



FEED THE FUTURE

The U.S. Government's Global Hunger & Food Security Initiative



FEED THE FUTURE INNOVATION LAB FOR THE REDUCTION OF POST-HARVEST LOSS **SEMI-ANNUAL REPORT**

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ADM Institute for the
Prevention of Postharvest Loss
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Research Progress Summary

A. Research progress made during the reporting period

Progress across the program has continued to gain momentum, focused on packaging and piloting innovations for ultimate uptake and scaling by development actors. This period marks a key transition in the program, spanning the end of the “research phase” (through December) and the start of the “engagement phase” (from January). The transition involves a continuous process, rather than a discrete break-point, of assessing outputs and outcomes to date and critical evaluation of lessons learned. Successful transition to engagement and piloting post-harvest reduction interventions into use involves adaptation of innovation packages (including technologies, practices, information and capacity) for uptake down the pathway to impact, by a range of targeted actors.

This transition period across the program has included:

1. Assessment of information, technologies and capacity produced by the program through the research phase, to drive adaptation of innovation packages for piloting and dissemination for downstream livelihood enhancement. This includes:
 - a. scientific analysis and interpretation of data, and presentation of results and conclusions at scientific conferences.
 - b. critical discussion at stakeholder meetings, including members of key government ministries, private sector, extension agents, development projects and agencies, and others.
 - c. Focus group discussions within communities for continued consideration of socioeconomic aspects including gender, related to deployment of the innovations.
2. Development of a tailored, targeted and phased approach to iteratively pilot innovations with next- and end-users, interwoven with ongoing consultations with stakeholder and advisory groups. This was conducted through a series of discussions and formal meetings, and was based on results to date and the scientific, stakeholder and in-country advisory group discussions.
3. For several PHILIL innovations, research and adaptations within the program have produced information and locally-suited technologies that are already translating to development outcomes down the pathway to impact. This includes training of trainers who are using PHILIL-imparted capacity in their extension and training activities, local production of technologies, technology uptake by early adopters, and initial plans to integrate information and technologies into government programs and policy.

Lessons learned in cross-cutting areas including gender and nutrition are being likewise assessed and integrated into the innovation packages and approaches moving forward, to help ensure maximal uptake, sustainability and impact of post-harvest reduction efforts arising from the program.

The bedrock foundation for all of these efforts is formed by several elements of PHILIL’s programmatic strategy. The leading research, extension/engagement and development experts initially recruited and added to the team over time have coalesced and evolved into multi-disciplinary, multi-sectoral, international partnerships that are driving the research outputs towards development outcomes. The baseline studies developed an appreciation for local context in which post-harvest losses must be

mitigated to best benefit the communities including women and children. Ultimately, the enhanced capacity and leadership of in-country partners now constitute a key resource as experts of local and national context, a voice as national and regional champions for post-harvest loss reduction, and an intrinsic part of augmented national capacity to address agricultural challenges of today and into the future.

Specific updates by country and cross-cutting area are detailed below (only outputs from this specific semi-annual period reported in narrative and numbers).

Bangladesh

The in-country leadership and capacity continued to push innovations along the pathway to impact. Progress has continued along all planned activities. Progress included and is not limited to:

Geographic expansion in the Feed the Future Zone of Influence: In addition to the existing 20 villages engaged by PHLIL, 30 villages in six districts namely Bogra, Dinajpur, Barishal, Sherpur, Mymensingh and Netrokona have been selected for scaling up the drying and storage technologies. In each of the villages, about 25 farm households have been selected for intervention in Boro season.

Performance and cost - drying: The performance study of the 500kg BAU-STR dryer was conducted during the 2016 Aman harvesting season (November to January) at selected areas of Netrokona, Mymensingh and Jessore districts of Bangladesh. With a required drying time of 3.0-4.7 hours, the operating cost of drying was calculated as Tk. 0.87 (one US cent) per kg (diesel generator operated blower). The benefit-cost ratio and payback period were found to be 1.9 and 0.28 years for a diesel generator operated BAU-STR dryer.

Mycotoxin testing: Testing for aflatoxins and fumonisins in rice continued, adding to the growing dataset spanning consecutive seasons. Moisture content was measured for the samples as well. Tested samples were collected in December 2016 from farmers in Phulpur, Mymensingh, Shyamganj, Netrokona, Manirampur and Sadar upazilla of Jessore districts.

Expanded BAU-STR dryer applications - farmer/women demand-driven: Use of the BAU-STR Dryer for parboiled paddy rice (high moisture content) has been expressed as an important potential application by farmer communities, particularly women who are responsible for this activity. In response, research is underway to enable this type of use, which would save considerable labor for women in the targeted communities and throughout the country.

Training: A training module with English and Bangla versions which includes paddy drying principle and method, importance of drying and operation and maintenance of the BAU-STR dryer has been produced for farmer and trader training programs. In this six month period, 272 people (44% women) have been trained on BAU-STR Dryer installation and operation, between dryer demonstrations and focus group discussions. Additionally, 88 people (48% women) have been given hands-on individual-basis training on hermetically storing rice seed.

Economic savings/new source of income for women in farming communities: Of smallholder farmers who have received training on hermetic storage in our pilot communities, who also used to purchase seed from government agencies and private companies, approximately 95% are now producing their

own seed storing in hermetic bags in Shyamganj, Netrokona. They are using the seed for their own production and the extra amount is sold to neighbors at a higher price. Storage of seed in hermetic bags is becoming popular among the farmers of Mymensingh, Netrokona and Jessore districts as it has a higher germination rate compared to seed purchased from the market. Women farmers have taken this as an income generation activity (IGA).

Awareness creation, communication and engagement: Several national electronic and print media of Bangladesh (news24.bd, The daily Ittefaq, The daily Janakantha, The daily Samakal, The daily Jugantor and The Bangladesh Protidin) have reported on the BAU-STR dryer. Rice millers and farmers are very interested to buy the BAU-STR dryer at a reasonable price. A leaflet on the BAU-STR dryer in English and Bangla versions was prepared as disseminating materials. The leaflet was disseminated in two international conferences – RENPER 7 and CASH-II. The leaflet was also disseminated to interested farmers and rice mill owners through the Mati Auto Rice Mill.

The BAU and KSU ME team visited the USAID Mission in November, and subsequently Dr. Alam attended a Feed the Future meeting organized by the USAID Bangladesh Mission as a speaker.

Storage: PICS and GrainPro bags are found to be superior rice storage technology in Bangladesh. Leaflets, training and demonstrations on hermetic rice storage bags played an effective role in disseminating these technologies at the farmer level. Most of the farmers accepted the hermetic bags; however, the price of the hermetic bags are still of concern. Local production of hermetic bags may reduce the price.

Gender: A gender equality assessment has been conducted in six villages of two sub-districts, Shyamhanj in Netrokona and Jessore Sadar in Jessore. It includes questions on the role of women in post-harvest activities, the use of post-harvest technologies, and social and economic empowerment. The findings of the PHLIL gender equality assessment report, from work in Netrokona and Jessore, have been disseminated and validated with farmers and local level NGO representatives through workshop cum training in Netrokona on October 18, 2016 and in Jessore Sadar of Jessore district on January 6, 2017. The training sensitized the participants about women's unrecognized roles in agriculture and the problems of women in post-harvest activities.

Public-Private Partnership: While farmers do prefer hermetic bags, they are concerned about the relatively high price; local manufacture could reduce the cost. Discussions with ACI Ltd. for potential manufacture of hermetic bags are ongoing.

Policy: Dr. Alam participated in meetings with the deputy secretary of agriculture, where an initial decision was made to include the STR dryer in the official government list of subsidized agricultural technologies. A final decision may be reached at the next formal meeting, later this year, whereafter the STR dryer would receive an official Bangladesh Government subsidy for anyone purchasing it. Discussions involving ACI Ltd. have also included consideration of allowing hermetic bags for grain storage, which is currently prohibited due to regulations meant to support the national jute industry.

Ethiopia

Despite civil unrest and a travel ban, progress has continued. It has included and is not limited to:

Develop manuscripts from research phase: Work has continued with graduate students. Bahir Dar and Mekelle Universities are contributing their own resources to send students to Kansas State University, for the Annual Meeting and to stay on for 10 days working on manuscripts with Professor Subramanyam. Three abstracts were selected and presented at the First All Africa Post-Harvest Congress and Exhibition in Nairobi in March.

Drying: The adapted 100kg cabinet dryer constructed at Mekelle University is being assessed for efficiency using chickpea. At Bahir Dar University, the GrainPro Solar Bubble Dryer as well as cabinet dryer with different operating modes (Direct, Indirect and Mixed mode) are being tested for maize, with farmer training integrated into the testing process.

Storage: Storage intervention technologies using hermetic bags, polypropylene and jute bags, metal and plastic drums continued at both universities using 50 kg of grain of wheat, maize, chickpea, and sesame. Data are being collected bimonthly until the end of this year. A total of 65 hermetic bags (35 PICS and 30 Superbags) were given to farmers in Humera for grain storage, and are being monitored by the researchers monthly as part of the piloting exercise. On-farm testing of hermetic bags (GrainPro super and PICS bags) was conducted in Mecha district on 30 farmers; mycotoxin analysis is underway. A similar on-farm storage testing of hermetic bags (45 bags, 10 Super Grain, and 35 PICS distributed) was initiated in Wenberima district with wheat farmers. Baseline sampling was made and data collection is being carried out. Of the total bags, 18 (9 GrainPro, and 9 PICS bags) were assigned for continuous follow up and compared against the polypropylene bags. Monthly evaluation of change in gas (O₂ and CO₂) composition will continue until the last week of May, 2017 (done with insect research team).

Engagement and associated materials: Trainings have been conducted by Mekelle and Bahir Dar universities. A trip is planned for May that will include Dr. John Ulmer, KSU Agricultural Education/Extension faculty member. As part of a team also including technical members, plans for developing new and adapting existing extension materials for Ethiopia will be explored.

Pesticide safety, handling, storage and disposal: Training was held from 16-18 December, 2016 at Bahir Dar and Mekelle universities. The 16 and 40 participants at Mekelle and Bahir Dar Universities, respectively, were selected from Woredas (counties). They were selected since they are involved in pesticide use. Training included safe handling and disposal of pesticides, standard applications of pesticides, and calibration techniques and pesticide formulations. Participants evaluated the training at the end, overall rating it highly citing that it was well organized and the content related to their real world situations.

Mycotoxins: Mycotoxin levels were measured in experimental samples, with overall data analysis to be undertaken with their PHLIL supervisors during the students' visit to KSU in April-May. The KSU-based training will enable the in-country PHLIL team members to evaluate mycotoxin data more independently in the future.

Gender: At the Feed the Future Quaterly Partners Meeting, organized by the USAID-Ethiopia Mission, Professor Fetien Abay presented and distributed a pamphlet on gender entitled "Women are key as seed keepers in Ethiopia." The content is based on her work with two projects: PHLIL; and a Norwegian project on seed safety through diversity, women and food science projects.

Ghana

Robust progress has proceeded on all fronts, with innovations accelerating to uptake. This portion of the PHLIL program provides a model whereby post-harvest interventions targeted at the aggregator/medium enterprise level can benefit both the smallholder farmers who supply them, as well as the consumers of the goods the enterprises produce. Progress has included and is not limited to:

Storage study - mycotoxin testing: Samples from experiments involving adapted local water tank storage silos were analyzed for aflatoxin and fumonisin levels. Data analysis is underway to determine the efficacy of this adapted storage technology on reducing post-harvest losses.

Technical publications and presentations: Three abstracts were selected and presented at the First All Africa Post-Harvest Congress and Exhibition in Nairobi in March. Several peer-reviewed manuscripts have been accepted and are in press or published, including: Field evaluation of the long-lasting treated storage bag, deltamethrin incorporated, (ZeroFly® Storage Bag) as a barrier to insect pest infestation (*in press*) Journal of Stored Products Research.

Public-private partnership for improved storage technologies: Dr. Opit's collaboration with Vestergaard Frandsen has helped produce a new generation of more effective ZeroFly bags. His team's work under PHLIL has provided an important part of the research basis on which they have released a new hermetic version of the ZeroFly bag. It is improved in that complete absence of insect pests was required with the initial ZeroFly bag; however, with the introduction of the hermetic aspect, this is no longer required. Given the involvement of the Research for Development team at VF (including economists), the new product is more effective and set to be priced lower than other hermetic bags, with the added advantage of a slow release insecticide-incorporated outer bag thwarting pests that can render standard hermetic bags compromised. This collaboration continues to further improve the product.

Engagement – post-harvest intervention trainings: The USAID Post-Harvest Loss team conducted a three-day workshop on January 10-12. Four US Institutions of Higher Education, USDA, one Ghana Institution of Higher Education, a local food bank, a representative from SAWBO and the in-country team leader assisted in conducting the event. The 43 participants were personnel from Ministry Extension, non-ministry extension, private company extension, and traders. Twenty-six participants were male, 12 were female, and five did not identify. The first two days of the event were hosted at the Crops Research Institute in Kumasi with the third day hosted at PENS Food Bank Ent. in Ejura. Seven overarching topics were addressed with several presentations addressing each one. The topics included: grain drying, grain monitoring, grain storage, insect monitoring, pest identification, safety and sanitation. While day one was the delivery of foundational information in the form of presentations, days two and three were more participant involved. Day two included a presentation and question and answer session on Aflatoxin and its implications. Also day two included hands-on stations to help participants connect to many of the materials that could be available for producers. Day three was conducted at the PENS Food Bank, a partner in much of the previous research. While at PENS, participants were introduced to a solar biomass hybrid dryer for grain drying and disinfesting grains. Participants were also hands-on with many of the grain storage techniques.

PHLIL program outputs (training materials) have further been used for trainings. This included the USDA-funded AMPLIFIES project, where 25 extension trainers were trained in March by a team mostly constituted of PHLIL team members.

Capacity building: Two PHLIL MSc students have graduated from KNUST, one of whom has started a position with the International Institute of Tropical Agriculture in Ghana.

Continued uptake and scaling: Post-harvest loss reduction innovation packages adapted and developed by PHLIL are in significant demand in Ghana. This includes variations of the Solar Biomass Hybrid Dryer, coupled with the EMC Moisture Meter and ZeroFly Hermetic bags, as a complete post-harvest intervention package. New progress includes:

- 20 EMC Moisture Meters have been ordered by the Ghana Grains Council. National partner KNUST is producing them locally, with training from Paul Armstrong (USDA-ARS), with delivery anticipated by the end of this month (April).
- The GIZ-funded Green Innovation Center has submitted a procurement request, awaiting approval by the Government, for the construction of 20 mobile 1-MT SBHDs, as well as for 30 EMC Moisture Meters and Hermetic ZeroFly bags. Designed under PHLIL, these will be deployed in Community Aggregation Centers to benefit many smallholder farmers.

Across these examples, the private sector (medium enterprises) are clamoring for post-harvest loss reduction technologies adapted and developed by the PHLIL program.

Guatemala

Progress in the Guatemala program proceeded towards finalizing research result analysis, presenting and getting dynamic feedback through meetings with stakeholder and advisory groups, and planning to deploy validated, context-appropriate post-harvest interventions into the target communities. Progress has included and is not limited to:

Research phase results analysis: The team has continued synthesizing the results from the research phase of the program, for presentation in a forthcoming report. The report will include technical findings in terms of post-harvest losses and efficacy of technologies, as well as an economic assessment of repayment periods for metal and plastic silos based on the ability of farmers to purchase and store maize after harvest when prices are low. This information will form the basis, along with previous studies by other groups and experience of our partners in country, to package and pilot interventions into use.

A publication was accepted in the Journal of Stored Products Research entitled “Traditional maize post-harvest management practices amongst smallholder farmers in the western highlands of Guatemala.” This is helping inform development of the Best Practice Manual, referenced below.

Development of a nutritional and equal gender assessment: Significant effort has been invested into development of a survey tool to assess socioeconomic factors related to adoption and scaling of post-harvest technologies. The research phase report is being used to drive the final determination of the specific post-harvest technologies to be included in the survey. Nutrition is being captured in a questionnaire section assessing dietary diversity and hunger. Gender information is being considered with a range of questions that have considered targeted sections of the Women’s Empowerment in Agriculture Index, as well as information gathered in the gender activities to date.

Drying: Earlier work by the Guatemala team identified that the best-off the shelf technologies available on the market globally were either not effective or else did not meet the preferences or environmental specifications needed by the farmers and their communities. The extreme conditions encountered in the highlands of Guatemala therefore require a more novel drying technology approach. A modified version of a STR dryer has been constructed and tested in Guatemala. Additionally, a newer optimized model has been constructed with lower cost material at KSU and testing will be conducted soon. At meetings in November, stakeholders and advisory group members advised that, in the short term, a Best Practices Manual be developed to help farmers adapt traditional drying practices to the extent possible, and remain focused on identifying a suitable drying solution in the longer term. The Best Practice Manual is under development.

Storage: The tested storage technologies were initially selected since they have been proven to be effective at reducing post-harvest losses through a litany of other studies. Nonetheless, additional data has been gathered to confirm this in the local context, focusing on farmer-participatory research to better understand how these technologies could be adapted (where necessary) and adopted.

Mycotoxin quantification: While testing the storage technologies, in association with either traditional drying (producing farms) or commercial drying (purchasing farms),¹ the levels of aflatoxin and fumonisin were quantified throughout storage. In general, corn from producing farms contained lower levels of toxin than corn purchased from the market. During storage the levels of toxin in the grain were for the most part maintained. However, during some periods of storage grain encountered conditions of temperature, relative humidity and moisture that could be suitable for toxin production. Better drying practices should contribute to reducing those occasions.

Gender: In February 2017 gender specialist Ana Chavarria held the final in a series of workshops focusing on women's empowerment in the PHLIL communities. Utilizing the Women's Empowerment in Agriculture Index, this session focused on indicators 7-10: group membership, speaking up in public, workload and satisfaction with leisure. Forty-seven women attended the sessions. At the end of this series of workshops, it is clear that gender equity can only be achieved through a long-term and integrated process, but these workshops are a tool in that process. They have allowed women to learn and understand concepts such as empowerment, citizen participation, power groups, etc. The women who participated better understand the importance of participating in groups and what groups might be available to them. They have been able to find solidarity in their roles and contributions to the household economy while recognizing that many already have some degree of capacity to make decisions for themselves. They have already organized themselves together and asked to be supported in projects such as breeding pigs or calves, raising hens, home gardening, etc.

Economic and sustainability analysis for technology: Within the constraints applied by the financial analysis, small farms would benefit from a metal silo, with a minimum probability of success equal to

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1. **Producing farmers:** Farmers in the Huehuetenango regions of Todos Santos and Chiantla who produced maize for self-consumption. These farmers on average harvest enough corn to only partially meet their family's food demand (3 to 4 months out of the year) due to their limiting planting area and production capacity.

Purchasing farmers: Farmers in the Huehuetenango regions of Todos Santos and Chiantla who either do not have land for agricultural production or may have land, but choose to plant different commodities other than corn. Therefore, farmers from this group solely depend on the local market to purchase corn to meet their family's demands.

88% of repaying the loan obtained, within 3 years, to acquire the storage technology. When the cost of the technology was excluded, all size farms showed at least a probability of 96% of saving money that could be used for diet diversification, education, or other benefits. Ultimate, technology acquisition is dependent on each farmer economic means. For example, a metal silo would be a better option in the long term due to its durability and lower cost per storage capacity; however it requires a higher initial investment. Polyethylene drums are higher cost per storage capacity, but their smaller size translates into a lower initial capital investment and the possibility of farmers to properly store several corn varieties simultaneously.

Awareness creation, communication and engagement: National media interviewed Dr. Campabadal at the stakeholder workshop in Huehuetenango, where he discussed the findings and importance of post-harvest loss reduction to food security.

EMC Moisture Meter

Progress on a second generation EMC Moisture Meter was supported through PHLIL funds and an internal USDA-ARS grant awarded to Dr. Armstrong. The KSU Electronics Design Lab has completed design of electronics and constructed a prototype. The new design was initiated to provide better functionality and lower cost. Improvements include longer battery life, ability to re-program the device with new EMC coefficients, Bluetooth communication and use of a much lower cost RH/T sensor. A custom designed enclosure will be designed for electronics when the e-design is finalized and tested. The enclosure design will be fabricated through a prototyping service that utilizes plastic injection molding. It is estimated that the new version will cost approximately \$35, and as before allow for local manufacture in country.

B. Issues or concerns encountered during the reporting period

In Ethiopia, civil unrest and volatile conditions leading to a travel ban, as well as restricted access to university campuses during this time, has led to delays in the planned visit and some planned activities. Overall, progress has continued nonetheless, with the team working to adapt and catch up where necessary.

A late stage and abbreviated funding allocation from USAID, coupled with some residual budget challenges, led to an intensive budget planning exercise by the Management Entity. This was involved, time-consuming and resulted in some delays in the transfer of funds to program partners into the current project year, which began on January 1. However, undertaking this exercise enabled the Management Entity to preserve funding for ongoing, essential on-the-ground activities and has provided the Management Entity with a clear path forward.

Appropriate dryer technology research is continuing, seeking to overcome geographic challenges in the highlands relating to cloud cover, widely-dispersed farms and poor road conditions.

III. Human and Institutional Capacity Development

A. Short-term training

Country of Training	Brief Purpose of Training	Who was Trained ²	Number Trained ³		
			M	F	Total
Bangladesh	BAU-STR dryer installation and operation; dryer demonstration and FGD (6 separate trainings)	Farmers and rice millers	153	119	272
	Demonstration on hermetically stored rice seed	Farmers	87	80	167
Ghana	Post-Harvest Loss Mitigation Training	Adventist Development and Relief Agency trainers, extension agents, ...	26	12	43 (5 did not identify)
Guatemala	Gender training: group membership, speaking up in public, workload and satisfaction with leisure	Women in pilot area farming communities	0	47	47
Ethiopia	Mitigation Training PICS and GrainPro Superbags training	Farmers Agriculture Extension Experts Investors at Humera	235	35	270
Overall			501	293	799

B. Long-term training

Support for graduate education is an important part of PHLIL’s mission to build capacity for the next generation of post-harvest experts. Graduate students are also essential in performing PHLIL’s activities, including lab and on-farm research and assisting in PHL trainings. In Bangladesh, PHLIL is supporting eight graduate students at Bangladesh Agricultural University. The students are working on master’s or doctoral degrees in our three key areas of drying, storage or mycotoxin analysis. There are seven graduate students involved with our programs in Ethiopia, six at Mekelle and Bahir Dar universities and one at Kansas State University. In Ghana, two graduate students from Kwame Nkrumah University of Science and Technology (KNUST) and one graduate student at Oklahoma State University are involved in PHLIL activities. In Guatemala, one graduate student at the University of Nebraska-Lincoln is engaging in PHLIL research and training, through joint funding with USDA.

IV. Innovation Transfer and Scaling Partnerships⁴

These are integrated within the overall program design, as described within the research summary above. In addition, production of the first generation PHL meter is being transferred to Mr. Joseph Akowuah’s group at KNUST, Agricultural Engineering Department in Ghana. This is being coordinated with Paul Armstrong, USDA-ARS, who is providing part lists and instructions on construction. This will provide experience with sourcing parts, developing technical fabrication skills, electronics testing and the infrastructure of tools needed to do this. Funding to do this technology transfer of a PHLIL-developed technology is from the AMPLIFIES project.

² Such as farmers, government officials, women entrepreneurs

³ Disaggregate by sex if known

⁴ Includes transfer of technologies and knowledge as applicable to your programs; reference the impact pathway

V. Future Work

Work is continuing along the Workplans for each portion of the program. The Annual Meeting in April will be used to critically assess the current transition between the research and engagement phases, ensuring that institutional and other higher-level innovations related to piloting technologies and practices into use are optimally realized. The External Advisory Council is comprised by members suited to the current phase of the program. They, the Internal Evaluation Committee, Ahmed Kablan and others will help guide and adapt moving forward.

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