We ensure this through our cross-cutting group of experts (Maier, Opit, Lilja, Higgins, Sonka, Bhadriraju, and Washburn) who provide input to the design of all projects. Additionally, these experts sit on the Internal Steering and Monitoring Committee that reviews the progress every six months. They will make sure that projects continue to take these factors into account.

**Gender**—Our gender strategy uses two approaches. First, we build the team’s capacity to address the gender dimension of agricultural research and extension through initial gender sensitization as well as through specific training in gender analysis tools and methods. Second, we integrate gender and participatory approaches into all stages of the project cycle, i.e., planning, assessment, pilot testing /technology evaluation, scaling up as well as in project monitoring and evaluation and impact assessment activities.

**Nutrition**—Chronic malnutrition rates are high in our four target countries; thus, reducing PHL is a critical and sustainable factor for improvement. In this project, we approach improving nutritional outcomes on four fronts, primarily using post-harvest technologies and best practices to contribute to food security. First, our research will help assure the quantity of staple food crops is increased through better post-harvest management and technology use, resulting in more grain for consumption and/or sale, both of which will decrease smallholder family members’ food insecurity. Second, we assess crop quality and safety and determine best post-harvest practices, particularly where mycotoxin contamination is a major concern. By reducing consumption of contaminated staple foods, this project will reduce negative impacts of mycotoxins on human health, which range from impaired immunity and nutritional status to death. Preventing staple foods from spoiling will also lead to maintenance of their nutritional value, such as their energy, protein and digestible carbohydrate content. Third, we will assess the feasibility of fortifying flour by adding pre-mixed nutritional supplement powders when the grains are milled at the local village mills. Utilizing produce to fortify masa flour will also be explored. Finally, culturally appropriate nutrition

education and behavior change messaging, integrating existing educational materials from partners such as SHARE, WISHH and others, will be a key part of our engagement strategy.

**Environment**—All research programs and activities proposed in this project in Bangladesh, Ethiopia, Ghana and Guatemala will adhere to USAID’s Environmental Compliance Procedures in Title 22 of the Code of Federal Regulations, Part 216 (22 CFR 216). Most proposed projects do not have a significant effect on the environment as they fall outside the 11 classes of action identified in Part 216.2 (d) (1). However, projects in Ethiopia and Ghana, which include the use of pesticides on commodities and in warehouses, shall comply with procedures set forth in Part 216.3. Whenever the project scope includes evaluation of insecticides (Ethiopia) or insecticide-treated bags (Ghana) in large field trials and multiple locations, Pesticide Procedures (22 CFR 216.3) will be followed.

Another aspect of environmental concerns is sustainability issues. The initial value chain analysis will help point out areas needing environmental mitigation. Additionally, the projects in each country will try to utilize renewal energy sources (e.g., solar drying) as much as possible as well as engage local artisans, business people and workers to create and develop locally-produced tools and technologies to aid in the sustainability of implemented technologies and practices.

7. **Engagement**—A major thrust of our engagement approach is to develop collaborative relationships with in-country partners (e.g., farmers organizations, Extension, universities, private sector companies, food banks/coops, NGOs, national and regional policymakers, provincial and local commissioners/officials, ministry employees) that will serve as the foundation for a multi-pronged education program. A robust train-the-trainer program will be established within this foundation involving the use of leadership teams, comprised of local stakeholders, who will have specialized training in the best technologies and practices developed by our research and who will help develop the training programs for the groups that they will train. National symposia modeled after the Ghana Grains Council Pre-Harvest Networking (ACDI/VOCA-ADVANCE, 2012) event will also be delivered. Village level training workshops will follow the symposia that will be reinforced by educational videos developed by UIUC’s Scientific Animations Without Borders (SAWBO). The videos will be made accessible via cell phone and the audio content will be broadcast by radio and cell phone. Finally, we will involve local university faculty and students in data collection and research projects to help train the next generation of in-country researchers in PHL investigation and prevention.

8. **Involvement of USAID Missions**—We will pursue Associate Awards to broaden the projects conducted, help scale up pilot projects and expand them through the regions and to other Feed the Future countries. We have engaged USAID Missions in each of the initial projects from the start. The Program Director and country project team leaders have travelled to each country and discussed and reviewed the proposed value chain assessments before they were initiated. Early in the second year, once research projects are up and running, the Program Director and country project team leaders will meet with USAID Mission staff at the project sites to review progress and explore scaling/expansion of projects in order to justify and develop Associate Awards. In addition to overall program oversight, the Program Director is expected to spend considerable effort during the second program year working with USAID staff in Washington and in Feed the Future countries to develop Associate Awards expanding the scope and impact.

## 9. Outcomes

- Measurable evidence and impact that PHL has been reduced because more smallholder/subsistence farmers, producer cooperatives and agribusiness enterprises have enhanced their capacity to reduce post-harvest loss through adoption of best practices and technologies that are linking/integrating them with market-based value chains from seed to end-user.

- Trained 60 professionals in 8 train-the-trainer workshops
- Trained 2,000 farmers, cooperative members, and agribusiness customers in 8 annual symposia
- Trained 5,400 smallholder farmers in 360 local Extension workshops
- Made available downloadable educational materials and videos/audio files on demand via cell phones, internet etc.

- Measurable evidence and impact that food security has improved because more people, at more times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

## V. **Research Project Report**

The PHL Innovation Lab is managing four parallel projects in four Feed the Future countries (e.g., Bangladesh, Ethiopia, Ghana, Guatemala). Each country project is led by two U.S. scientists representing the lead project organizations and an in-country counterpart from the primary subcontractor and collaborator. Following are the objectives of each country from the approved work plans for Year 1 and our accomplishments related to those objectives.

### **Bangladesh**

**Team Leaders:** Al Schmidley (IRRI); Dr. Prasanta Kalita (University of Illinois)

**Objective 1: Execute sub-award agreement between the University of Illinois, ADM Institute and IRRI.**

**Status:** Complete

The sub-award agreement between the University of Illinois, ADM Institute and IRRI was signed on August 13, 2014, and is complete.

**Objective 2: Participate in PHL Innovation Lab “kick-off” Meeting**

**Status:** Complete

This meeting was held in Manhattan, January 28-29, 2014. Alfred Schmidley, IRRI Postharvest Value Chain Specialist and Team Leader for the Bangladesh component, prepared and shared tools, such as the post-harvest (PH) household survey, actor interview questions, and an earlier partner report on Bangladesh to demonstrate how these could be effectively used in a PH chain assessment. A general overview of Bangladesh and successful IRRI-promoted technologies in other Asian countries was also shared with the broader group (in PowerPoint), along with how the PHL Innovation Lab as a platform could support research pilots, training and capacity-building

amongst local stakeholders, and development of sustainable market-driven business models for delivery.

**Objective 3: Design job profiles, recruit and hire local staff**

**Status:** Complete

IRRI recruited and hired two people: 1) Mr. Mobarak Khan Choudhury, a Senior Postharvest Specialist/Project Coordinator. He has more than twenty years hands-on experience piloting and adapting technologies and training poor and marginal farmers and other stakeholders, and 2) Mr. Latiful Bari, a Postharvest Engineer. His time and abilities will be leveraged 50-50 under the USAID funded CSISA Project. This will allow us to bring forward needs for piloting studies and verification with local actors of improved and locally-adapted PH technologies under the PHL Innovation Lab. Both candidates have extensive hands-on experience. Both candidates also attended a two-week intensive training course, “Post-production to Market,” at IRRI-HQ in the Philippines and took the final exam for certification as IRRI Basic Postharvest Trainers.

**Objective 4: Identify PH stakeholders and local partners**

**Status:** Complete

Through a series of stakeholder meetings, PH stakeholders were engaged by the Project Team early on using a framework to evaluate their interests and capacity as potential partners in Bangladesh. Several organizations and key persons were identified from public, NGO, and private sectors and engaged in start-up activities, including a Literature Review, PH Chain Assessment, and technical training and exposure trips for improved PH options, such as mechanical drying.

**Objective 5: Conduct Post-Harvest Assessment in Feed the Future Zone and broader PH landscape**

**Status:** In Process

Various assessment tools and methods, such as household surveys, focus discussion groups, and in-depth interviews were developed with suggestions and feedback from a number of local organizations with strong links to farmer networks, women Self-Help Groups, and other PH actors, then translated and finalized by the Project Team (January to April). The PH chain assessment is now being implemented (April to September) by the Project Team with help from several local partners that include Bangladeshi research institutions (Bangladesh Agricultural University, Bangladesh Rice Research Institute, etc.) and NGOs who operate in the Feed the Future zone. To date, 178 farm household surveys, 19 focus discussion group (FGDs), and 78 actors have been interviewed, in 19 villages representing 10 districts in the USAID Feed the Future zone. A local consulting firm has been engaged to tabulate household survey data for the final assessment report. In addition, a professor emeritus, Dr. Md. Abdul Baqui, (Bangabandhu Sheikh Mujibur Rahman Agricultural University) and retired head of BRRI Machinery and Postharvest Technologies Department has been engaged to coordinate the post-harvest literature review with input from local research institutions.

As such, the PHL assessment will include information from poor and marginal farmers, women self-help groups, and other PHL chain actors, and will include a literature review of 1) past PHL research, 2) government- and NGO-led projects, and 3) review of extension-related materials. This will help the project capture past lessons and avoid “reinventing the wheel” but also identify gaps and capacities of partners to be leveraged in the broader PH landscape. Interviews and data

collection will be completed August and a final report with entry points, strategies, and recommendations with local partners prepared in September.

**Objective 6: Conduct PHL Innovation Lab Inception Meeting for Bangladesh**

**Status:** Complete

The inception meeting held June 3 in Dhaka, followed numerous stakeholder consultations and aimed to address a “core group” of interested stakeholders. Thirty-three participants from 17 organizations participated in this event that had these objectives: 1) De-brief potential local partners and key stakeholders on the project’s goals and next steps, 2) Share initial plans and ideas for collaborative activities gathered thus far, and 3) Plan next steps for conducting a post-harvest chain assessment and identify potential partners, capacities, and areas of interest in the project. Time was optimized for participants to interact and provide information where there organization’s activities and post-harvest in rice intersect. The afternoon’s break-out sessions allowed participants to share knowledge of past research and projects over many years that they knew of or were engaged in (i.e., research, extension, and development projects). Lastly, participants described their organization’s current plans, gaps that need to be addressed, and priority stakeholder needs. These outputs were inputted into the PHL assessment for follow up discussion and planning activities with individual organizations. The event received excellent news coverage (see: <http://agrillife24.com/index.php/2013-07-01-16-26-51/123-2013-07-02-16-06-36/3818-inceptionworkshop-for-innovation-lab-for-reduction-of-post-harvest-loss>).

The Year 1 work plan included January to December, so Objectives 7, 8, and 9 have been moved to Year 2.

**Objective 10: Develop work plans for year 2 and write up and submit year-end report to USAID**

**Status:** Year 2 work plan development is in process.

**Ethiopia**

**Team Leaders:** Dr. Subramanyam Bhadriraju (Kansas State University); Dr. Rizana Mahroof (South Carolina State University)

**Objective 1: Accumulate data on postharvest losses in maize, wheat, sorghum, and pulses**

**Status:** Completed

Data on the production of these four crops in Ethiopia has been compiled by region. Literature postharvest losses are available for maize and sesame, but losses in wheat and chickpea are scanty. Losses in sesame are in the range of 15-20% and losses of 15-30% have been reported for maize. All available literature published in Ethiopian journals and other international journals have been compiled through library searches, interlibrary literature requests, and from scientists in Ethiopia. Only a limited number of papers exist on the role of gender in postharvest loss reduction. All data have been summarized, and a hard copy of the literature on postharvest losses, and postharvest technologies such as hermetic storage methods, and evaluation of traditional pest management practices has been shared with our in-country partners at Mekelle University in Ethiopia. Information on the entities involved in research and/or technology transfer activities in Ethiopia has been summarized with the help of Dr. Abraham Tadesse.

We have identified scientists at Mekelle University as our in-country partner. Scientists at this institute have been in contact with the US team since February 2014. Funds have been transferred

to Mekelle University to initiate year 1 project, which is to collect data through surveys on the postharvest losses of the four commodities. The in-country partners held a meeting in June 28, 2014, at Mekelle University to discuss how to conduct a postharvest loss assessment of the four commodities. This meeting was attended by representatives from the Ethiopian Institute of Agricultural Research (EIAR) crop research directorate, individuals from the federal and regional research centers, input suppliers, and the heads of regional bureaus of agriculture. The leaders for each crop team have been identified, and in turn these individuals recruited members to serve under each crop team. The following individuals attended the meeting. Mr. Mussa Jarso from the EIAR (Holetta); Dr. Fetien Abay, Dr. Ibrahim Fitway, Dr. Beshir Ahmed, Dr. Girmay Tesfaye, Dr. Yohannes Tekle, Dr. Dereje Assafa, Dr. Atinkut Mezgebu, Mr. Mulugeta Hagos, Mr. Hadush Tsehaye, and Mr. Tsegab Meles from Mekelle University; Dr. Eyasu Abraha from the Tigray Agricultural Research Institute; Dr. Asnake Fikre, EIAR, Addis Ababa; Dr. Geremew Terefe, Sesame Business Network; Mr. Abraham Abiyu, Gondor Agricultural Research Institute; Dr. Tedesse Desalegn, EIAR, Kulumsa agricultural Research Institute; Mr. Fissaha Bezabih, Bureau of Agricultural Research and Development, Tigray; and Muluken Sintayehu, Bahir Dar University. A list of all of these stakeholders, including Dr. Adam J. Silagyi from USAID Mission office in Addis Ababa, has been compiled. The plan of work in Ethiopia for year 1 has been finalized and an agreement between Kansas State University and Mekelle University is in place as of June 2014.

The US team members except for Drs. Ambrose Kingsly and Shannon Washburn also visited Ethiopia during April 18-May 4, 2014. During the first trip, the team met representatives from the Ministry of Agriculture, International Seed Sector Development, GrainPro (a private company that sells cocoons and grain Superbags), ACDI/VOCA, and Agricultural Transformation Agency in Addis Ababa. The team visited Mekelle University to finalize the contract between Kansas State University and Mekelle University, and visited a smallholder farmer site to observe underground pit storage. In Mekelle the team visited the Bureau of Agriculture representatives to understand how the bureaus work at the regional, zonal, village and community levels. From Mekelle University the team visited Humera to discuss and understand postharvest loss situation in sesame and met representatives of the Sesame Business Network actively serving the farmer cooperatives. From Humera the team visited the Amhara Agricultural Research Institute and discussed postharvest loss issues in maize. This meeting was also attended by two scientists from Bahir Dar University. The team visited the Kulumsa Agricultural Research Center in Oromiya to understand research being done on wheat and heard a talk on postharvest losses in wheat. Finally, the team visited the USAID Mission office in Addis Ababa and discussed the PHL Innovation Laboratory work on postharvest losses with Dr. Silyagi.

The second trip to Ethiopia, where all US team members were involved, occurred during July 18-31, 2014. The team flew to Mekelle University and visited with scientists involved in postharvest research. We heard talks on molds and mycotoxins in grains and on how grains are stored in Ethiopia. We visited the engineering department and observed solar dryers made for drying fruits and vegetables. These dryers were developed by Mekelle University engineers and can be modified for drying grain. The US team gave several tools for capturing insects in grains, and gave a moisture meter and several commercial traps and lures for monitoring insects in grain stores. From Mekelle, the team visited Bahir Dar University to forge new alliances and met key individuals who will be involved in conducting the maize postharvest loss assessments. In Bahir Dar the team visited a smallholder farmer's site and observed how grain is stored inside homes in structures made of mud, teff, and cow dung (Gota). The team also came to know of a solar dryer developed by Bahir Dar University scientists. The team visited Tigray and Amhara agricultural regional offices and discussions here gave the team a very good understanding of how these

government extension offices are run. The infrastructure in place in Ethiopia is useful for information dissemination as we embark on research projects during years 2 through five.

The team visited Bako Agricultural and Mechanization Research Center, where research on maize breeding is being conducted. Scientists from this research center have done considerable work on management of postharvest losses in maize. We had a brief talk on the research and were given copies of their published research work. We met Dr. Abraham Tadesse in Addis Ababa, who has been conducting postharvest pest management research for nearly 20 years. He shared his publications and entities involved in Ethiopia involved in postharvest research. Finally the team met GrainPro and HIWAT mechanization representatives. These are our private partners in research and extension activities planned for years two through five. The second trip allowed us to make new contacts and renew contacts with those whom we met during our first trip such as representatives from ACDI/VOCA.

We were unable to see harvest of crops as this would occur in late October or in November. The commodity crop teams in place in Ethiopia will identify smallholder farmers for the postharvest loss project.

### **Objective 2: Develop PHL assessment survey questionnaire**

**Status:** Complete

A postharvest loss assessment survey was developed and initially reviewed by the US team members, and this survey instrument was shared with the in-country partners for their input. During the second visit, a special meeting was held at the EIAR Headquarters in Addis Ababa where stakeholders involved in this project met and reviewed questions in the postharvest loss survey instrument. This survey was amended after input from in-country partners and four crop-specific surveys were shared with all in-country partners. The survey instrument is detailed and is designed to gather information on crop production, losses at the time of harvest and after harvest, amount of losses during various postharvest operations, role of gender in postharvest activities, utilization of commodity by farmers, nutrition issues, and issues related to use of pest management practices, pesticide safety, and environmental issues. This survey is currently being translated into local languages by the in-country partners.

The questionnaire has been mailed to in-country partners during the second week of August. The third visit to Ethiopia to observe data collection efforts will take place during October 24-31, 2014. During the third trip, we intend to observe harvest of at least two crops, maize and sesame.

The in-country partners are using enumerators to visit smallholder farmers to gather postharvest loss data using the survey questionnaire. The plan is to obtain at least 200 responses for each commodity by end of October. The data gathered will be analyzed during November, and a detailed report will be submitted by the end of December.

### **Objective 3: Compile and analyze PHL assessment survey questionnaire data**

**Status:** In Process

The questionnaire has been mailed to in-country partners during the second week of August. The third visit to Ethiopia to observe data collection efforts will take place during October 24-31, 2014. During the third trip, we intend to observe harvest of at least two crops, maize and sesame.

The in-country partners are using enumerators to visit smallholder farmers to gather postharvest loss data using the survey questionnaire. The plan is to obtain at least 200 responses for each

commodity by end of October. The data gathered will be analyzed during November, and a detailed report will be submitted by the end of December.

**Objective 4: Evaluation of stakeholders and collaborators, and development of an annual report**

**Status:** Ongoing

Evaluation of stakeholders and collaborators is ongoing.

**Ghana**

**Team Leaders:** Dr. George Opit (Oklahoma State University), Dr. Samuel McNeill (University of Kentucky, Princeton, KY)

**Objective 1: Hire an In-Country Coordinator (ICC) and identify in-country stakeholders for PHL surveys etc.**

**Status:** Complete

The internal country coordinator (ICC; Mr. Kwabena Adu-Gyamfi) was hired and sub-contract agreement signed on March 24, 2014. The Ghana Team worked with the ICC and identified in-country stakeholders who were visited/interviewed during the first PHL survey trip (5/16-31/14).

**Objective 2: Gain overall understanding of the maize value chain and conduct a PHL verbal survey (face-to-face interviews)**

**Status:** Complete

The Ghana Team developed a questionnaire for a verbal PHL survey. The team conducted the first Ghana PHL assessment of the maize value chain during the period 5/16-31/14 (in-country 5/17-30/14). The assessment focused on the understanding of maize PHL in the Middle Belt during the major season for maize production (April-August/September). The Ghana Team prepared a 2-page document on findings of the first PHL assessment trip and presented to the USAID Office of Economic Management Accra, Ghana on 5/30/14. The team identified successful tactics already in use in Ghana but which are not yet widely adopted or need further refinement that could significantly mitigate maize PHL if refined and widely adopted. Cooperators, topics, and locations for research to be conducted in Years 2 and 3 have been identified. The Ghana Team has completed writing a report on the first PHL survey and this is to be submitted to stakeholders and the USAID Office of Economic Management, Accra, Ghana.

**Objective 3: Identify and facilitate admission of three Ghanaian M.S. students to Kwame Nkrumah University of Science and Technology (KNUST) and Oklahoma State University (OSU) in Fall of 2014**

**Status:** Ongoing

Two M.S. students, Mr. Kofi James Danso and Ms. Naomi Manu, were identified and have been admitted for studies at Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana where they started on 8/15/14. The search for a third M.S. student to start at Oklahoma State University, Stillwater, OK on 1/12/15 or in the fall is ongoing. These research topics for the 2 Ghanaian M.S. students admitted to KNUST have been proposed but are pending confirmation by the Ghana Team.

**Objective 4: Gain overall understanding of the maize value chain and conduct the 2nd PHL verbal survey (face-to-face interviews).**

**Status:** Year 1 work plan included January to December, so this objective is being moved to Year 2.

**Objective 5: Write an annual report.**

**Status:** Complete

## **Guatemala**

**Team Leaders:** Dr. Carlos Campabadal (Kansas State University); Dr. Andreia Bianchini (University of Nebraska)

**Objective 1: To identify and engage in-country stakeholders**

**Status:** Complete

Literature was reviewed to examine the current situation on postharvest techniques used in the Western Highlands in Guatemala and incidence of the presence of mycotoxins on corn. Also, it was reviewed which organizations are currently working on similar projects or have outreach programs in the Western Highlands (Huehuetenango region). After several meetings to discuss the project, SHARE Guatemala (NGO) was chosen as the primary in-country stakeholder and collaborator to develop the project in conjunction with the PHL Innovation Lab. Also, the Universidad del Valle (local private university) was chosen as a collaborator to develop trainings, conduct grain quality analysis, participate in scale up research, etc. The group from the PHL Innovation Lab traveled to Guatemala (March 16-21, May 26-30, August 17-28) to discuss in depth the project with SHARE Guatemala and Universidad del Valle. The Western Highlands (Huehuetenango Region) were visited to identify the potential Feed the Future regions (municipalities) to conduct the project, meet community leaders from each of the visited regions, and learned about the communities. During the visit to the Western Highlands (Chiantla and Todos los Santos municipalities), the current postharvest practices were observed and discussed with their community leaders and SHARE technical staff for these regions. During the visit to Guatemala, the PHL Innovation Lab connected with the identified stakeholders: SHARE Guatemala, Universidad del Valle, Molinos Modernos, Central Agrícola and Alimentos S.A. The work plan and expectations for the project were delivered and explained to SHARE Guatemala and also shared with Universidad del Valle. Several suggestions and comments were received from them that fit with the goals of the project. During the visit to Guatemala, the PHL Innovation Lab team also visited the USAID Guatemala Mission office to connect and explain the project. Several suggestions and comments were received by them that fit with the goals of the project.

**Objective 2: Development of PHL Assessment Survey Questionnaire, review and execute the survey**

**Status:** In Process

The Post-harvest Loss Assessment Survey Questionnaire was developed by the PHL Innovation Lab team for Guatemala. The PHL Innovation Lab Guatemala team obtained a USDA-funded research grant on the SCRP project proposal: From the “Milpas” to the market: a feasibility study on the use of metal silos for safer and better storage of Guatemalan native corn. This project will help fund several research goals that are complementary to the PHL Innovation Lab project for

Guatemala. The Postharvest Loss Assessment Survey Questionnaire was reviewed by the PHL Innovation Lab engagement team. The team traveled to Guatemala to do the final review of the Post-harvest Loss Assessment Survey Questionnaire and to plan the survey assessment with SHARE. SHARE Guatemala validated the Post-harvest Loss Assessment Survey Questionnaire.

**Objective 3: Compile the responses, analyze survey data and identify potential projects, technologies and responsible collaborators for the projects**

**Status:** Year 1 work plan included January to December, so this objective is being moved to Year 2.

This activity was originally in the Year 1 work plan covering January through December. However, the Year 1 work plan is revised to cover January to September. This activity is moved to the Year 2 work plan being developed.

**Objective 4: Evaluation of stakeholders and collaborators, and development of annual report**

**Status:** Ongoing

Evaluation of stakeholders and collaborators is ongoing.

## VI. **Human and Institutional Capacity Development**

- Dr. Andreia Bianchini-Huebner and Luis Sabillon (Guatemala project) traveled to Guatemala City August 7-13, 2014, and trained University of del Valle testing lab employees on using the Romer Lab mycotoxin/aflatoxin test kits.
- Funds were budgeted in the following country projects to support graduate students who will conduct research in support of the Feed the Future PHL Innovation Lab:
  - Mr. Kofi James Danso, MPhil Student in Entomology, Manu Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana; started 8/15/14
  - Ms. Naomi Manu, MPhil Student in Entomology, Manu Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana; started 8/15/14
- Although not directly funded by the Feed the Future PHL Innovation Lab, the following graduate students have expressed interest in contributing to various aspects of in-country projects:
  - Sam Cook, M.S. Student in Grain Science, Department of Grain Science and Industry, Kansas State University (Guatemala project; major professor: Dr. Dirk Maier)
  - Jennifer Frederick, Ph.D. Student in Grain Science, Department of Grain Science and Industry, Kansas State University (Guatemala project; Dr. Subramanyam Bhadriraju)
  - Luis Sabillon, Ph.D. student in Food Science and Technology, University of Nebraska (Guatemala project; Dr. Andreia Bianchini-Huebner)
- Discussions are taking place with Dr. Eneyew Tadesse Malaku, Chairman of Food & Beverage Process Technologies, Bahir Dar University and Dr. Baylie Damtie, President, Bahir Dar University about an MOU between KSU and Bahir Dar University for collaboration on milling and baking technologies. The MOU includes specific mutually agreeable initiatives. The standard MOU has been revised by KSU and sent to Bahir Dar University for approval and signatures.
- Plans are being developed to set up a Grain and Flour Quality Lab at Bahir Dar University to support training and certification of Ethiopian industry personnel.

- Collaboration with TechnoServe and Partners in Food Solutions (PFS) is on-going to help the Ethiopian milling industry to improve flour quality and functionality through improvement in flour extraction and quality.

## VII. Project Management Activity

The PHL Innovation Lab held its kick-off meeting in Manhattan, KS January 28-29, 2014. We had a great attendance by team members. Those that weren't able to attend on-site were able to connect via videoconferencing. Below is the picture of all those that were able to attend in person. Those that attended the kick-off meeting are:

Kingsly Ambrose (Kansas State University)  
Subramanyam Bhadriraju (Kansas State University)  
Carlos Campabadal (Kansas State University)  
Janice Cole (Kansas State University)  
Jason Ellis (Kansas State University)  
Mark Fowler (Kansas State University)  
Mary Meck Higgins (Kansas State University)  
Roberta Hodges (Kansas State University)  
Nina Lilja (Kansas State University)  
Dirk Maier (Kansas State University)  
Mary Lou Marino (Kansas State University)  
Jan Middendorf (Kansas State University)  
Tom Phillips (Kansas State University)  
Venkat Reddy (Kansas State University)  
Rick Umscheid (Kansas State University)  
Shannon Washburn (Kansas State University)  
Naaz Yasmin (Kansas State University)  
Barry Pittendrigh\* (University of Illinois-Urbana  
Champaign)

\*attended via videoconference

Steve Sonka (University of Illinois-Urbana Champaign)  
George Mbata\* (Fort Valley State University)  
Alfred Schmidley\* (IRRI)  
George Opit (Oklahoma State University)  
Bruce Hamaker (Purdue University)  
Rizana Mahroof (South Carolina State University)  
Beth Mitcham (University of California-Davis)  
Andreia Bianchini Huebner (University of Nebraska-  
Lincoln)  
Rolando Flores\* (University of Nebraska-Lincoln)  
Heather Hallen-Adams\* (University of Nebraska-  
Lincoln)  
John Bowman (USAID)  
Angela Records (USAID)  
Paul Armstrong (USDA-ARS)  
Franklin Arthur (USDA-ARS)  
Jim Campbell (USDA-ARS)  
Floyd Dowell (USDA-ARS)  
Georgina Zivanovic (Vestergaard)



The website for the PHL Innovation Lab [www.reducePHL.org](http://www.reducePHL.org) was launched shortly after the kick-off meeting.

The PHL Innovation held monthly leadership team meetings beginning in April (April 2, May 7, June 11, July 17 and August 18; agendas are included as Appendix B) to keep the communication open as to what is taking place in each country as well as in the US.

Memorandums of agreement with various partners (listed below) have now all been signed and are actively in place.

- University of Illinois – Urbana-Champaign
- International Rice Research Institute (IRRI)
- Oklahoma State University
- South Carolina State University
- University of Nebraska – Lincoln
- Mekelle University (Ethiopia)
- SHARE Guatemala

The year 1 work plans along with other planning documents requested by USAID were submitted and approved on June 30. The Bangladesh work plan for year 1 was revised due to the delay in the signing of the sub-award agreement. The revised work plan was submitted and approved on August 11. The annual report is now being submitted and the year 2 work plans are in process and will be submitted soon.

We will be asking the PHL Innovation Lab team members to complete a survey reflecting on year 1 of the project. The survey is expected to go out the beginning of September. This will help us to see what we can do to improve project communication, planning, execution and management as we go forward.

## **VIII. Other Topics**

### a) Cross Cutting Issues

i. Gender – With the help of the Gender Coordinator (Nina Lilja), the PHL Innovation Lab Managing Technical Director (Venkat Reddy), and the country team leaders, gender specialist consultants have been and are still being identified. Ada Rocina will be hired to be the gender consultant for the PHL Innovation Lab’s work in Guatemala. In Ghana and Ethiopia, resumes of gender experts are currently being reviewed with the expectation that one will be hired in each country very soon. In Bangladesh, the names of qualified candidates are still being sought.

ii. Economics – Economic decision making to effectively reduce postharvest loss traditionally has lacked effective tools to inform smallholder farmers and the managers who serve them as to the best actions to reduce loss. While lack of measured data is a key impediment, a robust economic framework combined with effective tools is needed to enhance decision making. Efforts within the Innovation Lab’s economic cross-cutting issue have focused on collaborating to initiate the advances needed which can lead to an improved framework and useful tools.

The framework and a prototype version of the decision making tool, called the Postharvest Investment Tool, were created through collaboration of researchers at the Centrec Consulting Group, the PHL Innovation Lab and the ADM Institute for the Prevention of Postharvest Loss (ADMI). (These can be accessed at the following URL [http://postharvestinstitute.illinois.edu/tools\\_outreach.html](http://postharvestinstitute.illinois.edu/tools_outreach.html)). The tool produces reasonable estimates based on what is known about postharvest practices and expected loss percentages at various stages of a supply chain. Furthermore, the tool provides insights on how changes in practice could affect postharvest loss in both quantity and quality. With the information provided by the tool, decision makers can better evaluate the potentials of their prospective loss-reducing investments.

These advances were first presented in May 2014, at a convening of postharvest experts co-hosted by the Bill & Melinda Gates Foundation and the ADMI. Titled, “Postharvest Loss Metrics, Measurement, and Mitigation: Resolving the Unmet Needs”, the convening was a

platform for cross-sector experts to discuss challenges presented by the lack of decision-relevant information on postharvest loss. Several PHL Innovation Lab members were in attendance (Maier, Sonka, Kalita, Middendorf).

A second tool, the African Postharvest Losses Information System (APHLIS) was also presented. Given it is available online, we initiated a review to determine whether it could be utilized by the country teams of the PHL Innovation Lab. A white paper is currently being reviewed by the leadership team. An Abstract has been accepted for oral presentation at the 11<sup>th</sup> IWCSPP in Thailand this November.

iii. Nutrition – In Year 1, we included sessions on nutrition-related aspects of our project in the leadership team’s kick-off training and during many of the monthly leadership team conference calls. We also incorporated nutrition questions into each of our country post-harvest loss assessment surveys.

iv. Environment – Given that no demonstration and research projects have yet been initiated, no environmental impact assessment has been needed so far.

## **IX. Issues and how they are being addressed**

- Gender Coordinators – In addition to an overall gender coordinator (Dr. Nina Lilja) it was decided that it would be best to identify and hire a gender consultant in each of the four countries. That process is still on-going. Once complete there will be a training of the entire project team with the hired gender consultants with the help of the overall gender coordinator.
- Hiring in-country staff – This has taken longer than anticipated in part because in-country partners had not been completely identified in Ethiopia and Bangladesh at the time the grant was approved. Since then, it took longer than planned to get the subcontracts executed in large part due to slowness in KSU’s Grants and Contracts office. This bottleneck has since been overcome.
- Shift of calendar/timeline – Given the contract between USAID and Kansas State University was not signed until late in 2013, it was agreed that the start date of the Feed the Future PHL Innovation Lab is January 1, 2014. Given projects are based on the federal budget year, the first project year is only nine months long. As a result, Year 1 budgets and work plans had to be adjusted accordingly.
- Leadership change in UIUC’s ADM Institute – The founding director Dr. Steve Sonka, who served as co-PI for the Feed the Future PHL Innovation Lab grant, has stepped down but continues to serve as the Economics Coordinator for the project. Dr. Prasanta Kalita serves as the new Director, co-PI of this grant, and co-leader of the Bangladesh project.

## **X. Future Work**

- As a follow up to attending the inaugural meeting of the Purdue University-led Food Processing Innovation Lab (FPL), Dr. Maier will be working on creating and encouraging linkages between the Objective 1 and 2 leaders of the FPL and counterpart scientists in the PHL Innovation Lab.
- Contact has been made with the Peanut and Mycotoxin Innovation Lab for the purpose of identifying reliable analytical labs in the four project countries where our project teams can submit samples for mycotoxin analysis. Additionally, given the concern over aflatoxin in each of our four countries, our PHL Innovation Lab will explore close coordination with the Peanut and Mycotoxin Innovation Lab in our Feed the Future countries.
- Work plans for Year 2 are being refined and finalized and will be initiated during the coming months.

## **XI. Appendices**

### **Appendix A**

#### **Participants List for PHL Innovation Lab Inception Meeting in Bangladesh**

1. Dr. Shahidur Rahman Bhuiyan, Senior Ag & Food Policy Adviser, USAID, Dhaka
2. Dr. Paul Fox, IRRI Rep Bangladesh, IRRI, Dhaka
3. Mr. Alfred Schmidley, Bus. Model & Value Chain Specialist , IRRI, Philippines
4. Mr. Timothy Russell, Chief of Party, CSISA-BD, Dhaka
5. Ms. Loretta Hemsall, Manager, Corporate Services , IRRI, Dhaka
6. Mr. Bidyuth K. Mahalder, Deputy Country Coordinator, CSISA-BD, Dhaka
7. Mr. A.K.M. Ferdous, Senior Specialist-Agricultural Research and Development, CSISABD, Jessore
8. Mr. Arif Hossain , Senior Specialist - Communication and Outreach, Golden Rice, Dhaka
9. Mr. Mobarak H. K. Choudhury, Sr. Agricultural Specialist Postharvest, IRRI / Innovations Lab, Dhaka
10. Mr. Latiful Bari, Postharvest Engineer, Innovations Lab /CSISA-BD, Jessore
11. Dr. Khairul Bashar, Project Coordinator, HarvestPlus, Dhaka
12. Dr. M A Sattar Mandal, Professor (former Sr Secretary, Planning Commission), BAU, Mymensingh
13. Dr. A. T. M. Ziauddin , Professor, BAU, Mymensingh
14. Dr. Monjurul Alam, Professor, BAU, Mymensingh
15. Dr. Chayan Kumar Saha, Associate Professor, DFPM, BAU, Mymensingh
16. Dr. Md. Rostom Ali, Assoc Professor & Head DFPM,BAU, Mymensingh
17. Dr. Md. Abdul Momin, Associate Professor, DFPM,BAU, Mymensingh
18. Dr. M. A. Baqui, Consultant & Visiting Professor, BSMRAU, Dhaka
19. Dr. Abdur Rahman, Head FM&PH Division, BRRI, Gazipur
20. Mr. Bidhan Chandra Nath, SSO,FM&PH Division, BRRI, Gazipur
21. Dr. Md. Ayub Hossain, PSO,FM&PE Division, BARI, Gazipur,
22. Dr. Sultan Ahmmed, MD, BARC, Dhaka
23. Richard Rose , Technical Director Team , iDE, Dhaka
24. Mr. Abdur Rob, Head of Food, Agriculture and Market, Practical Action, Dhaka
25. Mozharul Islam, Coordinator (Monitoring and Evaluation),Practical Action, Dhaka
26. Momotaz Khatun, Executive Director, Ashroy Foundation, Khulna
27. Ms. Mary Archana Costa, Sr.Asst Admin Coordinator, CSISA-BD, Dhaka
28. Mr. Md. Rezaul Karim, Office Attendant , CSISA-BD, Dhaka
29. Dr. Nguyen Thanh Nghi, Researcher, Center for Agricultural Energy & Machinery, Nong Lam University, Vietnam
30. Miguelito Diestro, Consultant, Crop and Environmental Science Division, IRRI-HQ
31. Muhammad Nuruzzaman, Project Management Assistant (Ag-Policy), Economic Growth Office, USAID,
32. Mohammad Sayed Shibly, Project Management Specialist, Economic Growth Office USAID, Dhaka
33. Mr. Sohrab Hossain , Joint Editor, The Daily Protham Alo

## **Appendix B**

### **Agendas from the PHL Innovation Lab Leadership Team Monthly Meetings**

#### **Innovation Lab for the Reduction of Post-Harvest Loss Leadership Team Teleconference April 2, 2014 5:00 pm CT**

1. Welcome and Introductions - Dirk
2. Update on PHL Innovation Lab office and staffing - Dirk
3. Travel Matrix – Venkat & Roberta
4. Status of sub-awards to in-country coordinators – Venkat, Al, Subi, George, Carlos
5. Target country updates - Venkat, Al, Subi, George, Carlos
6. PHL survey documents - Venkat, Al, Subi, George, Carlos
7. Status of reducePHL.org - Roberta
8. K-State Online for sharing documents - Roberta
9. Semi-Annual Performance Report due to USAID April 30 (Jan. 1 to March 31) – Venkat
10. Leveraging PHL Innovation Lab - Dirk
11. Other
12. Roundtable

#### **Innovation Lab for the Reduction of Post-Harvest Loss Leadership Team Meeting May 7, 2014 5:00 pm CT**

1. Welcome and Introductions – Dirk
2. Finalize Meeting Time – Venkat
3. Status of sub-awards to in-country coordinators – Venkat, Al, Subi, George, Carlos
4. Target country updates - Venkat, Al, Subi, George, Carlos
5. Leveraging PHL Innovation Lab – Dirk
6. Other
7. Roundtable

**Innovation Lab for the Reduction of Post-Harvest Loss**  
**Leadership Team Teleconference**  
**June 11, 2014**  
**9:00 am CT**

1. Welcome - Dirk
2. In-country Graduate Student Support – Venkat
3. Status of sub-awards to in-country coordinators – Venkat, Al, Subi, George, Carlos
4. Target country updates - Venkat, Al, Subi, George, Carlos
5. PHL survey documents - Venkat, Al, Subi, George, Carlos
6. Leveraging PHL Innovation Lab - Dirk
7. Other
8. Roundtable

**Innovation Lab for the Reduction of Post-Harvest Loss**  
**Leadership Team Teleconference**  
**July 17, 2014**  
**9:00 am CT**

1. Welcome - Dirk
2. Target country updates - Venkat, Al, Subi, George, Carlos
3. PHL survey documents - Venkat, Al, Subi, George, Carlos
4. Leveraging PHL Innovation Lab – Dirk
5. Gender cross cutting issues: Identify in country expert for auditing our program activities in that country related to our handling of gender issues - Venkat
6. Aflatoxin Test Kits: Preparations for getting aflatoxin test kits, readers and any training regarding - Venkat
7. Hermetic bag requirements: Estimate number of bags needed ex: PICS, Super Bags, Pesticide treated bags - Venkat
8. Dryers to be tested: Local or in country designs/availability – Venkat
9. Annual Report Preparation - Venkat
10. Finalize list of in-country stakeholders – Dirk/Venkat
11. Meeting day and time for Fall semester - Venkat
12. PHL Innovation Lab shirts and hats - Venkat
13. Other
14. Roundtable

**Innovation Lab for the Reduction of Post-Harvest Loss  
Leadership Team Teleconference  
August 18, 2014  
9:00 am CT**

1. Target country updates - Venkat, Al, Subi, George, Carlos
2. Year 1 Annual Report – Venkat
3. Year 2 Work Plans - Venkat
4. Leveraging PHL Innovation Lab
5. Other
6. Roundtable

## **Appendix C**

### **News Releases**

#### **K-State Feed the Future PHL Innovation Lab Receives USDA Award to Study Use of Metal Silos in Guatemala June 25, 2014**

Manhattan, KS—The Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss at Kansas State University recently received a two-year, \$39,050 award from USDA-SCRIP titled “From the ‘Milpas’ to the market: a feasibility study on the use of metal silos for safer and better storage of Guatemalan native corn.”

“This project fits with the PHL Innovation Lab overall objectives because its main goal is to improve storage conditions of corn harvested in the highlands of Guatemala by introducing improved post-harvest technologies, i.e. metal silos.

“It is also complimentary to the overall objectives of the PHL Innovation Lab because it evaluates the economic feasibility of such technologies,” says Andreia Bianchini, University of Nebraska - Lincoln research assistant professor, co-country coordinator for Guatemala, and PI for the USDA-SCRIP grant.

Bianchini adds, “Guatemala not only has one of the lowest food security indicators in the world, but also has the fourth highest prevalence of chronic malnutrition among all countries. Corn is the dietary staple and its availability, quality and safety is directly related to food security and public health.”

“Much of the corn that is produced in the Guatemalan Highlands is cultivated, harvested and handled via subsistence-oriented agricultural practices connected to Mayan heritage.

“These traditional practices may lead to improper post-harvest management and storage conditions which can cause losses up to 30% primarily due to stored grain pests.

“Insects in stored grain can also create entry points for mold establishment as well as transfer mold spores from infected kernels to healthy kernels,” says Bianchini.

The Food and Agriculture Organization of the United Nations identifies limited use of improved technologies, such as drying and storage facilities, as the main constraint to improved productivity.

In turn, the inability of many smallholders to acquire credit (i.e. micro-financing) is the primary barrier to obtaining these improved technologies.

To address these constraints, this project will evaluate the feasibility of dryers and metal silos as a way to achieve rural food security and improve public health.

The goal is to evaluate whether reduction in post-harvest losses and mycotoxin levels in Guatemalan native corn would lead not only to better quality and safe grain for household consumption, but also to surplus that could be sold by farmers, generating income to repay any loans for implementing such technologies.

The interventions provided by this project are expected to positively impact the health of the people living in the Huehuetenango region in Guatemala by reducing their exposure to mycotoxins, providing education regarding the benefits of good post-harvest practices, and providing additional income.

Additionally, in the long term, it is expected that, if implemented practices are maintained, the levels of stunting among children under five years old, as well as the child mortality rate related to malnutrition, would be reduced.

For more information about the Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss, visit [www.reducePHL.org](http://www.reducePHL.org)

## **SC State researcher part of global leadership to ensure food security from post-harvest loss**

**July 08, 2014**

The need to feed an expanding population around the world has increased and many people are undernourished as a result of post-harvest losses, which can occur along the food production chain.

To help address the fight against global food hunger, researchers in the United States and abroad have teamed up to establish the Feed the Future Innovation Lab for the Reduction of Post-Harvest Losses. SC State University Associate Professor of biological sciences and Entomologist Dr. Rizana Mahroof is part of this five-year, \$8.5 million grant funded by the U.S. Agency for International Development (USAID).

This federal government initiative will assist developing countries in reducing post-harvest losses of durable staple commodities, and is initially targeting feed the future countries such as Ghana, Ethiopia, Bangladesh and Guatemala. These countries suffer food losses as a result of ineffective drying techniques, improper storage methods, insects and mold damage on stored commodities and issues related to transportation.

Much of the work will be conducted by teams of researchers that aim to implement educational programs for farmers, establish extension programs and adopt promising technologies to minimize post-harvest losses. The program targets small-scale farmers, farm cooperative members, farm enterprises, agribusiness enterprises and professionals from universities and research organizations.

Mahroof is a member of the research team that will travel and work in Ethiopia and Guatemala. The team's first trip to Ethiopia took place from April 25 – May 4. The in-country coordinating partner, Mekelle University, hosted the team and accompanied its members to various smallholder farmer sites and to research centers.

The team met with representatives from various agencies such as the Ministry of Agriculture-Government of Ethiopia, Ethiopian Institute of Agricultural Research and Kulumsa Agricultural Research Center.

Additionally, the team had opportunities to interact with a few industry partners such as GrainPro Inc., NAS Foods P.L.C. and with the Feed the Future team leader in the USAID Mission office.

The trip helped the team better understand and appreciate post-harvest loss issues and existing strategies for mitigating losses. It also helped them to target and explore solutions that may provide pathways out of poverty for women in the country who may not fare as well as their male counterparts in agriculture and rural employment.

“In addition to the direct engagement efforts to minimize post-harvest losses in the agricultural settings, this project also aims in addressing some of the cross-cutting issues like gender, nutrition and environment. One of the major approaches is to address the gender dimension of agricultural and post-harvest practices, with particular attention to women's involvement,” stated Mahroof.

The project is led by Kansas State University and is a collaborative effort with Oklahoma State University, the University of Illinois-Urbana, the University of Nebraska-Lincoln, the University of Kentucky and SC State University.

The Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss is a strategic and applied research and education program aimed at providing global leadership in food security by reducing post-harvest losses and food wastes of durable staple crops like grains, oil seeds, legumes, root crops, and seeds, and their processed value-added products.

“I am honored to represent the university. It shows that SC State has the expertise, commitment and the capability to work with this collaborative grant and with other universities. The project has a major impact on the university and offers our biology students the opportunity to be involved and trained in various aspects of the research,” stated Mahroof.

Mahroof’s expertise is in post-harvest entomology and her current research explores various sustainable techniques to control insects. Mahroof’s research is to study biology and ecology of stored product insects in several of the post-harvest systems and to implement techniques such as physical methods, semio-chemical-based management tactics and ecological-based methods to manage insects.

Mahroof’s research team plans to go on a second trip to Ethiopia in July this year.

For more information on Mahroof’s research projects, call (803) 536-8174 or visit our website at [www.scsu.edu](http://www.scsu.edu) and search for the Department of Biological and Physical Sciences.

**Romer Labs® Collaborates with Feed the Future Initiative in International Program to Reduce Post-Harvest Loss and Food Waste**  
**July 28, 2014**

Tulln, Austria July 17, 2014 – Romer Labs, a leading supplier of food safety diagnostics solutions has partnered with the Feed the Future Innovation Lab For the Reduction of Post-Harvest Loss based at Kansas State University to donate mycotoxin testing supplies to their USAID project aimed at reducing post-harvest loss. This Feed the Future PHL Innovation Lab is part of the U.S. government's Feed the Future initiative to reduce global hunger and improve food security. The initiative uses research, education and outreach to advance solutions to hunger, poverty, and under-nutrition in low-income countries.

The project aims to provide global leadership to reduce post-harvest loss (PHL) and food waste of durable staple crops (grains, oilseeds, legumes, root crops, seeds) and their processed value-added products with an initial focus on four Feed the Future countries (Bangladesh, Ethiopia, Ghana, and Guatemala). Interventions under this project will integrate smallholder farmers, producer cooperatives, and agribusiness enterprises with market-based value chains.

A key challenge in a number of Feed the Future countries is high moisture content of grains (especially maize) at harvest and presence of high mycotoxin levels (especially aflatoxin) at harvest and postharvest due to improper drying and storage practices. The initial pilot projects in Guatemala and Ghana will involve assessing the level of the problem faced by small holder farmers and the first market collection points, and ways to address this problem. Current practices allow for wet maize that often contains high levels of aflatoxin to enter the market and be consumed by farmers and villagers causing nutrition and health problems for children and adults.

Romer Labs' AgraStrip Aflatoxin and Fumonisin test strips and AgraVision reader will be used in these remote growing areas to assess the extent of the mycotoxin contamination. Using the data obtained in the study, the goal is to enhance the drying, conditioning, handling, storage, pest management and transportation of these crops thus increasing the quantity and quality of the grain available for human consumption and decreasing food waste.

About Romer Labs:

Romer Labs, founded in Washington, MO, in 1982, is a leading provider in diagnostic solutions for food and feed safety. It develops, manufactures and markets rapid test kits for food allergens, food pathogens, mycotoxins, veterinary drug residues and other food contaminants. The company also operates four accredited full-service laboratories on three continents. Romer Labs has facilities in Austria, Brazil, China, Malaysia, Singapore, the UK and the USA. For more than 30 years, Romer Labs has been a trusted partner for the food and feed industry worldwide. [www.romerlabs.com](http://www.romerlabs.com)

About Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss:

The Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss is a strategic and applied research and education program aimed at providing global leadership in food security by reducing post-harvest loss and food waste of durable staple crops (grains, oilseeds, legumes, root crops, seeds) and their processed value-added products. This program will require confronting constraints on integrating smallholder farmers, producer cooperatives, and agribusiness enterprises with market-based value chains from seed to end-user.

Post-Harvest Loss (PHL) estimates are distressingly high considering the current and estimated future need for food. These losses represent food already in the production system that could have been used to reduce food insecurity and hunger and to increase food quality/safety, nutrition, and market opportunities for the small landholder. PHL reduces real income for all consumers, which especially affects the poor, because such a high percentage of their disposable income is devoted to staple foods. PHL reduction also has significant gender implications since staple food production in most developing countries is the responsibility of women. For more information please visit [www.reducePHL.org](http://www.reducePHL.org)

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