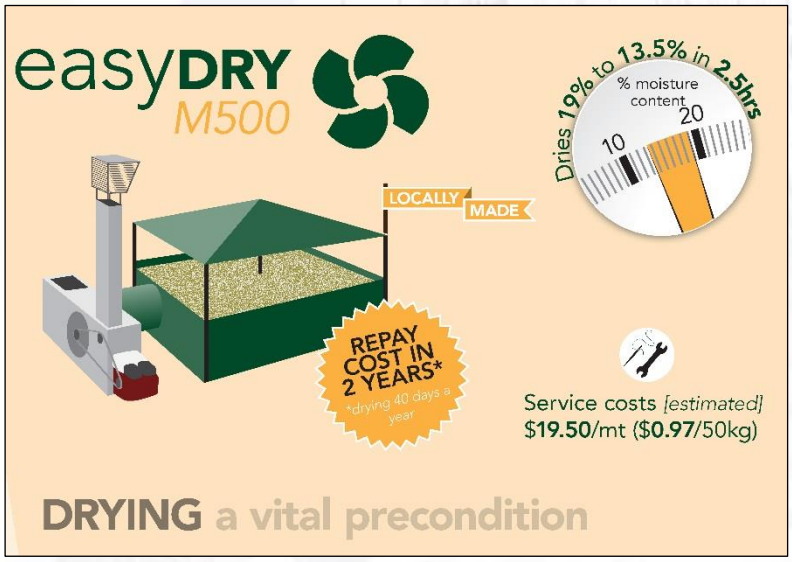
AFLASTOP: INNOVATIONS IN PORTABLE DRYING TECHNOLOGIES

Drying grain is an essential post-harvest handling step in much of Africa: it reduces post-harvest losses such as mold, affects marketability into premium markets, and is essential to reap the benefits of hermetic storage, which arrests the growth of aflatoxin[1].

Traditionally, shelled maize is dried on the ground over approximately a five-day span, and farmers watch the skies hoping it does not rain. Many farmers have made modest improvements by drying maize on tarpaulins, for example, instead of the ground, but these methods remain problematic in some climatic regions of East Africa, where there is a high possibility of rainfall during and after harvest. In these rural areas, there are virtually no alternative drying technologies available, tailored for a smallholder farmer market. Furthermore, the ideal moisture level for storing grain is 13.5%, but many farmers struggle to dry their maize down to below 14 or 15% even under favorable conditions. If the conditions are not favorable, they will lose maize to mold and discoloration, and receive a lower price when they sell to the market.

In this context, USAID and the Bill & Melinda Gates Foundation partnered to co-fund the AflaSTOP: Storage and Drying for Aflatoxin Prevention project. AflaSTOP embraced **human-centric design and a market-driven approach to develop and support the commercialization of viable drying options** that allow smallholder farmers to dry their grain to safe storage levels. AflaSTOP ultimately designed, locally manufactured, and is piloting through commercial markets the **EasyDry M500, a portable batch dryer** that can be incorporated into a farmer's normal post-harvest routine as a fee-based service.



This brief highlights AflaSTOP's design and business model development process, spotlights the EasyDry M500, and reflects on scale up potential and next steps for full market diffusion.

AflaSTOP is leveraging scientifically rigorous research and human-centric design, grounded in marketplace realities, to support post-harvest storage solutions and to develop and commercialize new drying technologies in order to prevent and control the spread of aflatoxin in maize. It is implemented by ACDI/VOCA and Agribusiness Systems International, under the direction of Meridian Institute and in support of the Partnership for Aflatoxin Control in Africa (PACA). AflaSTOP is funded through a Global Development Alliance between USAID and BMGF. For more information, visit www.acdivoca.org/aflastop.

[1] Aflatoxin is a naturally occurring, carcinogenic byproduct produced by toxic strains of the *aspergillus* fungus. For more on hermetic storage and AflaSTOP's research proving its efficacy at arresting the growth of aflatoxin, visit www.acdivoca.org/aflastop-publications.

1. Our R&D process: human-centric design

Human-centric design emphasizes the importance of people's experience and perspective as essential elements in R&D and key for engineers to consider, who are often focused on the technical performance of the technology at the exclusion of all else.

Embracing this perspective, AflaSTOP began by conducting a survey of drying practices amongst smallholder farmers in-Kenya to create and inform human-centric design parameters, and developed a sourcebook of potential technologies available worldwide. Catapult Designs a U.S. based, globally-focused appropriate technology development firm, was contracted to work on the research as well as to design, build and test in Kenya the initial prototype iterations of three dryer designs: two mechanical batch dryers and one solar option. Throughout this process, the implementing parties - ACDI/VOCA and Agribusiness Systems International, under the direction of Meridian Institute -collaborated closely with researchers, appropriate-technology engineers, formal manufacturers of largescale dryers such as Cimbria, formal users of these commercial-sized dryers such as Lesiolo Grain Handling (now Cargill) and government bodies such as the Ministry of Agriculture.

Each design was evaluated around three main criteria: *affordability* (for manufacturing processes and material), *accessibility* (simplicity of use), and *efficacy* (consistency in results, speed, and cost). The shallow bed dryer – which ultimately became named EasyDry M500[2] – performed the best, as detailed in this report. It was redesigned and then tested with farmers, and redesigned again. Interestingly, the design the project most expected to succeed — a basic, low-cost solar dryer which could be purchased by farmers for on-farm use — did not perform in humid, cloudy Kenya. Three key lessons from this process emerged as particularly critical:

- *Manufacturing must follow processes that can actually be used in country*. So, collaborate with local partners to ensure that technology and materials are suitable for where it will be deployed.
- *Change early — not late*: do not waste too much time coming up with the perfect design on paper. It is better to have an approximate design and business model and then get into the field test, generate data, discuss and redesign as early as possible.
- *Don't play favorites*: be ready to drop an idea if it does not work.

2. Refining the business case

The economics behind commercializing a technology must make sense for all stakeholders: it must offer all participants the opportunity to profit. Once the Easy Dry M500 (highlighted in Section 3) advanced outside of the R&D phase, these economics became the focus of extensive market research. AflaSTOP drew on quantitative data and qualitative feedback, making ample use of small pilots that allowed for adaptation. The business model and the technology were iteratively refined in response.

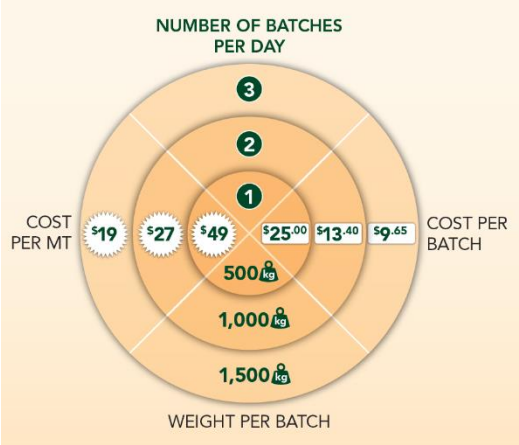
Demand by consumers for drying services is likely to be driven by three main factors:

- Access to a premium price for the product the farmer is selling
- Reduction in the cost the farmer is currently paying to do the job
- Reduction in losses experienced after challenging drying (such as during periods of rain)

AflaSTOP explored two potential routes to market for the EasyDry M500, each with unique business models: formal medium sized manufacturers with mass sales, or informal artisan fabricators who re-engineer products for custom orders. The project investigated both paths, conducting a manufacturing training with each group, hosting feedback sessions on design and price, and contracting a limited number of dryers from each to determine whether both sectors had

[2] The "M" in EasyDry M500 stands for maize, and it can dry up to 500 kgs at a time (i.e. per batch).

the capacity to build to performance criteria and what their process might tell us about design weaknesses, cost assumptions, and other factors. Ultimately, the artisan fabrication route was the most economically viable, and these feedback sessions provided crucial information on how they re-engineer technologies (by sight) and how the project's own approach to stimulating adoption would need to adapt accordingly. Most significantly, artisan fabricators can retail the EasyDry M500 in Kenya at a cost of $850 - which allows for an affordable service to be offered by businesses servicing smallholders - while the formal sector's higher price ultimately makes the service too expensive and out of reach.



The business case for the dryer operator is driven by the relatively large fixed costs and the ratio of maize dried per day. Fixed costs include the operator's salary, transport to the location, and the profit expectation. To cover these costs and offer a service which is affordable and desirable requires three batches of maize to be dried per day - see adjoining figure.

To refine the business case, it was important to pilot the dryers, using a similar model to services already supplied to farmer – e.g. shelling services. The aim of the pilot was to get the information needed on prices, mobility, functionality and adoption; all key to establishing whether the EasyDry could be a viable business opportunity to artisans and entrepreneurs and an attractive alternative drying solution to smallholders.

3. EasyDry M500: An Innovation in Portable Maize Drying

The EasyDry M500 is a highly mobile maize dryer targeted at servicing smallholders.

Photos, L to R: Service providers transport the EasyDry M500 to the next farm; The EasyDry M500 in operation

AflaSTOP developed the EasyDry M500 as an open source technology that can dry maize in batches of 500kgs, lowering the moisture level from 18 to 20% to approximately 13.5% in 3 hours, with the aim to dry three batches per day in one location. It has been piloted in Kenya, Tanzania and Rwanda to date. It is profiled on www.easydry.org.

Fabrication: The EasyDry M500 is designed for fabrication by local artisans and has been manufactured in Kenya with local materials at a cost of $850[3], including expected profit margins.

[3] Manufactured in Tanzania at $1050; AflaSTOP has estimated the price in Rwanda at $1660 and Uganda at $1060.

Service operator: Similar to mechanical maize shelling services, which most Kenyan smallholder farmers use, the EasyDry M500 will ideally be owned by a service provider, who visits different farmers every day of the drying season. As such, the EasyDry M500 was designed to be portable and can be transported on 2 motorbikes. Our market research found that entrepreneurs willing to provide the EasyDry M500 service would expect to recoup their investment (~$850/machine) within a two-year period, meaning that they would need to dry a **minimum 1.5MT/3 batches of maize per day at a cost to the farmer of ~$9.70/batch**; each batch is 500kgs. Based on an annual, 40 day drying season and a 2% adoption rate among smallholders, an EasyDry M500 operator could have sufficient customers to service within a 1.6km radius. Furthermore, an initial pilot of the EasyDry M500 found that 7% of maize farmers surveyed would be willing to pay $9.30/batch.

How it works: The dryer burns maize cobs as its main heat source, given that cobs are available on farm and at little to no-cost. The heat and smoke produced from burning the maize cobs passes through the heat exchange of the EasyDry M500 and then out the chimney. A second fan, powered by 5 liters of petrol per day, pushes clean air through alternative channels in the heat exchange. This dry, hot air is then pushed through the maize bed, which is suspended on a 'table' like structure, placed within a canvass 'bag'. Within 3 hours, up to 500 kg of 'wet' maize with a moisture content of approximately 19%, is dried to a level closer to 13.5%, which allows for safer post-harvest storage. A fabrication manual and an operator manual (for service providers) are both available online, along with a video here. As mentioned earlier – the EasyDry is simple to understand – instead of putting the maize on the ground and letting the sun evaporate the moisture, the maize is suspended and hot air pushed through. In terms of human acceptance; the process is easy next step.

4. Scaling Through the Informal Sector

While the EasyDry M500 can be built to specification by the informal sector – and as explored above under Section 2, Business Model, it offers many benefits - there are challenges specifically related to the scalability reach of this sector.

Firstly, artisan fabricators rely on bespoke business: a customer walks in through the door, asks whether they can build a product, provides a deposit and comes back for the finished product a few weeks later. The fabricator does not advertise, demonstrate or market the products. Therefore, awareness comes from the customer seeing the product working somewhere else. If a customer has not seen the EasyDry M500 performing, they will not look to buy it. If a fabricator cannot physically see a dryer, they will struggle to build it. Therefore, there is the need to demonstrate the effectiveness of the dryer to promote market demand.

Secondly, there are challenges related to the quality and precision of fabrication which are not clearly understood by an artisan fabricator on the first attempts to build the EasyDry M500. Poorly performing machines in the market, may imperil the dryer's reputation. AflaSTOP advises that local manufacturing needs to be accompanied by a capacity building program in order to promote efficient and correct machine setup by the informal sector.

Thirdly, the small businesses which buy the dryer do not have the capacity to do multiple demonstrations essential to persuade the farmers that their maize is safe being processed by a dryer.

They do not have the capacity to carry out large campaigns to find customers. Without this additional support there may not be enough perceived interest by small businesses to offer the service.

5. Expanding to Meet Regional Demand

Based on market research conducted by AflaSTOP, the cost of manufacturing the EasyDry M500 through the informal sector will likely be 10 to 20% higher in Tanzania than in Kenya, 14 - 20% higher in Uganda and at least 40% higher in Rwanda. This has implications on the ultimate fees passed on to customers and will need to be revised based on the small entrepreneur's profit expectations and the number of potential workdays per year.

Despite the higher potential cost, however, demand is likely to be stronger in Rwanda. In Tanzania, most buyers do not pay a premium for dried maize, and given the rolling nature of the harvest throughout the country, there always seems to be some area of the country offering maize that is dry enough for buyers. Conversely, in Rwanda's main season, everyone harvests at the same time and it's all wet. For this reason, new market players such as the East African Commodity Exchange has a set list of fees including cleaning and drying maize at their warehouses, and their costs are higher than what the EasyDry M500 would cost. There are also other private sector players in the market that are already using dryers (e.g. ENAS Ltd., Prodev-Rwanda Ltd.) and they supply a limited number of millers who offer higher prices for dried maize, rewarding the seller for their drying efforts. Kenya falls somewhere in between the examples of Tanzania and Rwanda, with farmers being assessed penalties for wetter maize, and the costs incurred often match the cost of using the EasyDry M500.

Looking Forward

Further investigation is needed to establish whether the heat of the drying process deactivates *aspergillus* spores; if so, heat-based drying would be an added mitigation to aflatoxin increases in storage. In addition, significant work remains to be done to fully commercialize the EasyDry M500 and support wide scale adoption of this valuable technology by fabricators, service providers, and farmer customers.

Yet AflaSTOP sees promise for adoption in the many technologies that have already improved smallholder farmers ability to farm:

….in the past farmers prepared their fields using hand hoes and now they use tractor services.
….farmers used to save seeds and now buy specialized seeds and fertilizer to improve yields.
….instead of beating maize cobs in bags with sticks, farmers now pay for maize shelling services.

However, when it comes to drying, farmers pray to God that it will not rain as they lay their maize out to, hopefully, dry quickly. Smallholder farmers should have other alternatives than prayer.

Scaling out and fully commercializing the EasyDry M500 will require demonstrations, capacity building of informal fabricators, and potentially entrepreneurs to invest. With expanded exposure and access to drying services in rural communities, the EasyDry M500 has the chance of becoming the next innovation that allows farmers to dry their harvested maize to healthy and more profitable levels, enabling longer storage and reducing post-harvest loss.

For more information on AflaSTOP, visit www.acdivoca.org/aflastop. To follow progress of the EasyDry M500, visit www.easydry.org or contact Sophie Walker at swalker@acdivoca.org.

This document was produced by review for the United States Agency for International Development. It was prepared by ACDI/VOCA and Agribusiness Systems International with funding from the USAID and BMGF-funded AflaSTOP program. The views expressed in this document do not necessarily reflect the view of the United States Agency for International Development or the United States Government.