



# 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

October 1, 2020 - March 31, 2021



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**Cover caption:**

Bangladeshi farmers attending a BAU-STR dryer refresher training in late 2020.

*Photo credit: Dr. Chayan Saha, Bangladesh Agricultural University*

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## RESEARCH AND SCALING PROGRESS SUMMARY

PHLIL has welcomed the invitation by USAID to articulate how our efforts contribute to climate change mitigation. Approximately one third of global food production is wasted or lost, contributing ~4.4 gigatons (or ~8% of anthropogenic) of greenhouse gasses annually. PHLIL contributes to reducing these losses through innovations that arrest contamination and spoilage by toxin-producing fungi and eliminate the need for using toxic chemicals to treat crops after harvest to prevent pest infestation. PHLIL researches innovations and technologies to dry, measure and control moisture content and safely store crops.

### Research Progress: October 1, 2020-March 31, 2021

The first half of fiscal year 2021 allowed for Phase II research and associated scaling objectives to continue to progress; details are provided below by country and workplan objective. Workplan progress has been inhibited for much of FY21 in Ethiopia due to the ongoing Tigray conflict originating in November 2020.

### **Bangladesh**

#### **Assessment of drying and storage technologies adaptation and impact**

PHLIL-Bangladesh was selected to participate in the innovation 2 impact (i2i) study funded by the Soybean Innovation Lab (SIL) in mid-2020. As a result, lead researchers at Bangladesh Agricultural University (BAU) conducted focus group discussions and key informant interviews in late 2020 to obtain user feedback on the BAU-STR dryer. Participants expressed that for traditional sun drying of rice paddy, the approximate cost of drying 500 kg of paddy for 2 laborers for at least 2 days is \$10.60 to 18.80 (USD), compared to only \$4.70 to 5.90 (USD) and 4-5 hours required if using the BAU-STR dryer. The traditional sun drying of paddy results in a loss of up to 2.4% of the grain whereas zero measured loss was observed by the farmers using the dryer. A majority of the farmers (78%) were found to have a high prospect of using the BAU-STR dryer.

#### **Provide logistical support to the PHLIL Ag Econ team for designing and implementing the Randomized Controlled Trial (RCT) on seed storage adoption**

The PHLIL-Bangladesh team worked as a liaison between the local agricultural extension officers and the Helen Keller International (HKI) team. Communication bridges between local HKI and the Department of Agricultural Extension (DAE) personnel were established so that the HKI team can easily identify farmers in the Sherpur Sadar, Nakla, Nalitabari, Narail Sadar, Kalia, and Lohagara Upazilas of Bangladesh. In order for the Ag Econ team to be able to conduct their endline survey, and to enhance field level cooperation with HKI enumerators, a letter was provided to DAE officials by BAU in January 2021.

The endline survey was significantly adapted based on preliminary observations from the baseline survey with regard to willingness-to-pay (WTP) for GrainPro bags. After finding a low WTP amongst participants from the baseline survey, the team decided to repeat the RCT of the baseline during the endline survey, among other adjustments, treatments, and changes. Additional modules were added to the questionnaire to collect information about price, utilization, and preferences around the use of GrainPro bags. During endline activities, the Ag Econ team reached 887 households and obtained willingness-to-pay estimates for 886 households. During the auction, 158 households won and received the bags. In January 2021, HKI enumerators were trained. The HKI team and enumerators completed the RCT's and survey in February 2021, and the HKI team is currently cleaning the data.

Finally, discussions are ongoing between the PHLIL Ag Econ team, HKI, and BAU regarding a late 2021 dryer survey that would assess the preliminary impacts of the BAU-STR dryer on the rural farm economy.

### **Engagement and Policy Advocacy**

Public and private organizations have been informed about post-harvest technologies through meetings and knowledge-sharing activities including with the Project Director of the Farm Mechanization Project (DAE), CIMMYT-Bangladesh, and a presentation at the Institution of Engineers, Bangladesh (IEB) where policy-level stakeholders were present. PHLIL-Bangladesh has also conducted knowledge-sharing meetings with Bangladesh Agricultural Development Corporation (BADC) personnel. PHLIL-Bangladesh P.I., Dr. Md. Monjurul Alam, attended a seminar about agricultural mechanization in January 2021 where the Agriculture Minister, Dr. Mohammad Abdur Razzaque, was present as chief guest. Dr. Alam talked about the post-harvest loss reduction technologies and proposed PHLIL-generated evidence-based policy recommendations with the minister, encouraging him to continue measures to disseminate the BAU-STR dryer and expand support for hermetic bags in Bangladesh.

### **Conduct a gender technology assessment for PHL technologies**

Prior to the pandemic, gender sensitization training was performed in person. To account for pandemic-related safety protocols, short term gender dimension and sensitization training were conducted virtually for attendees in Bogura, Khulna, and Barishal districts in December 2020. Male partners are beginning to realize the importance of women's labor in managing post-harvest activities as a result of these training sessions. By using both the BAU-STR dryer and hermetic bags, women have gained more confidence in adopting new technologies that may be presented to them. As was described to BAU researchers during short term training feedback and focus group discussions, women have also realized their value and contributions and feel more empowered to convince their husbands for an appropriate position in their family enterprise.

### **Preparation of scientific manuscript(s) and reports**

In spite of the ongoing COVID-19 pandemic, the research work (field survey and lab work) has been conducted maintaining social distancing rules. Thus far, 3 abstracts have been submitted in addition to having published 1 journal article and 1 blog post.

### **[Sub-component: Drying] Scaling of the BAU-STR Dryer**

A tri-party agreement has been signed between PHLIL-Bangladesh, AgroMech Development Initiative (ADI) Foundation (manufacturing of the dryer) and ACI Motors Limited (marketing of the dryer). ADI foundation is an independent private sector organization that designs, develops, and manufactures agricultural machinery; ACI is a leading agricultural machinery marketing company in Bangladesh. ADI and ACI will be responsible for manufacturing and selling at least 350 BAU-STR dryers per year.

### **[Sub-component: Drying] Appropriate scale dryer development for meso-level mills**

An ongoing study originally delayed by the COVID-19 pandemic has proposed a six-step drying method to dry both parboiled and aromatic rice in an appropriately sized 12 ton dryer. This size of dryer will optimize the capacity utilization of both major and husking mills (assessed at 29.2 and 24%, respectively) to 72.5% with huller capacity of at least 2.5 tons/hour. Manufacturing of the 12 ton dryer is ongoing and preparations for installation have begun (February 2021), as part of a Public-Private Partnership with Moti Auto Rice Mill. The manufacturing team is working to complete the dryer as early as possible with installation scheduled for the first dryer trials in April 2021.

### **[Sub-component: Storage] BADC Seed Storage Trials**

Based on the FY20 experiments in Aman and Boro seasons at BADC seed processing centers, detailed technical and financial analyses of hermetic GrainPro bags and cocoons along with existing traditional large-scale seed storage practices are being prepared to determine the best management practices of paddy seed storage at BADC. For the 2021 Aman season (Jan – May), both hermetic cocoons and GrainPro bag trials have been set up along with traditional practices of BADC large-scale paddy seed storage at Madhupur. The BADC seed production center in Mymensingh has been set up with GrainPro bags and traditionally-used Gunny sacks due to the COVID-19 pandemic.

## Ethiopia

### **Assess existing PHL extension manual for deficiencies and finalize materials as needed.**

Comments and suggestions from all involved team members were gathered in late FY20 allowing time to incorporate feedback for the post-harvest loss extension manual. Some comments raised the need for additional inputs from the U.S.-based team members. September 2021 is the target date for completion of the training manuals for the Ethiopia extension system within the Ministry of Agriculture, possibly to feature during a session in the All-Africa Post-Harvest Congress.

### **Engage National Post-Harvest Loss Advisory Committee**

Though the COVID-19 pandemic and Tigray region crises negatively affected the committee's scheduled meetings, progress has been made with regard to the evaluation and mentoring of overall activities related to post-harvest loss reduction. Improved post-harvest loss technologies were promoted and incorporated in regional agricultural strategies.

### **Enhance the inclusion of women and youth in PHL decision-making technology updates**

Throughout the COVID-19 pandemic and Tigray region crises, telephone communication has been the primary means of communication with women and youth who were previously targeted for training and technology dissemination. There have been ongoing movement restrictions and food shortages related to the Tigray region crises which women have shared stories about during the aforementioned telephone communications.

### **Support the establishment of a distribution system for PHL technologies**

Discussions have taken place with the regional engagement team regarding the establishment of a distribution system for PHL technologies. Regional research centers and agricultural officials agreed to the scale-up and distribute improved PHL technologies through the extension system. An intervention program is providing improved storage bags, drying facilities, and assisting with moisture testing issues to help respond to demands and requests raised by farmers.

### **Mycotoxin analysis of economically important grains**

Following close-down and re-allocation of PHLIL Guatemala funds, Dr. Andreia Bianchini's laboratory at University of Nebraska-Lincoln transitioned to a role in backstopping and capacity enhancement for the Ethiopia team in mycotoxin analysis. In her laboratory, progress has been made towards validating the detection platform for the quantification of mycotoxins in maize and sorghum, with an associated set of detailed standard operating procedures (SOPs) developed for Ethiopian technicians. In terms of specific toxin analyses validated and to be transferred to the Ethiopia team, the AgraQuant (Romer Labs) testing platform SOPs were successfully validated for quantification of aflatoxin, fumonisin and deoxynivalenol in maize and sorghum. Recoveries at two different contamination levels (low, high) have been performed. Similar validations for ochratoxin in these matrices/sample types are yet to be conducted. Planning is underway to resolve how to conduct a virtual training led by Dr. Bianchini for the teams back in Ethiopia.

### **Explore compilation of Ethiopian PHLIL project research output as a book**

Several teams were established from universities, research centers, and the private sector to collaborate on book content development, with in-country lead Professor Fetien Abay playing a catalytic role. Internet lockouts as a result of the Tigray crisis have caused limited communications with the established team in recent months despite early FY21 content development and collaborations.

### **Validation of Arc'teryx tent dryer for maize and sorghum**

Research is being carried out using five prototypes fabricated and donated by private company partner, Arc'teryx Equipment of Canada. The dryer was originally developed with support from and in collaboration with Global Good/Intellectual Ventures, until they handed off the partnership to PHLIL for further support. The Arc'teryx/PHLIL partnership aims to increase the number of grain dryer options available to farmers in developing countries by testing the validity of their solar chimney technology in Ethiopia. Experimental sites have been prepared at both Mekelle and Bahir Dar Universities. At present the teams are prepared, or preparing, to procure local maize grain with a moisture content level of 22-25% to test the validity of the dryer. The teams were facing challenges related to funding transfers due in part to internet lockouts during the Tigray crisis and grain shortages due to the COVID-19 pandemic; the crisis caused a delay of several months in funding moving from KSU to Mekelle University (the lead institution), which then proceeds on through their contractual subaward to Bahir Dar University. Now that funding is in place, the university teams are primed for grain procurement and experimentation initiation.

## **Ghana**

### **Continue creation of awareness and enhancement of demand for hermetic bags and GrainMate moisture meters**

Two economically interconnected pillars of PHLIL's work in Ghana are with smallholder farmer communities in the North and with larger scale farmers, members of the Women in Poultry Association (WPA) Dormaa Chapter in the Middle Belt. Due to PHLIL engagement (and previously to the USDA-funded AMPLIFIES project), WPA members have successfully addressed post-harvest losses to reduce operation costs, reduced or eliminated the need for/use of toxic fumigants and aflatoxin binders, increased poultry productivity, health and egg size/shell strength, and ultimately increased profitability and grown their businesses significantly. The early adoption of post-harvest technologies and resulting economic success of these poultry producers has in turn increased their demand for grain from smallholder farmers in Northern Ghana. This includes a particular interest in buying higher quality grain from farmers who have adopted ZeroFly® Hermetic bags which eliminates the cost of getting their grain to market. Trucks that will transport grain back to WPA operations take more eggs North as well, an important component of nutritional security for these socioeconomically vulnerable smallholder farmer communities. This development provides evidence that PHLIL is helping to strengthen food systems and increase resilience even during the severe health and food security shocks due to the pandemic. In Garu district alone, there are at least 48 farmer organizations eager to promote GrainMate and ZFH bags, and the Ministry of Food and Agriculture Director for Garu is eager to promote these technologies for farmers' benefit. These observations were made during a December 2020 field visit made by PHLIL Ghana P.I., Dr. George Opit.

### **MPhil student at KNUST conducts research, data summarization and analysis, and manuscript writing**

An MPhil student at Kwame Nkrumah University of Science and Technology is conducting research on locally produced, elevated platforms used for storing and drying maize. In February 2021, the student presented a proposal to the KNUST Department of Crop and Soil Science. All samples for the Middle Belt major season harvest have been collected for this study. Analysis of aflatoxin levels is complete and the student is finalizing fumonisin data analysis. Aflatoxin data indicated consistent reduction of aflatoxin levels in maize ears freshly harvested and piled on platforms for 14 days before shelling, with aflatoxin levels below 2 ppb compared to aflatoxin levels in maize ears heaped on the ground after 14 days were in the range of 13.3–18.3 ppb. The Ghana Standard Authority acceptable aflatoxin threshold is 15 ppb, however aflatoxin levels can rise precipitously under poor storage conditions such as heaping on the ground and subsequent poor storage. Dr. Stasiewicz' lab at University of Illinois is also analyzing *Aspergillus flavus* levels in the elevated platform experiment using quantitative PCR, so that the research can not only assess levels of aflatoxin but also accumulation of the aflatoxin-producing fungi as well.

### **Continue facilitating the establishment of efficient distribution channels for ZFH and PICS bags**

In the past 3 years, at least 12,500 ZeroFly® Hermetic (ZFH) bags have been brought into Ghana with PHLIL facilitation, and sold, and the distribution channels for ZFH bags are taking shape. During the same time period, 397 GrainMate devices have been sold. PHLIL Ghana now has 3 marketing agents for the ZFH bags in Dormaa and 6 marketing agents in northern Ghana. Importation of another 25,000 ZFH bags from Nigeria to Ghana for distribution and marketing is currently being arranged for completion by June 2021. An assessment is underway to determine how much the use of 3 cargo motor trikes (CMTs) will affect the transport availability and marketing of ZFH bags in Northern Ghana, a critical consideration for SME establishment and reducing postharvest losses with resource-poor smallholder farmers in that region. The CMTs were leased in October 2020.

USAID approval was secured to provide funds and training in support of the installation of a flatbed biomass assisted dryer (FBAD) for the Ghana Women in Poultry Association Dormaa chapter. This FBAD will facilitate proper drying of maize before it is stored in ZFH bags by the 50 members of the association. Members of this association are currently the largest market for ZFH bags in Dormaa.

### **Conduct experiments to perform single kernel sorting to assess the mycotoxin-reducing potential of an innovative mechanical cleaning system for maize developed by local poultry farms.**

A total of 176 maize samples, each 400 grams, from poultry farms located near the city of Dormaa Ahenkro were shipped to Dr. Stasiewicz laboratory at University of Illinois, and a graduate student was able to start the experiments required to achieve this objective. Samples are being milled for mycotoxin extraction and then analyzed for mycotoxin concentration using ELISA kits. The graduate student is screening single kernel samples for corn kernels that present characteristics associated with contamination of aflatoxin and fumonisin by using a UV light for bright-green-yellow fluorescence of aflatoxin and visual features, such as formation of mold and broken kernel typically associated with aflatoxin and fumonisin contamination. The initial bulk analysis will provide data on the impact of the presence of a local cleaning system on contamination. The team will then begin training the sorting spectrometer using high-risk features associated with aflatoxin and fumonisin contamination to analyze and reduce mycotoxin in corn.

### **Spectral kernel sorter: Continue improving the spectral classification and analysis of aflatoxin and fumonisin contamination in corn at the single kernel level and concluding spectral classification methods and manuscript writing.**

Preliminary data collected from naturally contaminated US corn was used to develop algorithms that can identify single kernels at or above 20 ppb aflatoxin and 2 ppm fumonisin thresholds. These methods will be implemented in Ghanaian corn samples which were imported in late 2020 with hopes of determining an improved solution for classification of co-occurrence of mycotoxins. Experiments will be conducted to improve spectral classification algorithms and sorting methods that distinguish and remove aflatoxin and fumonisin contamination in corn by using a UV-Vis-NIR spectrometer. Samples that are stratified for single kernel analysis will be used to implement the classification algorithms from the previously collected data and then tested in a similar sample set with the Ghanaian corn to demonstrate classification of co-occurrence of mycotoxins.

### **Complete adoption model in application to Ghanaian poultry farmers**

The Engagement team has completed data collection in Ghana. A total of 147 farmers who were previously trained by PHLIL team members responded to the questions. Data analysis is still pending and a manuscript is in process. Much has been learned about the instrument, and adjustments will be made for administration in other countries for future research. The team has initiated meaningful connections with the University of Ghana to begin qualitative data collection.

**Conduct gender technology assessment of hermetic bags and moisture meters, perform outreach with the Women in Poultry Association**

Focus group discussions have been conducted by the University of Development Studies' partners in 10 beneficiary communities and 9 non-beneficiary communities. The fieldwork has experienced some delays due to weather, the COVID-19 pandemic, and poor transcription/translation services. Additionally, two SAWBO videos have been translated into Asante Twi and distributed to the Women in Poultry Association (WPA) and other groups which focus on women and youth farmers. There were considerable delays with the production of videos and problems with the dialogue not matching up with the video which have now been resolved.

**Exploring a Randomized Controlled Trial and Survey in Ghana**

The PHLIL Ag Econ Team is currently in the design phase, exploring a couple of options to assess economic questions related to scaling of the ZeroFly® Hermetic bags. The research would be centered on the role of hermetic storage bags in storage and marketing decisions and/or credit uses of smallholders. The team has identified potential in-country implementing partners.

## Human and Institutional Capacity Development

### Short-term training

Country of Training	Brief Purpose of Training	Who was Trained	Number Trained		
			M	F	Total
Bangladesh	Training on BAU-STR dryer and hermetic bag use (November 28, 2020) Mymensingh	Producers	9	11	20
Bangladesh	Training on BAU-STR dryer and hermetic bag use (December 2, 2020) Jhalokathi	Producers, Government, Civil Society	19	8	27
Bangladesh	Training on BAU-STR dryer and hermetic bag use (December 3, 2020) Barishal	Producers, Civil Society	9	15	24
Bangladesh	Training on BAU-STR dryer and hermetic bag use (December 4, 2020) Jashore	Producers, Civil Society	7	16	23
Bangladesh	Training on BAU-STR dryer and hermetic bag use (December 14, 2020) Kishoreganj	Producers, Government	21	25	46
Bangladesh	Gender Dimensions and Sensitization Training (December 21, 2020) Khulna	Producers	13	19	32
Bangladesh	Gender Dimensions and Sensitization Training (December 24, 2020) Barishal	Producers	12	18	30
Bangladesh	Gender Dimensions and Sensitization Training (December 28, 2020) Bogura	Producers	11	21	32
<b>Bangladesh Subtotals</b>			<b>101</b>	<b>133</b>	<b>234</b>
Ethiopia	Integrated approach (threshing and hermetic storage) training for post-harvest loss reduction in maize (December 4-5, 2020) Bahir Dar University	Producers, Government	32	23	55
<b>Ethiopia Subtotals</b>			<b>32</b>	<b>23</b>	<b>55</b>
Ghana	Poultry Farmers training on drying, storage, and good sanitation (November 24-27, 2020) Dormaa	Poultry Producers	7	6	13
<b>Ghana Subtotals</b>			<b>7</b>	<b>6</b>	<b>13</b>

## Long-term training

Trainee Number	Sex	University	Degree	Major	Program End Date	Degree Granted	Home Country
<b>Bangladesh Team</b>							
1	F	Bangladesh Agric. Univ.	PhD	Plant Pathology	December 2021	In progress	Bangladesh
4	M	BAU	MSc	Agricultural Engineering	July 2021	In progress	
5	M	BAU	PhD	Agricultural Engineering	May 2022*	In progress	
20	F	BAU	MSc	Agricultural Engineering	July 2021	In progress	
21	F	BAU	MSc	Agricultural Economics	July 2021	In progress	
<b>Ethiopia Team</b>							
7	M	Mekelle University	PhD	Plant Science	July 2021	In progress	Ethiopia
8	M	Mekelle University	PhD	Plant Science	July 2021	In progress	
23	M	Mekelle University	MSc	Food Engineering	July 2021	In progress	
24	M	Bahir Dar University	MSc	Chemical Engineering	February 2021	Yes	
26	M	Bahir Dar University	MSc	Food Technology	October 2021	In progress	
<b>Ghana Team</b>							
13	M	Kwame Nkrumah University of Science and Technology	MPhil	Crop Protection (Entomology)	July 2021	In progress	Ghana
<b>Nepal Buy-In</b>							
14	F	Kansas State University	MSc	Plant Pathology	July 2021	In progress	Kenya

\* This student will be supported by BAU after the end of the PHLIL program.

PHLIL has additional graduate students who are engaged in PHLIL-affiliated research activities but who are not funded by USAID. These students are enrolled and funded wholly separately from PHLIL funds; however, they are assisting in research activities, often due to their being advised by faculty on our team. Thus we still seek to capture their significant contribution to our program:

Trainee Number	Sex	University	Degree	Major	Degree Granted	Home Country
<b>Ghana Team</b>						
15	M	University of Illinois Urbana Champaign	PhD	Food Science	In progress	Guatemala
25	M	Kwame Nkrumah University of Science and Technology (KNUST)	MPhil	Agricultural and Biosystems Engineering	In progress	Ghana
<b>Guatemala Team</b>						
16	M	University of Nebraska, Lincoln	PhD	Food Science and Technology	In progress	Guatemala
<b>Engagement Team</b>						
17	F	Iowa State University	PhD	Ag Education	In progress	Cameroon
<b>Ag Econ Team</b>						
18	F	Kansas State University	PhD	Ag Economics	In progress	Pakistan
19	M	Kansas State University	MSc	Ag Economics	In progress	Guatemala

## Innovation Transfer and Scaling Partnerships

**Ghana:** *SAWBO Instructional Videos on best practices, adapted to Asante Twi*

To date, two SAWBO videos have been adapted and translated to Asante Twi: the *Postharvest loss prevention video* and the *Mycotoxins in Crops and Postharvest Loss: Storage* video. The translation and recording of the local language videos was a group effort that included a Ghanaian graduate student at University of Illinois, Sesi Technologies and SAWBO. Coordination and sync of the videos presented some challenges, but the videos have been finalized and shared with various groups in Ghana including the Women in Poultry Association, Young Professionals in Agriculture and Rural Development, Women in Agriculture and Rural Development and Ghana Farmers' Association. The videos have been appreciated by all recipients.

## Future Work

Across the entire program, PHILIL's teams have actively adapted to pandemic-related disruptions to planned activities. Travel, group trainings and other planned activities have been delayed due to the pandemic, though research outcomes remain strong as evidenced by the FY20 performance indicator reports. The teams are committed to finishing strong with sustainable outcomes and innovations scaling towards resilient development outcomes. Nonetheless, pandemic-associated delay of some program activities was unavoidable, so an extension to the program duration will be necessary to complete all planned activities.

Work in Tigray continues to be a challenge. The ME is working to establish the best communications plan with the Mekelle University team and assess how their workplans need to be adapted in the face of significant challenges.

At the request of our AOR, the ME produced a Year 9 costed extension proposal that is under consideration. This would enable the program to leverage the first 8 years of progress and funding to achieve more significant scale-up and positive development outcomes.