AflaSTOP:
Drying and Storage for Aflatoxin Prevention
(Formerly the Post-Harvest Drying and Storage for Aflatoxin Prevention Project)
Cooperative Agreement No: AID-OAA-A-12-00010

Annual Report, April 2015-March 2016
PROJECT SUMMARY

AflaSTOP aims to develop and commercialize technologies for post-harvest storage and drying of staple grains to help prevent and control the incidence of aflatoxin. Aflatoxin is a highly toxic substance caused by growth of Aspergillus fungi. The toxin is known to cause cancer, immune-system suppression, growth retardation, liver disease, and death in both humans and domestic animals. Aflatoxin affects many important food crops in sub-Saharan Africa. Aflatoxin threatens efforts in sub-Saharan Africa to achieve agricultural development, food security and better health.

The AflaSTOP project will identify and develop commercialization strategies for existing, commercially viable, small-scale storage devices and develop new low cost drying technology that will either be affordable to the farmer as an investment or as a service. Storage and drying technology will also reduce post-harvest losses and improve crop handling and management practices. AflaSTOP is using a market-led approach, and is coordinating closely with the Partnership for Aflatoxin Control in Africa (PACA). AflaSTOP will promote the scaling-up of proven technologies across Sub-Saharan Africa by synthesizing and distributing lessons learned to different countries.

USAID and the Bill & Melinda Gates Foundation (BMGF) are funding the AflaSTOP project through a Global Development Alliance (GDA). Meridian Institute, ACDI/VOCA and Agribusiness Systems International (ASI) are implementing the project (the Implementing Partners). In this annual report, the Implementing Partners report on progress since the previous annual report, submitted in April 2015.

PROJECT ACCOMPLISHMENTS IN 2015

In this reporting period, AflaSTOP progressed in several objectives including:

- Key Activity 1 - Identify commercially viable small scale storage technology: Completed Phase 1 (off-farm testing of storage devices)
- Key Activity 1 - Identify commercially viable small scale storage technology: Continued Phase 2 (on-farm testing of storage devices)
- Key Activity 2 - Identify commercially viable drying technology: Completed the final design of the shallow bed portable batch dryer
- Key Activity 3 - Commercialization of Project Technology: Commenced development of commercialization strategies for project technologies
- Key Activity 4 - Synthesize and Distribute Lessons Learned: Released the first two issues of the AflaSTOP periodic newsletter to almost 400 subscribers
- Key Activity 4 - Synthesize and Distribute Lessons Learned: Received USAID’s Collaborate, Learn, Adapt (CLA) award
- Key Activity 5 - Expanding Technology to Different Countries: Commenced expansion of technology to Rwanda and Tanzania
In March 2016, the Implementing Partners requested a no-cost Extension from BMGF and USAID through the end of May 2017 for the prime award, and through the end of March 2017 for the ACDI/VOCA and ASI sub-agreements.

In this report, the Implementing Partners provide a summary of progress in all five Key Activity areas.

**PROGRESS SUMMARY OF KEY ACTIVITIES**

**Key Activity 1: Identify commercially viable small scale storage technology that prevents further aflatoxin contamination**

**Phase 1: Off-farm Testing of Storage Devices**

AflaSTOP completed Phase 1 (off-farm testing of storage devices), which investigated performance of five hermetic storage devices in a controlled environment and compared them with the farmers normal storage method. Table 1, below, provides an overview of each of these devices. AflaSTOP tested the hypothesis that enhanced storage would prevent increases in aflatoxin, fumonisin and insect infestation over a 6 month storage period.

**Table 1: Storage Devices**

<table>
<thead>
<tr>
<th>Storage technology</th>
<th>Characteristics</th>
<th>Storage Capacity and Estimated Price</th>
<th>Cost/Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal silo</td>
<td>Produced by local artisans, made out of aluminum, placed on a pallet, size ranges from 200 - 1,000 kg</td>
<td>~312 kg Costs ~$144</td>
<td>$0.46</td>
</tr>
<tr>
<td>Plastic silo</td>
<td>Produced by local large scale commercial water tank manufacturer Kentainers, made out of heavy duty reinforced plastic, placed on a pallet</td>
<td>~350 kg Costs ~$92</td>
<td>$0.26</td>
</tr>
<tr>
<td>Grain Pro Grain Safe II - Bulk Bag</td>
<td>Produced by Grain Pro and imported into the country duty free, made out of patented plastic technology, placed on custom made frame, capacity ranges from 800 - 1,300 kg (they are introducing a new 500kg bag)</td>
<td>Up to 1,300 kgs Frame and bulk bag ~$260</td>
<td>$0.20</td>
</tr>
<tr>
<td>PICs bag</td>
<td>Triple layer plastic bag introduced to W Africa by Purdue University, 90 - 100 kg now manufacture in Kenya by Bell Industries needs to be placed on a pallet, capacity ranges 90 - 100 kg</td>
<td>~90 kg Costs ~$2.80 per bag</td>
<td>$0.03</td>
</tr>
<tr>
<td>Grain Pro Super Grain Bag</td>
<td>Produced by Grain Pro and imported into the country duty free, made out of patented plastic technology, needs to be placed inside another bag and placed on a pallet capacity ranges 90 - 100 kg</td>
<td>~90kg Costs ~$2.50 each (plus an additional PP bag)</td>
<td>$0.03</td>
</tr>
</tbody>
</table>
AflaSTOP completed analysis of the grading data, aflatoxin and fumonisin data from the off-farm storage testing trials. The final, statistically verified results from the Phase 1 data analysis (initial results were summarized in the 2014 Annual Report) showed that:

- **Aflatoxin development as a function of grain moisture**: moisture levels up to 15% did not affect aflatoxin development in stored maize, but maize in all devices stored at higher moisture levels developed a strong odor, which indicates additional microbial activity in wet maize.

- **Aflatoxin development as a function of storage devices**: compared to the traditional, non-hermetic poly-propylene (PP) bags used by the majority of small-scale East African farmers; all tested devices significantly reduced the increase in total aflatoxin content.

- **Fumonisin**: hermetic storage did not arrest fumonisin increases during storage.

- **Insect Infestation**: all of the hermetic devices significantly reduced insect infestation and prevented insect damage.

AflaSTOP finalized the phase 1 report titled: “The Comparative Effects of Hermetic and Traditional Storage Devices on Grain: Key Findings from AflaSTOP’s ‘Off-Farm’ Controlled Tests in Eastern Kenya” with a full analysis of the results described above.

**Next Steps**: Implementing Partners will complete a draft article on the off-farm storage test results for a peer-reviewed academic journal during the second quarter of 2016.

**Phase 2: On-farm Testing of Storage Devices**

In Phase 2 testing, AflaSTOP loaned storage devices to 132 smallholder farmers to test the influence of (trained and untrained) smallholder farmer practices on the effectiveness of the storage devices. Real world manipulation and use of the storage devices is an important aspect of its overall effectiveness and acceptability for smallholder farmers. AflaSTOP collected monthly samples from the participating farmers which will be tested at the ILRI BecA facility. Since farmers are storing grain in their storage devices for longer than expected (up to 12 months, instead of the expected 6), testing for the samples was pushed back to February 2016.

AflaSTOP conducted and evaluated a number of surveys to assess farmer attitudes toward the devices. After seven rounds of sampling, the AflaSTOP team has identified a very low level of device failure in terms of observable characteristics (e.g. insect infestation). Despite low levels of device failure, few farmers were actually willing to pay for storage devices. Many farmers expect that NGO’s should provide
the devices for free. ACDI/VOCA experts and collaborators are continuing to look at different ways to collect information on willingness to pay and barriers to adoption. As part of this effort, AflaSTOP conducted end-of-storage surveys as farmers finish using their stored maize. Of the 132 farmers who received devices, 70 farmers have returned their devices and 10 have paid for their device. Of the balance, 17 claim they will pay in April 2016 and 35 farmers continue to avoid project contact. The Ministry of Agriculture sent representatives to try and help with the device collection process.

**Next Steps:** AflaSTOP will complete aflatoxin testing of the samples and analysis of survey results. Aflastop will disseminate the results to the participating farmers and then survey the farmers to see their response to their results. AflaSTOP will continue to retrieve the loaned storage devices from farmers.

**Key Activity 2: Identify commercially viable drying technology suitable for smallholder farmers**

AflaSTOP aims to develop grain drying technologies suitable for smallholder farmers to invest in as an on-farm asset or buy in as a service from someone moving the technology from farm to farm. After designing and testing three different types of dryers in November 2014, AflaSTOP selected the shallow bed dryer for further design improvements. To develop a locally reproducible and cost effective design, AflaSTOP held hands-on fabrication trainings for formal machinery fabricators and informal artisan builders in Kenya\(^1\) and commissioned five dryers from different producers. Based on the comparative performance of their dryers\(^2\), AflaSTOP engaged in a partnership with an informal fabricator to complete the final version of the shallow bed portable batch dryer. This collaboration resulted in several design improvements, which reduced the overall estimated sales price to approximately US$750. The dryer dries a batch of 500kgs of maize from 18% to 13.5% moisture content in less than 3.5 hours. The dryer is highly mobile, has reasonably low operating costs, and is affordable in the market. Smallholder farmers need this type of equipment to succeed at a more commercial approach to farming. The completed portable shallow-bed batch maize dryer design is now prospectively named the Easy-Dry M500. With the finalized design, AflaSTOP released a manufacturing manual\(^3\) and a Grain Drying Sourcebook\(^4\) in February and March 2016 as complementary resources.

**Next Steps:** AflaSTOP will focus on developing and testing commercialization strategies for the dryer.

**Key Activity 3: Commercialization of Project Technology**

AflaSTOP works to document steps necessary for commercial success and market penetration of the most promising storage and drying technologies, including production, distribution, marketing, sales and customer support. Considering the unique situation of the storage and drying technologies, AflaSTOP is

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\(^1\) See Report: [Demonstration Construction and Training for Formal and Informal (Artisan) Fabricators of the Portable Shallow-Bed Batch Dryer](#)

\(^2\) See Report: [Comparative Dryer Performance Testing: Artisan vs. Formal Fabricators](#)

\(^3\) See online publication: [Assembly, Operation and Maintenance of the Portable Shallow-Bed Batch Maize Dryer](#)

\(^4\) See online publication: [Grain Drying Sourcebook](#)
developing a customized approach for each technology. AflaSTOP is utilizing a phased approach to commercialization:

1. Data collection
2. Post-Harvest commercialization strategy per viable device
3. Final strategy, including incorporation of prevention of increasing aflatoxin issues
4. Pursuing adoption opportunities of the dryer in Kenya (and the region)
5. Pilot testing the dryer (subject to extension approval).

The first two phases are centered around assessing devices as they currently work in the market as a post-harvest technology. AflaSTOP is focusing on devices that participated in the On Farm test, hermetically store grain, which removes the need to treat maize with insecticide, or devices that dry grain to safe storage levels around 13.5% moisture content.

AflaSTOP hired a senior commercialization advisor to begin work on the first phase of commercialization strategy development for the three storage devices and the dryer. In 2015, the advisor outlined the desired outputs of each strategy and the data inputs that will inform the analysis. AflaSTOP recruited four MBA students to collect the feasibility data.

**Storage Commercialization Strategy**

In July and August 2015, the four student consultants – guided by the business/commercialization expert – visited a number of agro dealers, shellers, manufactures, and financial institutions in Kenya to collect baseline data for an initial supply chain analysis for storage technologies. Based on existing sales of insecticide to prevent infestation during storage (93% of farmers surveyed by AflaSTOP are already buying pesticides to treat stored maize) and the initial sales of PICs bags in Kenyan and international markets, AflaSTOP assumes that demand exists for improved storage devices if they are perceived as affordable. AflaSTOP found that agro-dealers earn their biggest post-harvest revenues from insecticide sales. Hermetic devices need to provide similar incentives and profit margins to agro-dealers as insecticide sales, and their manufacturers must match the investment of insecticide companies in marketing campaigns. Also, suppliers of hermetic devices need to improve their supply channels to ensure consistent supply.

Following the data collection phase, AflaSTOP conducted a commercial viability assessment of PICs bag, GrainPro Grain Safe, Metal Silo, and the traditional PP bag, in order to identify the storage device that has the greatest potential for adoption through commercial market channels. AflaSTOP’s analysis of both financial and non-financial factors indicated that the PICs bag is the most cost-effective storage device for smallholder farmers and AflaSTOP will therefore prioritize commercialization activities for the PICs bags in Kenya. AflaSTOP shared the results of this analysis with GDA partners in November 2015 in an internal report.
Bell Industries Ltd. (Bell) has been in operation in Kenya since 1991 and its primary business is importing, formulating, and blending industrial and agri-chemicals. Bell is Purdue University’s commercial PICS partner in Kenya, which gives Bell exclusive rights to promote the PICS bag in Kenya for an initial period of five years. AflaSTOP’s main aim of working with Bell Industries was to establish the steps needed to fully embrace the market potential in Kenya. As such, AflaSTOP provided technical assessments of market potential, Bell Industries business approach, manufacturing options, and marketing opportunities. AflaSTOP’s analysis is that the actual annual market potential for hermetic storage bags could be in the region of 3.1 million bags with a sales value at current pricing of $7.75 million dollars (ksh775 million). AflaSTOP’s commercialization strategy for Bell Industries and the PICS bag (hermetic device) is proprietary but a redacted version will be made available to donor partners in 2016.5

Dryer Commercialization Strategy

In developing the EasyDry M500 AflaSTOP has assumed that small business people will buy the dryer and offer services to multiple farmers, rather than individual farmers invest in buying a dryer. AflaSTOP tested the dryers with different potential operators to check whether farmers would pay for drying services. Smallholder farmers appear to be willing to pay for the service; in collaboration with an IFPRI project 40% of their farmers paid Ksh150 per bag to dry their maize. During the last harvest season in North Rift small businesses providing post-harvest services to farmers expressed interest in the technology, but were not willing to risk making an investment until it was field-proven effective.

Full commercialization of the dryer requires that, in the long term, the dryer is produced, purchased, financed, promoted and utilized without any subsidy or intervention by a publicly funded entity. AflaSTOP has developed a commercialization strategy that outlines a range of possible business models and will investigate what is required to identify, inform and support key stakeholders. Ultimately, the aim is that a business model or range of business models will develop independently based on private sector innovation. AflaSTOP is giving careful consideration to the opportunities and constraints of using the informal sector versus the formal sector as the main manufacturer of the technology and will investigate what donor funded interventions at key action points are most likely to produce positive impacts. AflaSTOP is continuing to work with informal manufacturers and formal manufacturers in Kenya to test their capacity to build dryers to specification.

Next Steps: AflaSTOP will share with the donor partners a summary of the commercialization strategy for PICs bags. AflaSTOP will publish a commercialization strategy for the dryer during the second quarter of 2016.

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5 AflaSTOP’s support to Bell Industries is consistent with the guidelines of the AgResults Kenya On-Farm Storage Pilot: [http://agresults.org/en/284/KenyaOnFarmStoragePilot](http://agresults.org/en/284/KenyaOnFarmStoragePilot).
Key Activity 4: Synthesize and Distribute Lessons Learned

In the past year, AflaSTOP undertook a number of communication activities in a variety of mediums, greatly expanding the network of stakeholders’ awareness. Notably, AflaSTOP was recognized with USAID’s Collaborate, Learn, Adapt (CLA) award for a case study on AflaSTOP’s drying activity that showed how AflaSTOP embraced CLA to drive technology adoption. ACDI/VOCA and ASI launched an online Publications and Resource site to enable broad sharing of project findings with stakeholders and began releasing a periodic newsletter for external stakeholders. The project team also participated in numerous events including successful public demonstrations of the shallow bed portable dryer, conferences, and meetings involving a broad range of stakeholders including: farmers, the scientific community working on solutions to mycotoxins and post-harvest technologies; funders and implementers; regional bodies such as PACA and EAGC; Kenya’s Ministry of Agriculture; farmers in areas with high aflatoxin prevalence; and private sector businesses (e.g. manufacturers, local service providers, and distributors). The key events attended during this period include:

- First International Congress on Postharvest Loss Prevention: 5-7 October 2015, Rome, Italy
- Ministry of Agriculture and Kenya Agricultural and Livestock Research Organization (KALRO) Meetings: October-December 2015, Nairobi, Kenya
- 6th African Grain Trade Summit: 5 October 2015, Kigali, Rwanda
- EAGC Agricultural Show: 14-15 August 2015, Nakuru, Kenya
- African Agro-Tech Summit Conference & Expo: 31 August – 2 September, Nairobi, Kenya
- PAEPARD Round table of experts on the mitigation of aflatoxin in food and feed in Africa: 25 January 2016, Brussels, Belgium

AflaSTOP has published two newsletters to almost 400 subscribers. The newsletters are available online.

Next Steps: AflaSTOP will continue to publish reports on all its project findings and will issue quarterly newsletters.

Key Activity 5: Expanding Technology to Different Countries

AflaSTOP aims to expand the effective storage and drying technologies to different countries in Africa. AflaSTOP will review its experimental design and identify what additional testing might be needed in different climatic environments before the device could be promoted as effectively arresting aflatoxin growth. The bulk of AflaSTOP’s activities will focus on the dryer, and AflaSTOP will consider limited activities around hermetic storage technologies, especially targeted at awareness raising of AflaSTOP’s research findings from Kenya. In late 2015, AflaSTOP began activity to explore future expansion of the

6 http://www.merid.org/en/AflaSTOP/Newsletters.aspx
dryer into Rwanda and Tanzania based on relationships with businesses and investors who have expressed interest in commercialization of the dryer. Three partners in Rwanda and Tanzania are moving forward with in-kind support from AflaSTOP. In Rwanda, PSDAG USAID program provided dryers to five cooperatives working to supply Minimex dried maize and four dryers were purchased by a private sector company, Win Win Deals. In Tanzania a private sector company MORAGG purchased one dryer and the World Food Program is interested in supporting further pilot testing the dryer. Organizations in Malawi, including Twin Trading, are interested in exploring conversion of the dryer to dry groundnuts in the shell.

**Next Steps:** AflaSTOP will continue to support initiatives in Rwanda and Tanzania to test commercialization of the dryer and will carry out Rwanda and Tanzania country assessments.

**Other Activities**

In addition to the Key Activities outlined in the work plan, Implementing Partners and others completed several activities that contribute to the goals of identifying and commercializing low-cost storage and drying technology. These include:

- **Distributing unused storage devices in Meru:** out of concern over very high levels of aflatoxin in Meru, AflaSTOP distributed the few leftover devices from the off farm storage test to several learning institutions such as universities, schools, and churches in Tharaka Nithi and Embu counties of Meru. Several plastic silos were also handed out as water storage devices. These devices were handed out in the presence of the Meru County Director and Deputy Directors for Agriculture, Area Member of County Assembly, and Ward Administrator. AflaSTOP team members trained the institutions on how to set up each device properly. A PICs supplier was also present and demonstrated the bag, selling all 50 bags he had bought.

- **Dryer tested in Guatemala:** AflaSTOP is assisting a professor at the Post Harvest Loss Innovation lab at Iowa State University to test the usage of the maize dryer in Guatemala. The professor had independently implemented one of the pre-alpha AflaSTOP dryer designs after hearing about it through a colleague, and after experiencing difficulties, began liaising with AflaSTOP to improve the maize dryer experience in Guatemala.

**PROJECT GOALS 2016**

As mentioned on page 2, AflaSTOP has requested a No-Cost Extension through the end of May 2017. The extension will allow AflaSTOP to extend the sustainability and scalability of its activities and to achieve its remaining intended results in 2016, including:

- **Drying and Commercialization**—AflaSTOP will complete the dryer technology manuals for manufacturing and operations. AflaSTOP will also support the market penetration and awareness of the portable shallow bed batch dryer by running an intensive pilot project in a
strategic location in Kenya to test the dryer’s market potential. AflaSTOP will assess whether the assumptions in its commercialization strategy are valid; give technical support to fabricators, companies, or projects interested in using the dryer; and identify additional support needed to increase market penetration.

- **Storage and Commercialization**—AflaSTOP will complete the (Phase 2) On-Farm Testing phase of the storage devices which was delayed due to farmers’ longer than anticipated storage timelines; increase awareness of AflaSTOP’s findings around hermetic storage for aflatoxin mitigation strategies and ensure knowledge transfer to local Kenyan farmers; and target the PICS storage bags for full commercialization strategy development, for example, by providing support to AflaSTOP’s private manufacturing and marketing partner (Bell Industries) for the commercialization of the PICS bag.

- **Expanding Technology to Different Countries**—AflaSTOP will improve the quality and depth of activities to generate technology transfer and commercial interest in the dryer outside of Kenya by: documenting key commercial and technology practices for success; conducting up to 3 country assessments; and providing training and product testing opportunities to partners in the countries of Rwanda, Tanzania, who have already expressed interest.

- **Lessons Learned**— AflaSTOP will continue to take advantage of stakeholder engagement opportunities to communicate awareness and lessons learned. Particularly, AflaSTOP plans to train Ministry of Agriculture (MoA) appointed extension officers on post-harvest strategies that help arrest aflatoxin growth.

**COST ANALYSIS**

Implementing Partners provide the following summary of budget and expenditures through March 2016. The following table shows budget and actual expenses for Meridian Institute (Direct Costs) and ACDI/VOCA (Subawards), which are funded by the USAID Cooperative Agreement. The table also shows leveraged funds provided by the Bill & Melinda Gates Foundation, which include Meridian Institute and ASI expenditures. The last row shows the total AflaSTOP budget and expenditures, as funded by USAID and BMGF.

<table>
<thead>
<tr>
<th></th>
<th>Budgeted</th>
<th>Expenditure Summary</th>
<th>Remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct Costs (Meridian Institute)</strong></td>
<td>$61,041.00</td>
<td>$36,235.12</td>
<td>$24,805.88</td>
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<tr>
<td><strong>Subawards (ACDI/VOCA)</strong></td>
<td>$2,341,129.00</td>
<td>$1,424,035.00</td>
<td>$917,094.00</td>
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<td><strong>USAID Total</strong></td>
<td>$2,402,170.00</td>
<td>$1,460,270.12</td>
<td>$941,899.88</td>
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<tr>
<td><strong>Leverage (BMGF Support for Meridian Institute and ASI)</strong></td>
<td>$2,402,170.00</td>
<td>$1,355,293.71</td>
<td>$1,046,876.29</td>
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<tr>
<td><strong>Total AflaSTOP Program</strong></td>
<td>$4,804,340.00</td>
<td>$2,815,563.83</td>
<td>$1,988,776.17</td>
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