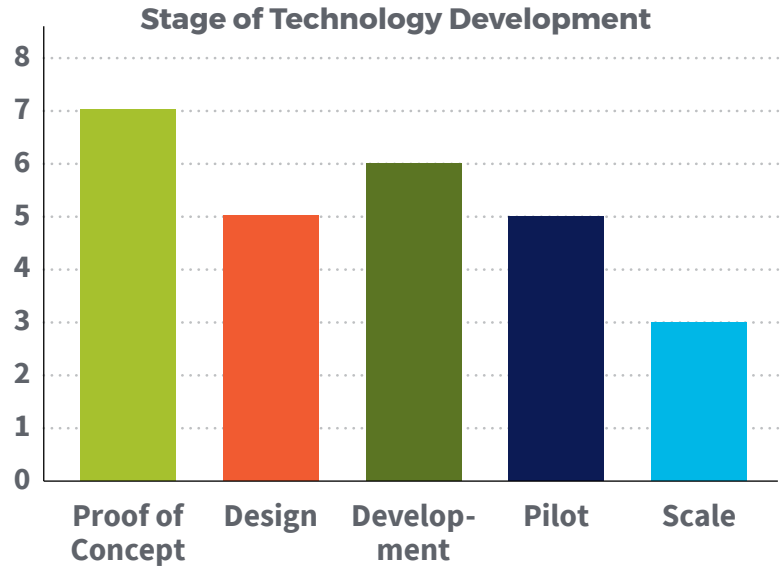
ADMI

Institute for the Prevention
of Postharvest Loss
University of Illinois

Decade of Impact

14

technologies & innovations designed, scaled and promoted



29,000

smallholder farmers directly trained in postharvest loss prevention technologies, practices, and food security issues

25%

of trainees are **women farmers**

Impacting close to

3,300

households globally and

200

farmer producer organizations

314

students at University of Illinois and international universities impacted through trainings

8,500

participated in ADMI-developed online course

Over 40,000

hermetic bags distributed directly to smallholder farmers

212

small-scale grain dryers developed and set up in Bangladesh and India, reaching over **4,200 smallholder farmers**

60

equipment fabricators trained in postharvest equipment fabrication

70

public extension workers and community workers trained on postharvest management practices

More than

80

projects funded through ADMI awards

engaging more than

57

faculty at University of Illinois and international universities

resulting in

77

research papers published in peer-reviewed journals

Project Funding by Thematic Area

- Capacity Building
- Extension
- Innovation
- Research
- Policy

688

participants from **32 countries** attended ADMI-led conferences, side events and workshops

66

collaborators and partnerships in **14 countries**

- Government Agencies
- Foundations
- Professional Associations
- Other Non-Profits
- Research Institutions
- Private Sector
- Universities

Social Media and Communications

3,140

Facebook & Twitter followers

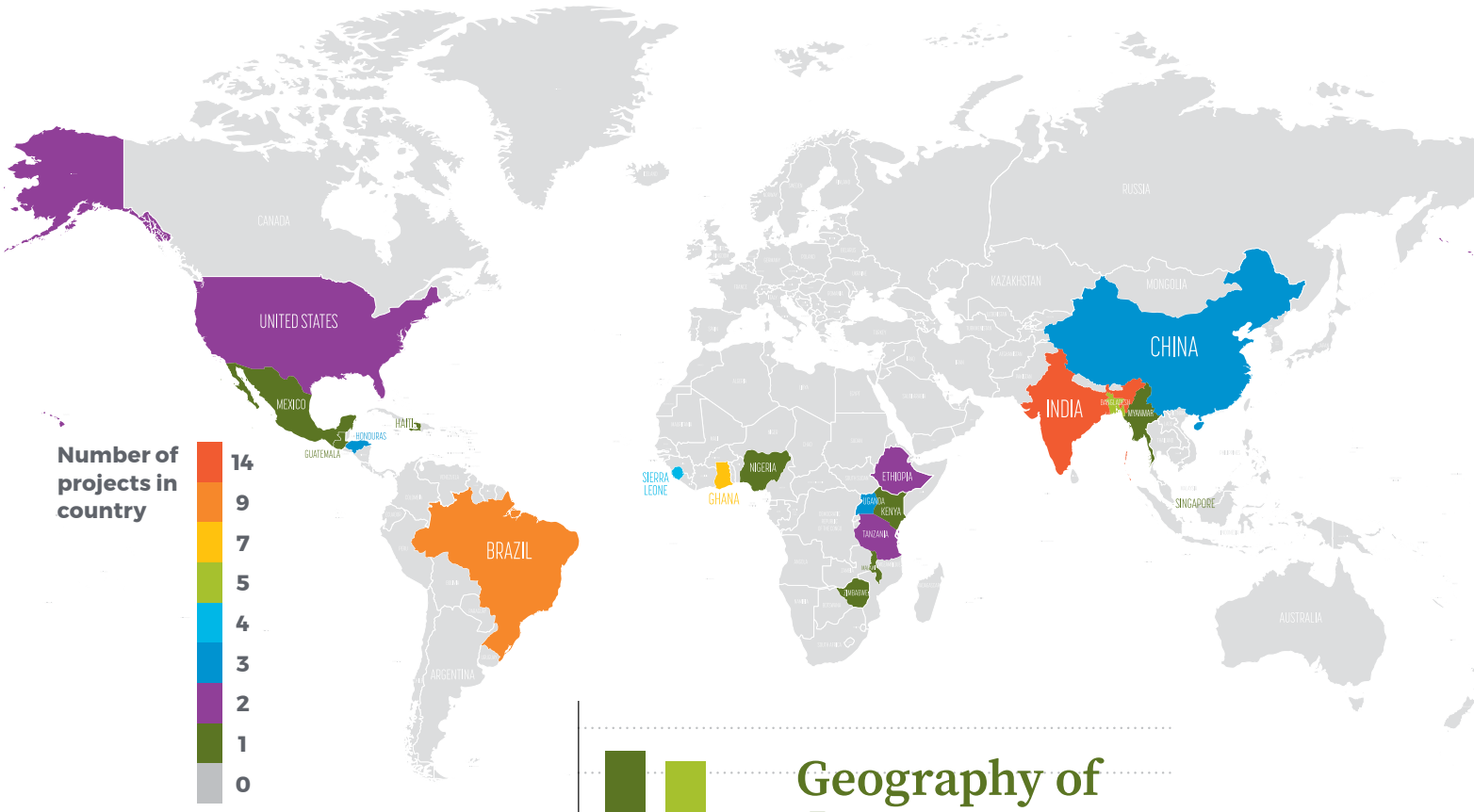
73

newsletters sent to **637 people**

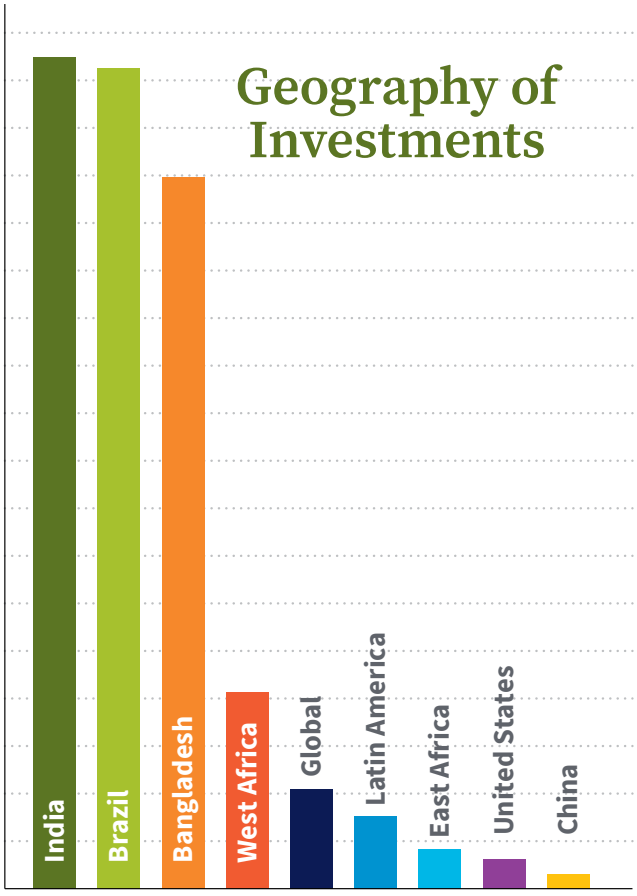
126

blogposts

Partnering with the World



Geography of Investments



From the Director

In January 2011, when ADMI was established, the problem of food loss and waste was recognized but not well understood. The food security and environmental factors motivating the creation of an institute for the prevention of postharvest loss were summarized in the words of Patricia A. Woertz, ADM chairman, CEO and president at the time, "Clearly, preserving what is already grown is fundamental to feeding the world, and to making the most of the land, water, energy and other inputs already used to grow crops." Later that year the FAO gave measure to the global scale of the issues with the oft-cited estimate that one third of global food production was lost or wasted before reaching the consumer.

Since then, our understanding of postharvest loss has become more nuanced and progress has been made in many respects. That the issue is now firmly established in discussions of environmental sustainability and poverty alleviation is clear from Sustainable Development Goal Target 12.3, which commits the United Nations member states to work to "reduce food losses along production and supply chains, including post-harvest losses."

At one level, the technical challenges and solutions for preventing postharvest loss are well known. Grain must be dried to an appropriate degree, stored in a manner that protects it from moisture and pests, and transported and processed efficiently. While the technologies and practices for achieving those individual functions exist, their coordinated application remains uneven. The resulting food loss is sometimes attributed to failure to recognize the problem, inability to apply existing solutions, absence of locally appropriate and readily available solutions, or failures in the food system to enable and incentivize use of improved practices.

The approach of ADMI has been to address postharvest loss through raising awareness, building capacity, and promoting innovations, all with a food systems perspective. ADMI's food systems approach recognizes that the problems of food loss anywhere in a value chain may reflect failures and potential interventions elsewhere in that chain. We are proud of the metrics that show progress in the form of more knowledgeable farmers, traders, students, and government officials; more capable institutions for research, policy, and farmer support; and the creation of new knowledge and contextually appropriate innovations. More importantly, we are confident that the people, institutions, and innovations we have invested in will have an increasing impact on poverty reduction and environmental sustainability by enhancing postharvest management in the food system.

The progress that we celebrate in this 10 year anniversary report was possible because of partnerships. The complexity of the food system requires a multidimensional response that can only be mustered by uniting diverse institutions, perspectives, and expertise. The initial gift from ADM Corporation to the University of Illinois reflects a remarkable awareness of the importance of linking higher education and research with the private sector. Our many partnerships with universities around the world bear witness to the importance contextual knowledge that comes only from people and institutions embedded in a location. Partnerships with other initiatives focused on specific commodities or crosscutting themes have been essential to tapping multidisciplinary talent to face complex problems. Likewise, engagement with government agencies and non-profits has been essential to creating an enabling environment for better postharvest management.

Over the last 10 years, ADMI has woven a great web of relationships and built a deep understanding of the complex factors driving postharvest outcomes. Over the next 10 years, we look forward to continued work with partners to build food security and environmental sustainability through the reduction of postharvest loss.

—Alex Winter-Nelson

History of ADMI

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

2011

- Institute established with $10 million gift from ADM Corporation
- PHL in the News, website, and social media accounts launched

See interviews with early ADMI researchers and leaders

"The Institute is ahead of the curve in engaging with this particular problem. It was great insight on the part of the leadership at ADM to recognize the problem and seek to engage with finding solutions proactively."

—Dr. Robert Easter

2012

- 9 startup seed projects funded
- First sponsored study abroad trip to India

Coordinated first-ever **Workshop on Post-Harvest Losses** in Sinop, Mato Grosso, Brazil

2013

- Hosted first side event forum at World Food Prize Borlaug Dialogue
- USAID Innovation Lab for the Reduction of Post-Harvest Loss (PHLIL) awarded to Kansas State with ADMI as co-lead

"Reducing PHL was perceived as an 'easy' problem. However, we now know that post-harvest loss is a complex problem, intertwined with other challenging food system issues."

—Dr. Steven Sonka

2014

- Global Learning Assessment project for Rockefeller Foundation begins
- Co-hosted PHL experts convening with Gates Foundation in Washington, D.C.
- Hosted first postharvest training event for State Academy of Grain, China

Read Early Learning Report

Blog posts

2015

- Reduction of PHL for Smallholder Farmers project begins in India
- Coursera course PHL 101 goes online with first cohort
- ADMI Village inaugurated in Bihar, India
- First International Congress on Postharvest Loss Prevention convened in Rome, Italy

"We brought the whole world together! People were so connected, because they realized they were not the only ones thinking about these postharvest loss issues."

—Dr. Prasanta Kalita

2016

- PHL 101 becomes an on-demand online offering
- ADMI co-hosts Appropriate Scale Mechanization Consortium symposium
- First farmer trainings take place in the ADMI Village

2017

- Launch of the Bangladesh Integrated Food Policy Research Program
- Dedication of PHL Reduction Lab facility at Bangladesh Agricultural University
- Redesigned ADMI website increases accessibility to postharvest information

2018

- PHLIL Phase 2 awarded by USAID
- First group of PHL Scholars announced
- India and Bangladesh project engineers meet for knowledge exchange
- ADMI hosts first Bangladesh Ministry of Food cohort for food policy short course

2019

- ADMI Village integrated into State of Bihar Climate-Smart Villages program
- First PHL Scholar graduates with doctoral degree
- ADM Cares funds five postharvest projects through ADMI

"Many innovations and technologies exist that could dramatically reduce postharvest loss even during the disruptions of Covid-19, but those solutions will remain underused until smallholder farmers are aware of their grain losses and the ways to address them and have reliable market access to postharvest technologies."

—Dr. Alex Winter-Nelson

2020

- ADMI hosts "Securing the Harvest: A forum on improved grain storage in India" in New Delhi
- Expanded partnership with IFPRI for off-farm storage research in Bangladesh
- 300 learners complete PHL 101 in a single year

2021

- Digital outreach partnership with Grow Indigo launched
- Initiated postharvest policy research initiative in India with ICRIER
- Hosted round table discussion with AIARD and presented with Consumer Goods Forum
- Resources portal of ADMI website goes live

"The momentum garnered by the research, engagement, educational projects at the ADMI will lead to a significant societal and environmental impact over the years. By increasing food availability and enhancing the well-being of small farmers, ADMI is positively impacting food and economic security, especially in rural communities."

—Pradeep Khanna

Innovation Scaling

BAU-STR Dryer

Storage losses in grains are often a result of improper and inadequate drying. The BAU-STR dryer is an efficient, low-cost, small-batch mobile grain dryer developed by Bangladesh Agricultural University (BAU) with support from ADMI and the USAID Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss (**PHLIL**). Adapted from the STR dryer introduced in Vietnam, this locally manufactured hot air circulating dryer provides an alternative to traditional sun drying for farmers and small traders, thereby significantly reducing moisture-caused postharvest losses.

Led by Dr. Monjurul Alam, a team of faculty and students at BAU have developed the BAU-STR dryer over the course of six years of intensive research work modifying the design, selecting proper manufacturing materials, reducing costs, and standardizing installation and operating procedures for the dryer. As of 2021, more than 200 BAU-STR dryers are in use, enabling 4,000 smallholder farmers and traders to dry paddy, wheat, and maize. BAU has developed partnerships with private sector companies to manufacture and distribute the dryer, and the dryer has been formally included in the Government of Bangladesh's agricultural machinery subsidy program, which opens access to millions of smallholder farmers, farmer groups, and traders. The BAU-STR dryer design is widely available and been used in India and Nepal.

Highlights

- Since 2015, more than 1,200 farmers (336 women) and other stakeholders have been trained on the usage, operation, and maintenance of the dryer.
- In 2021, a new agreement was signed with BAU, ADI foundation and ACI Motors Ltd. to co-ordinate, supervise local production, and market the BAU-STR dryer throughout Bangladesh and provide after-sales service through their service centers.
- The BAU-STR dryer has been formally included in the government's subsidy program with a 70% subsidy in low-lying areas and a 50% subsidy in the rest of the country in 2021. Through a new DAE mechanization project (USD 365 million) 5,000 dryers including the BAU-STR dryer will be provided to smallholder famers by 2025.

Scaling & Impact

The **BAU-STR** dryer is a success story in innovation development and scaling for impact. Scaling success can be attributed to the variety of activities supporting the technology development process: research and development, field testing, farmer demonstration and training, building capacity of local fabricators, knowledge dissemination and close engagement with the government and private sector actors.

Engaging Farmers

Training and research have been crucial to scaling the BAU-STR dryer. Since 2015, more than 1,200 farmers (336 women) and other stakeholders have received training on dryer usage, operation, and maintenance. Field visits and focus group discussions revealed that over 78% of farmers who have used the dryer have had a positive experience and benefitted from the drying. A farmer group in Mymensingh cited saving about USD 588 equivalent of paddy from rainy weather, recovering a large share of the dryer's cost in one season.

Engaging Women Farmers

In Bangladesh, postharvest activities such as sun drying, winnowing, and parboiling are the responsibility of women. Therefore, engaging women farmers has been a key priority for BAU. In 2019, BAU conducted a gender assessment and found that the dryer was easy for women to fix, dismantle, and operate. The BAU-STR dryer also saved women time and labor associated with sun drying, monitoring, and cleaning stored grain in households. Moreover, local women entrepreneurs have received training through women's groups to provide fee-based drying services to the community.

Engaging Private Sector

As a key component of scaling research to practice, BAU has invested in building the capacity of local manufacturers and fabricators such as Bhai Bhai Engineering and Kamal Machine Tools to design and manufacture the BAU-STR dryers at scale for distribution to farmer organizations and other interested buyers.

In 2021, a new agreement was signed with BAU, ADI Foundation and ACI Motors Ltd. This agreement will enable ADI to coordinate and supervise local production of the BAU-STR dryer, and ACI Motors Ltd. to market the BAU-STR dryer throughout Bangladesh through their strong marketing channels and provide after-sales service through their service centers

The Technology

Funded jointly by ADMI, the USAID Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss (PHLIL), and the Appropriate Scale Mechanization Consortium (USAID Feed the Future Innovation Lab for Sustainable Intensification), the BAU-STR dryer is designed for smallholder farmers and small-scale seed traders.

The dryer has a capacity of 500 kg and can dry a batch of grain in 4 to 5 hours. It reduces grain loss during drying to 0.5% compared to 3-4% using conventional methods. When coupled with hermetic storage, the dryer enables farmers to reduce storage losses significantly.

The BAU-STR dryer can now be entirely manufactured in Bangladesh, and can be repaired and maintained by local businesses. Mechanized drying creates value for smallholders in these groups.

The heating element of the dryer was originally designed for rice-husk briquettes but was modified by BAU to run on LPG based on farmer feedback. In addition to being a cleaner-burning fuel, LPG is widely available in Bangladesh, enabling easier fuel accessibility.

The payback period of LPG-based BAU-STR dryer with local blower (designed in 2019) is less than a year.

Engaging Government

In partnership with the Bangladesh Ministry of Agriculture's Department of Agricultural Extension's (DAE) Integrated Agricultural Approach for Ensuring Nutrition and Food Security project, 184 farmer organizations in six districts each received a BAU-STR dryer. BAU also provided fabrication training, technical assistance, and conducted train-the-trainer workshops for sub-assistant agricultural officers and other trainers.

Success from this initiative coupled with BAU's policy engagement has led the BAU-STR dryer to be formally included in the government's subsidy program with a 70% subsidy in low-lying areas and a 50% subsidy in the rest of the country in 2021. Through a new DAE mechanization project 5,000 dryers will be provided to smallholder famers by 2025.

Video

Hermetic Storage

Postharvest losses are usually concentrated at the storage stage. Over the past decade, ADMI has strongly prioritized research, development, and promotion of various hermetic storage technologies such as hermetic bags, cocoons, and modified metal silos in India and Bangladesh.

Hermetic Bags

ADMI Grain Handling Technique

Bangladesh Agricultural University helped pioneer the ADMI Grain Handling technique of pairing hermetic storage with the BAU-STR dryer. In partnership with civil society organizations such as the Ara Bangla Society, BAU has worked with numerous farmer groups, including women's groups, to encourage adoption of hermetic storage coupled with dryer usage, especially for paddy seed storage.

Technology demonstration through the ADMI Village

From 2015-2018, ADMI invested in the development of the ADMI Village in the state of Bihar, India. Together with partners Bihar Agricultural University, Dr. Rajendra Prasad Central Agricultural University, and the Borlaug Institute for South Asia (BISA), the ADMI Village focused on reducing postharvest losses in wheat, rice, maize, and lentil crops in five districts in Bihar.

At the ADMI Village, ADMI researchers identified appropriate technology interventions, including hermetic bags, and created a technology demonstration and training hub, bringing together experts and smallholder farmers. The ADMI Village project worked with close to 10,000 farmers in 50 villages in Bihar improving awareness of postharvest issues and solutions through training on safe storage practices using hermetic bags. Training was accompanied by the distribution of more than 6,000 hermetic bags—both free and subsidized.

Scaling hermetic solutions in Bihar

In 2019, ADMI initiated a new partnership with BISA to scale postharvest solutions in Bihar through the Government of Bihar's Climate-Smart Agriculture program. In partnership with BISA, ADMI reached 75 **Climate-Smart Villages** in six districts in Bihar through distribution of hermetic bags, provision of drying services, and focused drying and storage training for farmers.

Through field demonstrations, farmer trainings and awareness campaigns, the project reached more than 6,000 farmers in Bihar with hermetic technology, drying technologies, and basic postharvest loss awareness and prevention methods. More than 18,000 hermetic bags were distributed in 75 villages during 2019-20. In the second year of the project, the project worked with local retailers and entrepreneurs to encourage subsidized sales of hermetic bags.

COVID-19 lockdowns increased the use of digital mobile platforms, and the project launched multiple farmer WhatsApp groups to encourage

Highlights

- From 2015–18, more than 10,000 farmers in 50 villages in Bihar, India received training on safe storage practices using hermetic bags, mycotoxin contamination, and drying practices. Training was accompanied by the distribution of more than 6,000 hermetic bags—both free and subsidized.
- From 2019–20, nearly 9,000 farmers from 75 villages in Bihar, India, were reached, with 1/3 of them being women. More than 18,000 hermetic bags were distributed during the same period.
- 200 near-hermetic metal bins of 50 kg and 100 kg capacities were fabricated and distributed among 100 farm households in Bangladesh.

peer-to-peer learning and communication with project trainers. Trainers developed simple videos on proper use of hermetic bags, shared via WhatsApp.

Metal Bins

While the benefits of hermetic bags have been researched and demonstrated, in Bangladesh they face barriers in adoption due to government restrictions on single-use plastics and associated high tax rates. With ADMI's support, BAU designed and developed a contextually appropriate durable **near-hermetic metal bin** that can be locally produced.

Supported by ADM Cares funding, BAU fabricated and distributed 200 near-hermetic metal bins of 50 kg and 100 kg capacities. The bins are currently undergoing field-testing in 100 farm households in Mymensingh. The development of the metal bin was coupled with fabrication training for 14 local workshop owners.

Cocoons

One path to addressing storage losses in the public and private sector is by scaling hermetic cocoons for off-farm storage.

ADMI and the International Food Policy Research Institute (IFPRI) South Asia supported BAU in work with Moti Auto Rice Mill and the Bangladesh Agricultural Development Corporation (BADC) to set up hermetic cocoons to demonstrate their use and functionality and test the technical and financial feasibility for grain storage and seed storage.

The Technology

Hermetic bags (usually 50-100 kg in capacity) are composed of multiple layers of plastic that minimize oxygen permeability rendering oxygen levels too low for survival of insects and microorganisms. Especially in tropical regions, hermetic bags are a proven technology to reduce grain spoilage and grain loss by preventing stored grains from absorbing or losing moisture due to humidity variations.

Hermetic bins are metal or plastic silos offer near-hermetic environments, preventing the need for chemical pesticides, reducing plastic waste, and offering larger storage capacity than bags.

Hermetic cocoons are storage systems for bagged grains and seeds. Similar to hermetic bags, cocoons can safely preserve dry agricultural commodities in bulk quantities.

In a partnership with Moti Auto Rice Mill, BAU researchers **piloted multiple 5-ton hermetic cocoons** and evaluated them over a four-month period. BAU also focused on training warehouse staff on proper use of the hermetic cocoons and evaluated different business models for continued use of the cocoons. The research identified a specific type of cocoon that offered the greatest economic and technical performance.

With BADC, the Government of Bangladesh's seed-producing institution which supplies 38% of rice seed in the country, BAU research showed that use of 30-ton hermetic cocoons reduces the need for and cost of fumigation or insecticide treatment, re-drying and re-lotting, and periodic moisture measurement and germination tests.

Multi-Crop Thresher

Threshing is second only to storage loss as a contributor to postharvest losses in most crops. **The Multi-Crop Thresher** (MCT) is a low-cost, locally produced, durable medium-scale thresher that can shell maize and thresh soybean, rice, beans, and sorghum. The MCT reduces threshing time by 80% and reduces postharvest loss to less than 2%.

A shared commitment to reduce quality and quantity losses associated with poor threshing is the foundation of the long-standing partnership between ADMI and the USAID Feed the Future Soybean Innovation Lab (SIL). Since 2018, with funds from ADM Cares and ADMI, SIL has trained local artisans in thresher construction and business development, built capacity of local engineers to innovate and train others, conducted field-testing and demonstrations with smallholder farmers, evaluated performance and profitability, and specifically enabled women farmers' access to the MCT.

Scaling & Impact

Building Local Capacity by Training Fabricators

A local skilled workforce is a necessity for the adoption and long-term sustainability of postharvest innovations. The SIL mechanization team has **trained local fabricators** in Malawi, Ethiopia, Sierra Leone, Nigeria, and Zimbabwe to build, service, and maintain the threshers. Fabricators were trained through a combination of hands-on fabrication training events and seminars. Local fabricators have played an important role adapting MCT design to local context and providing maintenance and repair services. Currently, SIL has a network of over 200 trained fabricators across 10 countries. Seventy entrepreneurs are now commercially operating over 280 MCTs across sub-Saharan Africa. Each machine can serve up to 200 farmers.

Proving Effectiveness

Robust evaluations have shown that the MCT increases market value of farmers' produce, reduces the time and cost of threshing, and reduces postharvest losses. The MCT is spurring rural industrial production, expanding opportunities for youth and women-led businesses. Service providers can pay back the capital cost, earn a high rate of return (gross margins range from 64-80%), and achieve profits of around $57 per day when threshing 50% maize and 50% soy.

Furthermore, evaluations with women-led thresher groups have shown that MCTs reduce women's labor, increase production, and increase income, thereby improving household food security and empowering women.

Highlights

- SIL has a network of more than 200 trained fabricators across 10 countries, and 70 entrepreneurs are now commercially operating over 280 MCTs across sub-Saharan Africa. Each machine can serve up to 200 farmers.
- Service providers can pay back the capital cost, earn a high rate of return (gross margins range from 64–80%), and achieve profits of around $57 per day when threshing 50% maize and 50% soy.

The Technology

Developed by Ghanaian fabricators within SIL, the Multi-Crop Thresher (MCT) is sized and priced for purchase and use by mid-sized farmers or service providers. It can be powered with a diesel engine or through a tractor power take-off.

While traditional hand-threshing is labor intensive and can take up to two weeks for an acre of soybean, the MCT reduces threshing time to four hours and requires only two operators. The MCT is designed to be quickly and easily switched between crops by changing out a perforated metal sieve concave.

The resulting grain from the MCT is free of contaminants such as rocks and sand and is more marketable than stick-threshed grains, enabling farmers to receive higher sale prices due to better grain quality. It also reduces grain quality losses from spillage and breakage and protects seed quality ensuring high germination levels.

The MCT designs are open source and provide users with free access to **CAD plans and operator manuals**.

SPOTLIGHT

Success Story

Khodeza Begum is a farmer, entrepreneur, and field facilitator with DAE in Mymensingh district. Khodeza first learned of the BAU-STR dryer in 2016 from Gramaus (NGO) and was interested in the dryer's potential to dry paddy harvested in the rainy season. In 2017, Khodeza participated in field demonstrations and hands-on training on operating and maintaining the BAU-STR dryer as part of her farmer group. Within one year of a BAU-STR dryer being placed in her homestead for demonstration and trial, Khodeza had dried five batches of harvested paddy and enabled her neighbors to dry their paddy using the same dryer.

To prevent major crop loss during the 2020 Boro harvest due to COVID-19 lock-downs and heavy prolonged monsoon rains, Khodeza and her farmer group dried about 13.7 tons of paddy, which amounted to saving (in paddy prices) more than the actual cost of the BAU-STR dryer. Moreover, in an innovative method, her farmer group also uses the dryer's blower as a winnower!

Recently, Khodeza Begum was awarded the 2021 Professor Dr. Ashraf Ali Khan Memorial Agricultural Award by the Bangladesh Agricultural University Research System (BAURES) during the annual research workshop for her contribution in agricultural mechanization, especially encouraging neighbors and farmers with improved postharvest practices of drying and storage, and her contributions in reducing postharvest loss of paddy in her area.

Knowledge Sharing

Prior to 2011, the impact of postharvest losses on food security, food safety, economics and the environment was not well known. Over the past decade, ADMI has played a key role in advocating for the reduction of postharvest losses through knowledge sharing with a broad range of stakeholders that has included smallholder farmers, government agencies, policy makers, researchers and the private sector.

ADMI has facilitated multiple convenings, conferences, seminars and round table discussions, bringing together postharvest loss actors from different sectors and stages of the value chain to build consensus for finding solutions.

First International Congress on Postharvest Loss Prevention

The early campaign to raise the profile of postharvest loss led to the First International Congress on Postharvest Loss Prevention in October 2015 in Rome, Italy. Co-sponsored by the Food and Agricultural Organization (FAO), the Bill and Melinda Gates Foundation, the Rockefeller Foundation, and John Deere, the congress brought together more than 260 scientists, policymakers, industry leaders, practitioners, educators, and students from 62 nations to discuss postharvest loss prevention. The first of its kind, the congress raised awareness of the significance of postharvest losses in the context of global hunger issues and provided a knowledge exchange platform for postharvest loss reduction intervention plans, practices and policies.

"It was so exciting. People were so connected to each other. It was like a family reunion of the people who worry about postharvest losses…and right after that, everyone started talking about their regional conferences—Latin America, African regional conferences. All those things have evolved from ADMI initiating the first postharvest congress."

—Dr. Prasanta Kalita (ADMI Director 2014-2017)

A critical outcome of the congress was the creation of the **postharvest loss roadmap**, which incorporated participant feedback through the collection of best practices and approaches for reducing losses at each stage of the postharvest value chain. Furthermore, this first-ever convening on postharvest loss reduction paved the way for multiple future gatherings of thought leaders such as the All-Africa Postharvest Loss Congress (2017, 2019, 2021).

A key focus of the conference was to assemble a global coalition of postharvest loss experts and practioners to build partnerships and collaboratively address postharvest loss issues. To that end, the conference secured multiple sponsorships to enable the participation of 80 researchers and students from multiple countries including Ghana, Kenya, Burkina Faso, Zimbabwe, Egypt, Nigeria, South Africa, Bangladesh, Thailand, Philippines, Indonesia, Costa Rica, Brazil, and Uruguay.

Forum for Improving Storage for Smallholder Farmers

In February 2020, ADMI and the International Food Policy Research Institute (IFPRI) South Asia collaborated to host **"Securing the Harvest: A forum on improving storage for smallholder farmers in India"**. Held in New Delhi, the event brought together more than 85 thought leaders, researchers, and practitioners from the public and private sectors to discuss ways to reduce postharvest losses in India and South Asia with a focus on storage losses.

In addition to discussing the scope and scale of the postharvest problem, emphasis was placed on panel and group discussions on the barriers to the adoption of hermetic storage bags by smallholder farmers and the public sector in India; and explore policy interventions to capitalize on the potential for hermetic storage. The forum pointed the need for research that maps differentiated market structure and addresses postharvest issues across various actors in the food system. A result of the forum has been two new partnerships with **ICRIER** and **Grow Indigo**.

"We see that technologies seem to have a place in this battle against postharvest loss, but we recognize that there are a lot of steps between innovative technology and widespread usage. We need to identify the unseen constraints."

—Dr. Alex Winter-Nelson (ADMI Director)

Online knowledge sharing

ADMI website

The **ADMI website** and **accompanying blog** has been a source of information about the institute and postharvest loss issues for the past 10 years. Although it looks very different now than it did at the beginning, the goal is the same: to provide convenient access to postharvest loss prevention information. In the last year, ADMI staff overhauled a significant portion of the site, refreshing it up with updated information about **ADMI's active projects and partnerships**. The **Resources** section of the site is all-new, and provides a one-stop shop for information related to postharvest loss at all stages of the value chain, in addition to e-learning and PHL calculation resources.

PHL in the News

ADMI launched the **PHL in the News** email newsletter in June 2011 as an aggregation of global postharvest loss news and events. At the time, there was no other source devoted exclusively to PHL news. Over the years, the format and frequency has changed, but the publication continues to be a curated collection of PHL news, research, reports and upcoming events. To date, 73 issues of the newsletter have been sent, with a global mailing list of 637 people.

SAWBO videos

Scientific Animations Without Borders (SAWBO) uses downloadable animations to preserve and disseminate information and knowledge, particularly for low-literate populations. SAWBO was established by Barry Pittendrigh and Julia Bello-Bravo at the University of Illinois in 2010. ADMI established a partnership with the project in 2011 and supported the creation of a **series of postharvest loss-related animations**. More recently, SAWBO worked with Bangladesh Agricultural University to produce a video about the **BAU-STR grain dryer**.

Impacting Food Systems

The food systems approach recognizes that problems of food loss anywhere in a value chain may reflect failures and potential interventions elsewhere in that chain. With this in mind, ADMI has executed multifaceted programs engaging different stages of food systems to leverage research for innovations and policies that reduce postharvest losses and promote development. A review of our 10-year record in India and Bangladesh demonstrates a food systems approach for preventing postharvest loss.

Food Systems Research in Bihar, India

The state of Bihar is one of least economically developed states in India, where close to 80% of the population is dependent on agriculture as their main livelihood. Ninety-one percent of Bihar's agricultural land is owned by marginal farmers, who own less than a hectare and predominantly grow cereal grains such as maize, pulses, wheat, and rice.

ADMI funded the first **large-scale micro-level analyses on postharvest losses in Bihar** through a randomized control trial (an experimental form of impact evaluation) from 2015-2018. The research, led by Dr. Kathy Baylis, Pallavi Shukla, and Hemant Pullabhotla, gathered data on postharvest management, postharvest losses, and food security from more than 4,000 farm households across four districts.

The research showed that smallholder farmers in Bihar lose up to 10% of their cereal harvest due to poor drying and storage capacity. Moreover, households faced difficulty in maintaining food safety leading to high prevalence of aflatoxin levels (36%) in maize that resulted in significant quality and economic losses (30% decrease in price). This represents lost income to impoverished farm households and wasted land and water, in a setting where both resources are increasingly scarce and food insecurity is common.

Over the past decade, ADMI has identified promising technologies, such as hermetic bags, that smallholder farmers can use to avoid storage losses and improve grain quality. In a study that measured the **return on investment of hermetic bags and farmers' willingness to pay**, data showed that Bihar producers stand to gain a 24% increase in maize revenue through the adoption of better postharvest practices to reduce quantity and quality losses. Moreover, traders were willing to pay 10% higher prices for grain stored in hermetic bags. The research also demonstrated the importance of food safety from both a household consumption and market sale standpoint. Farmers' willingness to pay increased (13%) when provided with information

on harmful health effects of consuming aflatoxin-contaminated grains and how hermetic storage can reduce aflatoxin contamination.

Research findings informed capacity building trainings and workshops for more than 18,000 farmers and community workers in Bihar as part of the ADMI Village project and the **Climate-Smart Villages project** implemented by Borlaug Institute of South Asia, Bihar Agricultural University, and Dr. Rajendra Prasad Central Agriculture University. The capacity building projects were grounds to validate technical feasibility of postharvest loss technologies, such as moisture meters. Dr. Kent Rausch and PHL Scholar Amir Jafari conducted **an evaluation of grain moisture meters** to test their suitability for use in developing countries by comparing against the oven-drying method.

While ADMI research has shown the advantages of using better postharvest management technologies, such as hermetic bags in combination with drying technologies, there have been significant barriers to scaling. This formed the basis of the **ADMI-IFPRI forum on improved storage**, which brought together the public, private, and research sectors in India to identify solutions to scale appropriate solutions for better postharvest management. The forum revealed the need for granular data on postharvest losses across the value chain that could inform national and state-level policies, and the lack of established markets for improved postharvest technologies.

In response to the forum, ADMI partnered with the Indian Council for Research on International Economic Relations (ICRIER) on the **Postharvest Loss Reduction Policy Initiative** to inform and amplify the policy discussion regarding reduction of food loss and waste along the food value chain in India through joint research and policy engagement. The initiative will develop quality research, provide evidence-based recommendations about policies, and advance policy solutions through engagement with relevant stakeholders focusing on reducing postharvest losses in grains and oilseeds at a national scale through better storage and handling. Currently, a "Review of food loss in India: a macroeconomic perspective" paper has been drafted and efforts are underway to conduct a field study of value chain losses in Bihar.

Additionally, ADMI is addressing the lack of established last-mile distribution networks through a recent partnership with private sector company Grow Indigo. Funded by ADM Cares and ADMI, this research brings together a multi-disciplinary team of economists and business experts led by Baylis and Dr. Madhu Viswanathan to analyze the **role of agricultural input dealers in increasing adoption of postharvest technologies** and the impact of digital platforms in technology adoption.

Preliminary interviews with agro-retailers in target districts in Madhya Pradesh have revealed the informal yet critical role agro-retailers play in promoting new inputs and ag-technologies to farmers, and the importance of the social networks of ag-input manufacturers and distributors. Currently, a short series of instructional videos on the purpose and benefits of hermetic bags have been developed through a collaborative process with farmers. Through an upcoming randomized controlled experiment, researchers will analyze the impact of information dissemination to retailers in the adoption of postharvest technologies. The research uses Grow Indigo's digital sales platform 'Grow Online' to connect and work with agro-retailers to promote adoption of hermetic bags.

Paddy Food Systems Research with Bangladesh Agricultural University

Bangladesh's smallholder farmers bear the cost of climate change. With multiple rice production seasons each year, harvests inevitably come during rainy periods and open-air grain drying has become impractical. There is a critical need for affordable and accessible drying and moisture management solutions that minimize postharvest and build smallholder farmers' resilience to climate change. Through a long-standing partnership with Bangladesh Agricultural University (BAU), Mymensingh, ADMI has aided the development of appropriate drying technology, piloted the use of hermetic bags, explored alternative storage methods such as hermetic cocoons and metal bins, built capacity through lab facilities, and engaged in policy through training and research. The multifaceted and integrated set of interventions has become a success story for modernizing postharvest management.

Research for appropriate grain drying and storage

The **BAU-STR dryer** developed by BAU within the USAID Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss (PHLIL) is an example of holistic research funded by ADMI that has taken the technology through technical validation and piloting with male and female farmers, to scaling with government support. The dryer has been adapted to farmers' needs, can be locally manufactured through trained fabricators (Bhai Bhai Engineering and Kamal Machine Tools), and collaborations with private sector (ACI Motors) for distribution. Moreover, specific research ensures the dryer is gender sensitive and accessible to women farmers who are responsible for grain drying. In 2020 alone, more than 1,000 Bangladeshi producers have trained on or used one of the 197 BAU-STR dryers currently in the field. Additionally, the Government of Bangladesh announced subsidies to support farmers in the purchase of up to 5,000 BAU-STR dryers, exhibiting government acceptance of the dryer.

To aid in monsoon season paddy harvest and in response to climate change, BAU has developed a **12-ton recirculating batch grain dryer** in a public-private partnership with Moti Auto Rice Mill, a small-scale private sector rice-milling enterprise. Small- and medium-scale private rice husking mills handle 45% of total paddy production in Bangladesh and are a market for smallholder farmers selling their harvest. Millers reported a rise in smallholder farmers selling "wet paddy," while farmers complain of traders' unwillingness to buy such grain at an acceptable price. In response to local demand, BAU is collaborating with Moti Auto Rice Mill to develop and manufacture 12-ton dryers with locally available parts and components in the expectation that such dryers will enable millers to be a more reliable market for smallholders.

The 12-ton dryer is unique because it matches the capacity of the local husking mills, enabling them to maintain good capacity utilization regardless of weather. Moreover, the dryers can dry either paddy or parboiled rice, unlike other available dryers. This combination of scale and versatility makes it easier for existing mills to operate year-round and provide a more reliable market for smallholder farmers. With just 25% of Bangladesh's 14,500 small-scale mills adopting the dryer, 1.4 to 1.5 million farmers could have a stable market for Boro

or Aus harvest, despite high moisture content in grain during those harvest periods, reducing their risk.

With respect to **grain storage**, BAU has researched the effectiveness of various hermetic bags, developed a contextually appropriate durable near-hermetic metal bin that can be locally produced, and conducted field experiments with hermetic cocoons for off-farm storage by private millers (Moti Auto Rice Mill) and public seed storage warehouses (BADC).

Building human and institutional capacity through laboratory facilities and global engagement

Building human and institutional capacity is key to ADMI's work. Through collaborative research projects between BAU and UIUC, engagement in global conferences, and establishment of postharvest research laboratories, ADMI is ensuring the sustainability of postharvest loss research initiatives at BAU.

In 2017, BAU opened a new **Postharvest Loss Reduction Lab** to serve as a research and training center for postharvest loss problems and solutions. Through the lab's equipment for drying and storage technologies and mycotoxin analysis, BAU has engaged with faculty and students to develop new postharvest loss preventing technologies.

The close partnership between BAU and ADMI/University of Illinois has **increased the research, extension, and education capacity at BAU**. For example, BAU and UIUC have closely collaborated on multiple research projects such as testing hermetic cocoons at the rice mill, developing metal hermetic storage, and the adaptation of the BAU-STR dryer through the USAID-funded PHLIL and Appropriate Scale Mechanization Consortium (ASMC). In 2019, both labs collaborated in training BAU faculty and students in conducting **gender technology assessments** through field-based qualitative research on harvesting equipment. BAU further utilized the methodology and training to conduct four additional gender assessments covering various technologies such as hermetic bags, BAU-STR dryer, planter, and rice transplanter. BAU has also engaged deeply in ADMI-led **global convenings** such as the Postharvest Congress in Rome and the Forum in New Delhi, which have led to recognition for research and training achievements on a global level. As of 2021, BAU's increased capacity and stellar achievements have led them to become direct sub-awardees on an extension of the PHLIL project and highlighted on the USAID-funded Innovation to Impact toolkit (i2i), a collection of innovations that have demonstrated success across the five stages of impact, from ideation to scale.

Policy engagement with the Ministry of Food

In addition to technical innovations and capacity building, confronting the challenge of drying and storage in the Bangladesh food system requires an appropriate policy environment at the highest level. In collaboration with IFPRI-South Asia, on the **Bangladesh Integrated Food Policy Research Program**, part of the Government of Bangladesh's Modern Food Storage Facilities Program, ADMI has built policy capacity with training programs in food systems and food policy.

In parallel, ADMI Director Dr. Alex Winter-Nelson and graduate students Reajul Chowdhury and Shahadat Hossain **analyzed the economic feasibility for private investments in modern food storage** and possible policies to support better postharvest practices

throughout the system. The research explored the lack of widespread private investment in improved grain storage and examined the potential for public support to stimulate greater private sector investment in modern storage. This included return on investment calculations on bulk grain silos upgrading to hermetic cocoons, assessment of grain loss prevented from conversion to such technologies, and the public support required to trigger private investment in modern storage systems. The research has opened discussion of possible reforms to import policies that could trigger adoption of improved storage practices that identified through ADMI's work on storage with BAU.

ADMI's experience in India and Bangladesh has made clear that food systems thinking leads to multidimensional interventions that can have real impact for development. The experience also reveals the importance of partnerships for identifying interventions and executing change.

Measuring Postharvest Losses in Brazil

ADMI's research engagement in Brazil began in 2011 and addresses postharvest losses in the soybean and corn industry with a food systems perspective. A team of researchers from the University of Illinois, in collaboration with five Brazilian universities (Universidade Federal de Viçosa, Universidade Federal de Goiás, Federal University of Mato Grosso, Federal University of Latin American Integration (UNILA), and Western Paraná State University (UNIOESTE)) and multiple producer associations, documented losses, measured on-farm and off-farm losses with farmers, and developed best postharvest management practices.

Documenting losses in Parana & Mato Grosso

- Research by Drs. Peter Goldsmith, Altair Moura (Universidade Federal de Viçosa), Mary-Grace Danao, and Richard Gates measured the extent and cost of postharvest losses in corn and soybean production and processing the states of Mato Grosso, Paraná, Jataí, Sorriso, and Sinop. The scale of total losses motivated efforts to better understand where they emerged in the system.

Measuring on-farm losses

- Goldsmith and graduate student Anamaria Guadencio in collaboration with APROSOJA, a Brazilian soybean association, studied Brazilian farmer perceptions of soybean postharvest losses in their fields in Mato Grosso, Brazil. They focused on the extent and causes of on-farm loss and identified that farmers may not prioritize loss reduction over other objectives, signaling the need for a management-oriented approach.
- Dr. Mary Arends-Kuenning and Marcos Garcias of UNILA examined the nature of smallholder agriculture in São Paulo and Paraná states and the implications for postharvest loss in those areas. Through a detailed farmer survey, researchers identified lack of machinery, poor transportation infrastructure, and poor storage facilities as the key factors affecting losses. The study also examined the **impact of government policies** on postharvest loss reduction.
- Goldsmith and Moura examined postharvest losses in soybeans from the double-cropping system (safrinha) in Mato Grosso. The double-cropping system allows farmers to plant two crops in the same field in succession in the same crop year. The time pressure that this system creates has implications for postharvest loss that could be mitigated by **policymakers and private investors**.

Examination of the complex grain system in Brazil reveals multiple actors making management decisions with a range of motivations that collectively result in substantial losses. New tools, practices, and techniques can create space to reconcile the objectives of different value chain actors with reduced postharvest losses.

Measuring on-farm losses

- Arends-Kuenning, Garcias, and Pery Shikida (UNIOESTE) worked with Cooperativa Lar, a large cooperative in western Paraná, to measure soybean losses on the farm. Analysis revealed that average losses among the farmers were **2.6% of production**, costing western Paraná soy producers USD 35 million. A research article currently under review finds that farmers who hire out their harvesting experience 1.5% higher losses than those who harvest their own crop. Aligning incentives between farmers and combine operators may lower losses.
- Arends-Kuenning is working with UNIOESTE and UNILA to study the impact of **women's empowerment on postharvest management** with Cooperativa Lar. Using the Women's Empowerment in Agriculture Index, researchers are studying the extent to which women make farm decisions on the purchase and use of harvesting mechanization.

Measuring off-farm losses

- In Brazil, over 60% of soybeans are transported by truck from farms to processing, storage, and export terminals. Poor road conditions, improper truck maintenance, overloading, and inefficient transfer of grain all contribute to transportation losses. Danao, Gates, and their team measured the postharvest losses during handling and transportation in Mato Grosso, Brazil, by **installing grain probes** in trucks to monitor temperature, moisture and CO2 concentrations. Analysis showed that **monitoring carbon dioxide concentration** in the trucks was a more effective way to determine spoilage than temperature monitoring.
- Gates, with graduate students Ana Beatriz Pereira da Silva and Loren Steinman, studied the maximum allowable storage time (MAST) for soybeans to predict quality losses under different transport and storage conditions. Researchers **established the effects of respiration management** on soybean loss rates and use **dry matter loss data to determine MAST benchmarks** for Brazilian condition. While MAST data exists for soybeans harvested in the United States, the warmer and wetter conditions in Brazil called for a different set of standards.

Human and Institutional Capacity Building

ADMI was set up as an institution that not only promoted cutting edge research but also built and strengthened capacity to sustainably address postharvest losses at a local, regional, national, and global scale. Over the past decade, the institute has made large investments in capacity building focusing on diverse stakeholders, including smallholder farmers, students, research and educational institutions, and government agencies.

Farmer Education and Support Initiatives

Farmer training is a cornerstone of ADMI's work. In partnership with local institutions, ADMI has enabled postharvest loss reduction technology transfer to smallholder farmers through a variety of farmer training programs, including kisan melas, kisan goshtis, field demonstrations, and farmer cooperative training. Examples of in-depth capacity building programs are detailed below.

Subsistence Marketplaces Initiative: Partners in building knowledge for farmers

Led by Dr. Madhu Viswanathan, the **Subsistence Marketplaces Initiative**, a longtime ADMI partner, has improved the lives and livelihoods of smallholder farmers through innovative training methods. Through a combination of ADMI funds and ADM Cares grants, the Subsistence Marketplace Initiative has trained close to 2,000 smallholder farmers in India, Tanzania, Honduras, and Uganda on postharvest loss reduction.

Highlights include the first agriculture-centered marketplace literacy program (2018–19), which enabled subsistence women farmers in southern India to gain appropriate market knowledge, awareness of rights and opportunities, and the self-confidence to move forward in creating their own market conditions and outcomes. Postharvest loss prevention was emphasized within the broader value chain as an entrepreneurial opportunity with the intent of helping smallholder farmers keep more of their profits in hand.

Similarly, a sustainability literacy program (2019-20) for farmers focused on postharvest loss prevention in Honduras, India, Tanzania, and Uganda within the context of climate change and its impact on agriculture. Viswanathan and his team designed, piloted, and delivered the program to a variety of participants—rural/semi-rural village clusters near Chennai, India, a Maasai tribal community in Tanzania, Nakivale refugee settlement in Uganda, and villages in Honduras. The program used "bottom-up understanding", the process of getting information and gauging knowledge from the farmers while the program is being designed. This has ensured the trainings are contextually appropriate and meets the farmers where they are and enhances their understanding.

Highlights

ADMI's capacity building has focused on providing a combination of the following:

- Information on latest postharvest technologies, practices and solutions
- Resources, tools, and capacity to implement postharvest practices and research
- Knowledge and research skills

29,000
farmers trained

25%
of trainees are women farmers

3,293
farmer households trained

Technology transfer in India and Bangladesh

The ADMI Village project worked with close to 10,000 farmers in 50 villages in Bihar improving awareness of postharvest issues and solutions. Through five technology centers managed by a trained community worker, farmers accessed training on topics such as safe storage practices using hermetic bags, mycotoxin contamination, and drying practices. The centers served as information and training hubs and were equipped with postharvest equipment, such as an STR dryer, moisture meter, hermetic bags, and a backup generator.

ADMI's research and investment in technology development in India and Bangladesh pioneered the "**ADMI Grain Handling System**", which demonstrates that improved grain drying and storage together can be key to mitigating postharvest loss, resulting in improved food security and food safety for both smallholder farmers and end consumers. Farmers using the BAU-STR dryer with hermetic storage achieved 95% germination rates from saved seed, as opposed to 35% for other households. Through the technology centers, more than 6,000 hermetic bags—both free and subsidized—were distributed to smallholder farmers, coupled with grain drying services. The impact from ADMI Village carried over to the Climate-Smart Villages project, which added postharvest loss reduction practices to the Government of Bihar's work in Climate-Smart Agriculture. The project trained close to 9,000 farmers in 75 villages on postharvest storage solutions.

"Participation in the project has helped me to learn how the available local resources can be put into use to produce crops for better food security in household."

—Justin Mann, ACES student

Moreover, in Bangladesh and in India, multiple local fabricators received training in the production of small-scale grain dryers. For more information, see here

Youth Capacity Building Through Experiential Learning, Research, and Online Education:

Youth engagement through classes and degree programs has been an important aspect of ADMI's work. Through a combination of online education, experiential learning and research scholarships, ADMI has invested in the next generation of scholars who will continue to expand the field of postharvest loss reduction. In the past decade, ADMI has engaged with 200+ students at the University of Illinois and internationally. Furthermore, 8,500 students have benefited from ADMI's online course.

Student experiential learning through study abroad

Experiential learning is more effective at strengthening the capacity of students to

understand the realities and complexities of postharvest loss and global value chains. ADMI has sponsored short-term student study abroad trips to immerse them in field realities and arrive at innovative solutions that directly assist smallholder farmers. Examples of ADMI funded student engagement include:

- 60 students learned about postharvest loss in the context of agricultural supply chain management with Dr. Udatta Palekar.
- 19 students from the Gies College of Business and Grainger College of Engineering conducted **field market research** to develop appropriate grain storage products and associated business plans for smallholder farmers in India with Dr. Madhu Viswanathan.
- 10 students from the University of Illinois and Gulu University, Uganda, led by Dr. Paul McNamara developed **a series of farmer-to-farmer videos** for delivering extension training in northern Uganda.

Building young researchers' capacity through the PHL Scholars program

The Prevention of Postharvest Loss Scholars (**PHL Scholars**) program provides master's and doctoral students with research assistantship funding for work on projects related to postharvest loss. The program equips the next generation of scientists to confront postharvest losses in the quality or quantity of food from the perspective of economics, engineering, food science, and agriculture. Since 2018, five PHL scholars have graduated through the program with a focus on:

- **Ruben Chavez**, Food Science and Human Nutrition, is working on multi-spectral sorting methods to reduce mycotoxins in maize to prevent post-harvest loss in corn. The work is in collaboration with Dr. Matt Stasiewicz and the Postharvest Loss Innovation Lab work in Ghana.
- **Loren Steinman**, Agricultural and Biological Engineering, measured postharvest dry matter loss in soybeans by measuring maximum allowable storage time for tropical harvest conditions with Dr. Kent Rasuch.
- **Gowthami Venkateswaran**, Agricultural and Consumer Economics, is examining the economic impacts of post-harvest loss prevention through three unique projects based in India that measure smallholder farmers' willingness to adopt postharvest loss technologies.
- **Amir Jafari**, Agricultural and Biological Engineering, evaluated moisture meters suitable for developing countries and looked at modifications to the STR dryer so that smallholder farmers will be able to dry crops other than paddy rice and prevent losses
- **Pallavi Shukla**, Agricultural and Consumer Economics, researched the demand and pricing policy for improved storage technology in Bihar, India. Her work played a key role in supporting and advancing ADMI projects in Bihar.

SPOTLIGHT

ADMI Interns

Undergraduate and graduate students are an important part of the ADMI team. Interns have engaged in a variety of roles from research to operations, for example: writing newsletters, managing social media, taking photos, improving our website, conducting literature reviews, and writing researched fact sheets. Working at ADMI has given students a real-world exposure to food security programming and international development.

Coursera: PHL 101

In 2015, ADMI launched an online course through the Coursera platform, **"Global Postharvest Loss Prevention: Fundamentals, Technologies and Actors"**, also known as PHL 101. The course was the first free online course specifically focused on postharvest loss, and one of the first University of Illinois courses offered on the Coursera platform.

The course was available in 2015 in two sessions, in February and June, which together attracted more than 5,000 learners from 166 countries. In summer 2016, the course converted to an on-demand model, allowing learners to proceed through the course at their own pace. Since 2016, an additional 3,500 students have begun the course, with 550 completing the entire sequence. During the COVID-19 pandemic, interest in PHL 101 soared with more than 450 learners completing the course in 2020–21, more than the previous four years combined.

Government Agencies

Strengthening institutional and human capacity in targeted government agencies is necessary to enable policy decisions in postharvest loss reduction. To that end ADMI functions as a knowledge hub and hosts short-term technical training for mid to high level professionals from the public sector.

In 2014, ADMI hosted a 10-day training program with Chinese government officials from the State Administration of Grain (SAG). Trainees consisting of engineers and managers learned about the effects of postharvest practices and grain quality on ethanol production and corn milling, in addition to learning about supply chains in the U.S. and public-private partnerships.

ADMI has hosted two short-term trainings for officials engaged in food policy issues with the Government of Bangladesh as a component of the Bangladesh Integrated Food Policy Research Program—a collaboration with the International Food Policy Research Institute (IFPRI) South Asia. The program is part of the Government of Bangladesh's Modern Food Storage Facilities Program funded through the World Bank.

In 2018 and 2019, 16 officials from the **Bangladesh Ministry of Food** participated in a series of seminars at the University of Illinois, and in field trips that gave them new perspectives on food systems, food policy, and postharvest management. Participants learned from University of Illinois experts in a range of fields, including commodity marketing, food fortification, grain storage and processing, and food policy analysis. The course included guided research and concluded with presenting policy briefs authored by the participants at IFPRI's headquarters in Washington, D.C. Policy brief topics have included mechanization in Bangladesh, cash transfers vs. food distribution in government assistance programs, increasing government paddy procurement, rice fortification, and the feasibility of public-private partnerships for grain storage.

Research and Educational Institutions

From the beginning, ADMI has adopted a facilitative approach to strengthening the capacity of local organizations to develop their abilities to reduce postharvest losses. Through collaborative partnerships, ADMI has built a legacy of sustainable capacity strengthening over time. ADMI's engagement with higher education and research institutions has spanned research capacity development, laboratory equipment sponsorship and faculty engagement.

"We created that course to reach all people through Coursera. We wanted to create a sensation with that course—what is postharvest loss, how can we reduce it? We reached a lot of people in different parts of the world—we mailed out CDs, flash drives to people who didn't have internet."

—Dr. Prasanta Kalita (ADMI Director 2014-2017)

Njala University

The University of Illinois has a long history with Njala University, Sierra Leone. The relationship began in 1963 when Njala was established with support from USAID and University of Illinois as the implementing partner. Currently, the universities host a number of joint activities through their academic partnership. This partnership creates many opportunities for students, faculty and staff to collaborate with one another through study abroad programs or research projects carried out in Sierra Leone.

ADMI has funded a number of research and student learning capacity-building projects at Njala University since 2013. Most recently, with support from ADM Cares, a **Postharvest Experimental Training Hub** was established in 2019. One of the purposes of the hub is to engage students in postharvest loss education and research activities to build their capacity and deepen their knowledge of relevant technologies and approaches. Currently, 53 students from Njala University and the University of Illinois have benefitted from trainings at the center. An additional 24 students have been working together in the Agribusiness program and Learning in Community classes to study postharvest interventions implemented by NGOs in the cocoa and rice sector.

ADM Cares grants have enabled AgReach, led by Dr. Paul McNamara, to conduct training workshops at Njala University for NGOs, the Ministry of Agriculture, and farmer organizations in postharvest loss prevention. Over 300 farmers in four villages have been trained on aflatoxin contamination during storage and using hermetic storage. AgReach has also worked with Njala University instructors to incorporate PHL learning and experiences into the curriculum of the College of Agriculture and the School of Technology. This includes pilot testing technologies and best practices. Currently, the Hub has constructed prototype flatbed and silo dryers.

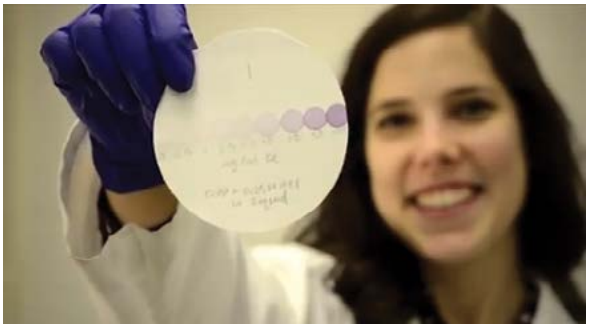
Gender and Nutrition

Improving Nutrition

ADMI projects integrate nutrition within postharvest management through a dual focus on ensuring food safety in cereals and improving the nutritional quality of food consumed in low-income households.

Postharvest interventions like food fortification combat hidden hunger by enhancing the nutrient quality of food. However, many programs in low-income countries lack resources to determine if an appropriate amount of fortified nutrients is consistently present in food products. Dr. Juan Andrade and Anna Waller developed an affordable, reliable paper-based sensor called **NU3PX to detect levels of iron in fortified food products**. The new technology combines chemistry, engineering, nutrition, and food science to develop the color-changing paper sensor that can detect iron in food, along with an easy-to-use cellphone app. At just $0.10 per test, the inexpensive and easy-to-use paper-based assay changes color to a bright magenta in response to iron in fortified foods. With **the app**, the user can upload a photo of the paper sensor after the color appears and the app determines the iron level. This eliminates the need for a computer and software to perform image analysis and enables use in a low-income setting. The assay and app have been tested for feasibility in Mexico.

In Ghana, one of the main byproducts from processing soymilk is **okara**, which is commonly used to make wet food for pigs. However, okara is high in protein, carbohydrates, and fiber, making it a potentially attractive nutritional ingredient for food products. Andrade, in partnership with Dr. Francis Amagloh at the University of Development Studies within the USAID Feed the Future Soybean Innovation Lab, received ADM Cares funding to **research fortifying commonly used flours in Ghana with dried okara-soy flour**. Commonly



used flours such as gari (cassava) and tuo zaafi (maize and millet) are widely consumed and provide a good source of energy, but are limited in quality protein and micronutrients. Andrade's research has examined the incorporation of dried okara flour, defatted soy flour, and full-fat soy flour into these traditional staple flours. Research included the development of a dryer to dry okara and process it into flour, conducting a nutrition composition analysis of the dried flour, and evaluating the **shelf stability of the flour fortification under real storage conditions**.

Also in Ghana, Dr. Matt Stasiewicz and PHL Scholar Ruben Chavez have developed a **small-scale kernel sorting system** that effectively removes mycotoxin-contaminated kernels of maize from the food supply. As part of the PHLIL project, Stasiewicz and Chavez have developed a spectral sorting technology that can reduce postharvest losses, both in terms of the numbers of kernels that are safe to consume and the nutrition content of the kernels that remain. The system has been tested with maize kernels sourced from Ghanaian poultry farms with a mechanical cleaning system for corn, which may reduce mycotoxin levels. Through **numerous experiments** where the team is using contaminated kernels to train discrimination algorithms using spectral data, results have shown a 75% sensitivity to identify single kernels at or above 20 ppb aflatoxin and 2 ppm fumonisin thresholds. Sorting a 200 gram bag of contaminated maize showed rejection of a small proportion (<10%) of the sample, most of which look visibly moldy, discolored, or broken.

Integrating Gender

Globally, women smallholder farmers are responsible for multiple post-harvest activities, such as threshing, drying, winnowing, storage, cleaning, processing, and marketing. ADMI's efforts to promote gender integration include conducting research on women's preferences for postharvest technologies through gender technology assessments, working with women's associations to promote access to mechanization, and including women in training programs. Across all projects, ADMI ensures at least 25% of farmer trainees are women.

While numerous postharvest loss-reducing innovations exist, organizations and programs need to consider gender dimensions of such technologies and address gendered barriers. The **Gender Technology Assessment** methodology developed through **AgReach**-led project INGENAES is widely promoted and used by numerous ADMI partners in the context of postharvest loss research. Bangladesh Agricultural University (BAU) researchers utilized this methodology to assess the gender sensitivity of hermetic bags and the BAU-STR dryer promoted within the PHLIL project. The assessment revealed that both hermetic bags and the BAU-STR dryer significantly saved women's time and labor in comparison to traditional storage and drying methods. Similarly, in collaboration with the University of Development Studies, Ghana, Dr. Anna Snider trained 20 faculty and students on the gender technology assessment methodology and led gender assessments on the GrainMate moisture meter, hermetic bags, and crop aggregation centers.

Also in Ghana, ADMI funds helped the Soybean Innovation Lab (SIL) expand **women's access to post-harvest agricultural mechanization through multi-crop threshers** by working with 20 women's village savings and loan associations. Drs. Kathleen Ragsdale, Mary Read-Wahidi, and Kerry Clark analyzed ownership models that were the most productive and sustainable for female group ownership of agricultural equipment, like the thresher, and evaluated the benefits and challenges that women smallholder farmers encounter as members of thresher micro-enterprises.

Training women farmers has been critical to gender integration. Drs. Paul McNamara and Anna Snider are leading efforts to **reach women farmers through gender-sensitive postharvest management training** to the Women's Poultry Association (WPA), a subsidiary of the National Poultry Farmers Association. Thus far, SAWBO videos (originally funded by ADMI) and Access Agriculture's videos have been translated and produced in the local Asante Twi and Dgbanli languages, and are being shared to more than 50 WPA members through WhatsApp. Similarly, in Bangladesh, BAU has purposefully engaged women farmers by training female entrepreneurs such Khodeza Begum to provide community drying services for a fee and serve as training agents for other female farmers. BAU has also engaged with women's groups in Bagura village to provide targeted postharvest training and resources. In India, Dr. Madhu Viswanathan is leading efforts to train women farmers on **marketplace social sustainability literacy**.

Building Global Partnerships

Partnerships are the bedrock upon which ADMI was built.

Postharvest loss is a complex problem that requires a multidimensional response that can only be mustered by uniting diverse institutions, perspectives, and expertise. ADM's original gift to the University of Illinois linked higher education with the private sector, the beginning of a global, food systems approach to reducing postharvest loss.

ADMI's partners span 14 countries, highlighting the need for contextual solutions spearheaded by local organizations and experts. Our partners include government agencies, national universities, non-profit organizations, research institutions, farmer cooperatives, and private sector companies.

We are grateful to our partners over the past 10 years and look forward to strengthening existing bonds and forging new partnerships to continue addressing postharvest losses.

- Archer Daniels Midland (ADM)
- AgReach, University of Illinois
- Association for International Agriculture and Rural Development (AIARD)
- All Africa Postharvest Congress and Exhibition (AAPHCE)
- Alliance for Green Revolution in Africa (AGRA)
- American Society of Agricultural and Biological Engineers (ASABE)
- Aprosoja (Brazilian Association of Soy Producers)
- Appropriate Scale Mechanization Consortium, University of Illinois (USAID funded project)
- Bangladesh Agricultural University (BAU)
- Bangladesh Ministry of Food and Agriculture
- Bihar Agricultural University
- Bill & Melinda Gates Foundation
- Borlaug Institute for South Asia (BISA)
- Caterpillar Inc.
- Chicago Council on Global Affairs
- CNA (National Confederation of Agriculture, Brazil)
- Compatible Technology International
- Consumer Goods Forum
- Digital Green
- Dr. Rajendra Prasad Central Agricultural University (DRPCAU)
- Embrapa (Brazil Agricultural Research Corporation)

Food and Agriculture Organization (FAO), Save Food Initiative

Federal University of Mato Grosso

Forum for the Future

Grow Indigo

Indian Council for Research on International Economic Relations (ICRIER)

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

International Food Policy Research Institute (IFPRI) South Asia

Indian Council of Agricultural Research (ICAR)

Indian Institute of Technology (IIT) Mumbai

Information Technology Research Academy (ITRA)

Institute of Food Technologists

Institution of Mechanical Engineers

International Rice Research Institute (IRRI)

John Deere

USAID Feed the Future Postharvest Loss Innovation Lab (PHLIL)

Kansas State University

Maharashtra Hybrid Seeds Company Limited (MAHYCO)

MarketMaker

MART

McLarty Associates

Monsanto

Njala University

Postharvest Education Foundation

Purdue University

Research Center for Rural Economy of China (RCRE)

Riverside Research

Rockefeller Foundation

Scientific Animations Without Borders (SAWBO)

Secretaria da Agricultura Familiar

Soybean Innovation Lab

State Administration of Grain (SAG)

Subsistence Marketplaces Initiative

Sun Buckets

University of Birmingham

University of California–Davis

Universidade Federal de Goiás

University of Development Studies

University of Greenwich Natural Resources Institute (APHLIS)

University of Iowa

University of Sao Paulo

University of Vicosa (Universidade Federal de Viçosa)

United States Agency for International Development (USAID)

United States Department of Agriculture (USDA)

World Bank

World Food Prize

World Resources Institute

Our Path Forward

The importance of ADMI's mission to address food insecurity and environmental damage through the prevention of postharvest loss is even more apparent today than it was a decade ago. From severe climate events to a global pandemic, recent experience has shown the importance of resilient food systems, and postharvest management has always been a pathway for building resilience. In the face of emerging strains in the food system, the essential role of postharvest management is now widely recognized. As we look ahead, it is useful to consider what has changed and what has remained the same in the postharvest loss landscape over the last decade.

A decade ago, postharvest loss was barely discussed in policy dialogues. Since then, the prominence of food loss and waste in strategy discussions for national governments and development organizations has risen dramatically. The UN Sustainable Development Goals prioritized food loss and waste, several countries have developed strategies for PHL reduction and allocated resources towards the efforts, and USAID and other development agencies as well as foundations like Rockefeller and non-profits all have programs focused on postharvest loss. While this represents a significant shift in the discussion and in funding, public investment in loss prevention remains low compared to investment in production technology.

A decade ago, food loss and waste was not measured in a consistent way, making it difficult to systematically identify problems and work to solutions. Today we have well-documented protocols to identify critical loss points and the interventions to address losses. Improved definitions and protocols have raised the quality of our data and our understanding, but they have also revealed the gap between identifying losses and operationalizing solutions. Despite many localized successes in addressing postharvest loss, there is little evidence of reduction in global rates of food loss and waste.

A decade ago, the technical solutions to postharvest loss seemed to be widely understood, while the factors constraining adoption of those solutions were the subject of speculation. Though some technologies are spreading in some places, adoption of improved drying and storage technology remains a challenge today. The understanding that improved postharvest management may be best pursued from a food systems perspective is relatively new, and guides ADMI as we move forward in our mission.

The path forward for ADMI is rooted in the recognition that improvement in postharvest management takes place within complex food systems and the systems as a whole must be understood to identify and implement solutions. The complexity of these food systems means ADMI will continue to build multifaceted programs that combine, as needed, technology adaptation and innovation, awareness campaigns and education, policy analysis and advocacy, and research on the drivers of adoption. These multifaceted interventions require partnerships, which ADMI will continue to develop and honor. As we look forward, we carry with us lessons learned, the support of a growing community of shared interest, and a platform of partnerships that we will leverage in our work to enable people to adopt the postharvest practices that contribute to more resilient food systems and a more food secure future.

External Advisory Board members 2011–2021

Robert Easter, University of Illinois * +

Pradeep Khanna, University of Illinois * +

Usha Barwale Zehr, Mahyco Seeds*

Jennifer Bernhard, University of Illinois*

Alesha Black, Chicago Council on Global Affairs

Carlos Campabadal, Asociación Americana Soys-IM

Dennis Fisher, ADM

Ashok Gulati, Indian Council for Research on International Economic Relations (ICRIER)*

Hans Joehr, Nestlé

Dirk Maier, Kansas State University

Charlene McKoin, Bill & Melinda Gates Foundation

Kent Miller, John Deere

Elizabeth Mitcham, University of California-Davis

Arlene Mitchell, Bill & Melinda Gates Foundation

Marcelo Duarte Monteiro, Brazilian Association of Cotton Producers (ABRAPA)*

Victoria Podesta, ADM

Daniel Queiroz, Universidade Federal de Viçosa

Jimmy Smith, International Livestock Research Institute*

Alison Taylor, ADM*

Robert Zeigler, International Rice Research Institute*

_____

** current board member*

+ served as chair

ADMI Directors

Steve Sonka | 2011–2013

Prasanta Kalita | 2014–2017

Neal Merchen (interim) | 2017

Alex Winter-Nelson | 2017–present

ADMI Staff

Alex Winter-Nelson, *Director*
alexwn@illinois.edu

Maria Jones, *Associate Director*
mjones10@illinois.edu

Sarah Schwartz, *Communications Coordinator*
sbingsch@illinois.edu

ADMI Institute for the Prevention of Postharvest Loss University of Illinois

Visit our website

postharvestinstitute.illinois.edu

Follow ADMI on social media

@phlinstitute

@PHL_Institute

Subscribe to PHL in the News

Find out what's new at ADMI and in postharvest loss

go.illinois.edu/ADMIsubscribe

College of Agricultural, Consumer & Environmental Sciences
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN