Feasibility of Up-scaling the EasyDry M500 Portable Maize Dryer to Kenya
The AflaSTOP: Storage and Drying for Aflatoxin Prevention (AflaSTOP) project is identifying the most promising storage options to arrest the growth of aflatoxin and designing viable drying options that will allow smallholder farmers to dry their grain to safe storage levels. The project works to ensure that businesses operating in Africa are able to provide these devices to smallholder farmers. It is jointly implemented by ACDI/VOCA and its affiliate Agribusiness Systems International (ASI) under the direction of Meridian Institute. For more information on AflaSTOP and other key reports and resources, visit: www.acdivoca.org/aflastop-publications.
BACKGROUND

Maize is a staple crop in Kenya, which is grown predominantly by ~3.5 million smallholder farmers 95% of whom farm less than 2 acres, who also consume most of what they produce. What they do not consume is sold - around 20% of the total harvest - providing a significant part of household income in rural areas most often allocated to school fees and production costs. The highest yields come from the Northern Rift Valley, however maize is grown in almost all the country; intercropped in South Nyanza, other parts of the Rift Valley, and Western Province. Production is highly variable based on the rains with 98% of maize being rainfed; it ranges annually from 2.2 – 3.5 million metric tons (MT) and is spread over two harvests – the long rains harvest from July 0 December with the peak in late October November is estimated to be 88% of the total annual production. The average yield is 2.89mt/hectare but again is highly variable ranging from 1.11 – 7.34mt/hect between low and high maize potential areas.

The lower than average long rains crop harvested in October/November 2016 and the very dry conditions due to drought have adversely impacted the 2016 short rains crop from Eastern Kenya that starts harvesting in February 2017, putting pressure on maize prices. In fact, the climatic impacts of La Niña have affected harvests regionally, hindering imports of maize from Tanzania and Uganda, the traditional suppliers to the Kenyan market.

The impact of the earlier poor rainfall in 2016 and La Niña can be seen on the FAO Cereal Balance sheet to the left, which shows declining production in 2016. However, some rainfall has resumed, and it is hoped that this will have a positive impact on yields, given that the maize value chain is of utmost important in Kenya - 3.72 million, 90kg bags are consumed every month by the country’s population of 42 million1; currently the rain pattern is not encouraging.

In this regard, the Ministry of Agriculture estimated that by June 2017 Kenya will need to have imported over 660,000mt (at least 300,000mt is normal from Uganda annually). While the Government anticipates some could be supplied from Tanzania, there is always the risk that the Tanzanian Government will impose export bans to protect its own supply base, which may also be low. Meanwhile, the Government of Kenya (GoK) has arranged the purchase of 275,000mt of maize from Ethiopia, and is granting import

1 http://www.coastweek.com/3710-agriculture-03.htm
licenses that allow duty-free import of non-GMO maize (yellow and white) from outside of the East African Community (EAC), in addition to importing from Mexico as well.

The GoK has also banned exports of maize and reduced fertilizer prices, and has embarked upon other supply side projects, including a million acre, irrigation project, where 500,000 acres will be put under maize cultivation. Nevertheless, these efforts will only pay dividends in the future and do not address the current crisis. In terms of the new irrigation project, if it was farmed at full yield potential, it could supply over a million metric tons of maize into the market, putting Kenya into a surplus situation, reducing the need to import maize from Ugandan, while also triggering a significant reduction in maize prices in Kenya.

With regard to the weather, Kenya’s growing season is characterized by one main season that coincides with the long rains that begin in March and is harvested depending on location between late July and December and a smaller harvest that follows the short rains that start in October and is harvested in February - March. However, with climate change, the planting seasons in Kenya have become more fluid, especially given late and/or erratic rainfall. This weather variability, as noted above, has reduced yields and pushed maize prices upwards. The second rains generally in October often effect smallholder farmers ability to dry the later harvest, while the long rains generally starting in March effect some areas harvesting the short rains crops. While wet maize and drying maize is sometimes a big problem for Kenyan farmers, the 2016 season turned out to be one of the driest harvest years on record, making it very easy for farmers to dry their maize in the field and on the ground.

The EasyDry M500 team believes that 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 costs incurred by the farmer to do the job;
• Reduction in losses experienced by farmer after challenging drying (such as during periods of rain).

In 2016, we offered the EasyDry M500 as a drying service to smallholder farmers in Turbo and Kapseret in North Rift, Kenya. While the weather was unusually hot, enabling farmers to dry their maize in the field, we did have some early innovators who paid Ksh185 per bag to dry their maize because they wanted to get on with other economic activities and not spend time watching maize dry.

Similar to mechanical maize shelling services, which most Kenyan smallholder farmers use in high productive areas, we believe that the EasyDry M500 will ideally be owned by a service provider (or a farmer group employing an operator), who visits different farmers every day of the drying season. Our market research found that entrepreneurs in Kenya 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 find sufficient customers to meet this target within a 1.6km radius. Furthermore, an initial pilot of the EasyDry M500 found that approximately 7% of maize farmers surveyed would be willing to pay $9.30/batch and more if it was raining.

While Kenya has the most competitive fabrication costs in East Africa, the demand from farmers and cooperatives for small-scale drying options is present across the region, and the EasyDry M500 is well positioned for expansion to Rwanda and Uganda. In fact, just in North Rift, there is potential for over 21,000 dryers to be deployed; Uganda offers considerably more demand; and Rwanda has the potential for 8,000 given its smaller crop. We estimate that each dryer deployed can save 2.1mt of post harvest drying losses per year, which is based on attributing 5% of post-harvest losses to poor drying and reducing this to 1.5% with EasyDry M500 use.
WHAT IS THE EASYDRY M500?
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 (the lower initial moisture level, the shorter the drying time). In addition, early tests have demonstrated that smallholder farmer maize, which had been dried on an earlier prototype of the EasyDryM500, had 77 percent less aflatoxin 2 to 3 months later than maize traditionally dried, and 51 percent less aflatoxin than maize that had been dried on an impermeable plastic sheet. However this needs further investigation prior to claiming mechanical heat based drying as an aflatoxin mitigation technology.

With regard to logistics, it has been designed to be transported easily and can be loaded onto two motorbikes. It has a small petrol engine, which uses about half a liter of petrol per hour to power two fans, and burns about 11kgs of maize cobs per hour to provide the heat, which dries the maize. The design is relatively simple and can be manufactured by a similar, informal manufacturer of a sheller, or chaff cutter. These manufacturers are informal and have lower overhead costs than formal manufacturers. However, the informal sector has little ability to market and build awareness of a new product.

If the farmers have access to electricity, the dryer can replace the petrol engine with an electric motor, which reduces the cost of operations. In Kenya the cost reduction to the farmer per 90kg bag would be about $0.33, however the farmer will then incur the electricity price which would mean overall the price would be about $0.25 lower. However, in the pilot area only 41% had an electricity connection.

MANUFACTURING OF EASYDRY M500
We explored two potential routes to market for the EasyDry M500. Ultimately, the artisan fabrication route was the most economically viable, with artisan fabricators able to retail the EasyDry M500 in Kenya at a cost of ~$800 to $850, which allows for an affordable service to be offered by businesses servicing smallholders. The EasyDry M500 is not a difficult machine to manufacture and therefore informal sector production does have some advantages, as well as disadvantages, compared to the formal sector. First, the costs of manufacturing in the informal sector are generally lower, since those operating in the area do not pay taxes either on their end products or on any staff employed. The informal sector also keeps very low inventories, only manufacturing the more expensive items by request. The two big disadvantages of the informal sector for manufacture relate to its inability to market a product and build awareness around a new technology, as well as the potential inconsistencies in manufacturing, which increase the risk of a buyer purchasing a machine, which does not work.
Accordingly, while formal manufacturer’s material costs are the same, their overhead costs are considerably higher. Additionally, they factor into the cost a degree of marketing and customer support costs. This, of course, increases the price of the end product. While initially they may be able to make high priced sales to the first adopters, once the informal sector is able to see the machines in the field, and potentially take them apart, they can start copying them and undercutting the price. The table to the left summarizes the success factors, risks and possible mitigation issues to consider.

A final consideration as related to manufacturing is around access to finance. The formal sector generally has access to financial instruments, which ease both their own cash flow constraints, and those of potential buyers of equipment by enabling the latter to spread payments over a number of years. Moreover, potential buyers have the ability to leverage the original cash available to purchase one machine to purchase additional machines (e.g. if a buyer has $1,500 through financing that could be used to purchase three machines putting a deposit on each machine, rather than buying a single machine outright for $1,500 – which would reduce operating costs if all three machines were deployed together allowing the business to offer drying services at a similar cost to a business who bought at $850). The informal sector, whether the manufacturer or the small informal business entity, do not have the same access to financing, have a fear of financing, and would require specific capacity building to even consider trying to access such resources.

**EASYDRY M500 PART SOURCING & ASSEMBLY**

AflaSTOP conducted market research in Kenya to estimate the cost of manufacturing the EasyDry M500 informally as compared manufacturing the same dryer in Kenya. For the most part, it was found that the EasyDry M500 can be built to specification by the informal sector. Nevertheless, 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 with the final payment. 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.
Overall, Kenya offers the most competitive pricing for building the EasyDry M500, followed by Tanzania and Uganda. Given the high costs of manufacture in Rwanda, it may make more sense to import a Kenyan built machine to Rwanda, as shown in the table below.

<table>
<thead>
<tr>
<th>Informal Manufacturing Costs for EasyDry M500 by Country</th>
<th>Kenya</th>
<th>Tanzania</th>
<th>Uganda</th>
<th>Rwanda</th>
<th>Ex-Kenyan machine to Rwanda</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials</td>
<td>$511</td>
<td>$630</td>
<td>$688</td>
<td>$1,027</td>
<td>$796</td>
</tr>
<tr>
<td>Labor</td>
<td>$140</td>
<td>$251</td>
<td>$195</td>
<td>$341</td>
<td></td>
</tr>
<tr>
<td>Transport</td>
<td>$15</td>
<td>$15</td>
<td>$17</td>
<td>$15</td>
<td>$200</td>
</tr>
<tr>
<td>VAT, Import duty</td>
<td>$1</td>
<td>$15</td>
<td>$17</td>
<td>$15</td>
<td>$183</td>
</tr>
<tr>
<td>Profit*</td>
<td>$130</td>
<td>$176</td>
<td>$177</td>
<td>$274</td>
<td></td>
</tr>
<tr>
<td>Total cost</td>
<td>$796</td>
<td>$1072</td>
<td>$1077</td>
<td>$1,657</td>
<td>$1,179</td>
</tr>
</tbody>
</table>

*Presumes 20% profit margin, however individual manufacturer profit requirements may vary.

**All costing may vary and subject to exchange rate and material cost fluctuations.

MARKET DEMAND FOR DRYING SERVICES

As previously mentioned, initial AflaSTOP research found that there are wet versus dry maize pricing differentials present within the Kenyan market, with the most widespread practice employed by traders being “subjective weight penalties,” which are applied by buyers when purchasing wet maize from the farmer. Where NCPB has drying facilities its advertised price of drying is Ksh 28 per 1% moisture reduction per 50 kg bag ($5.60 / mt). While some farmers might have the option of drying their maize with the National Cereals and Produce Board (NCPB), it is not a commonly used option at the smallholder farmer level particularly since they need to transport and handle wet maize to the NCPB facility. NCPB charges per % moisture drop, the EasyDry’s charges are based on how many batches completed in a day. Therefore, when the maize is dryer and all is required is a 2% drop in moisture the EasyDry can process 5 batches in a day which equates to 2,500 kgs per day at a lower price per kg/bag. NCPB is still slightly cheaper than the EasyDry but the EasyDry has the advantage that its on farm and the farmer does not loose money transporting and handling unwanted water. In a moderate to normal year, farmers would be better off hiring an EasyDry M500 operator, as anything more than a 3% reduction would be more expensive to dry with the NCPB.

<table>
<thead>
<tr>
<th>Illustrative Cost Comparison of Drying</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costing based on…</td>
</tr>
<tr>
<td>NCPB</td>
</tr>
<tr>
<td>EasyDry M500</td>
</tr>
</tbody>
</table>
^Does not include costs of transporting maize to drying facility, logistics for farmer, risk of delay, etc.
*This entails loading 2500kgs vs. 1500kgs, since the drying time per batch is reduced.

Large-scale formal millers producing processed maize flour and NCPB are the main formal buyers of maize in Kenya and are estimated to buy about 15 to 30% of the total crop produced\(^2\). NCPB, as an agency of the GoK, provides market signals when ordered to purchase grain. While its overall purchase mandate is large, it rarely buys these volumes and is not the primary market for most maize, particularly since payments for delivered maize can be delayed. This segment of the market demands dry maize with a moisture content of 13.5% or less.

The balance of the crop is processed at hammer mills, which are throughout the country in rural and urban areas. Since for the most part the customer brings in the maize they want to have processed into ‘flour’, the moisture level is what is normal for the informal market. At harvest this tends to be around 14.5 to 16% and as the crop dries in storage, it drops to below 13.5% over time.

Most smallholder farmers sell to farm gate aggregators, who sell onto middlemen who transport the maize through Kenya’s urban markets throughout the year. Based on demand and price structures, they will move the maize to the formal or informal market. If the maize needs drying, they will either off load or dry the maize on tarpaulins before moving it to the market. Depending on the market, informal or formal, they will dry to the levels acceptable. Depending on price structures in the market, they may deliver wetter maize to a formal miller with a maize dryer.

There is currently only one formal company, Cargill, offering warehousing (32,000mt) and drying services in Nakuru. Its main customers are the medium to large-scale farmers from the local area.

When asked about the cost of drying, farmers initial reaction is that it is free; because God freely provides the sun. However, when you ask them to think more explicitly about how they dry and the costs associated with drying it quickly becomes clear that it is only ‘free’ to farmers with the very smallest yield and no other constraints upon their time. Once the maize has been shelled it needs additional drying. For the most part in high productivity areas, they either buy or hire a tarpaulin, which can dry about 15 to 20 bags at a time. The tarpaulin generally has a 2-year life span and costs about Ksh3000. Before the school holidays, labour has to be hired to carry the bags of maize out, lay it on the tarpaulin, and then gather it back in either before it rains or by the end of the day. This labour has to be fed at lunchtime and be provided tea. (Once the holidays start, older children often help with this work). The owner of the maize generally stays around to supervise the drying – not trusting the work force not to steal from them. Finally, if

---

\(^2\) [https://agriknowledge.org/downloads/z603qx51g](https://agriknowledge.org/downloads/z603qx51g)
they cannot dry it well enough, there are losses when a portion of the maize goes bad; if its not too bad it goes to animal feed, if looks very bad it might be thrown away. When you calculate these costs, the cost of drying for farmers appears to range from around Ksh100 to Ksh220 - the larger the yield, the higher the cost.

**THE PROVISION OF THE DRYING SERVICE**

The EasyDry M500 provides the option of introducing drying service to smallholder maize farmers where they currently struggle to dry their harvest due to rains occurring shortly after harvest. Weather patterns indicate that areas of North Rift, Upper Meru and some areas in Western Kenya may have demand for drying services.

With the awareness that commercial viability is dependent on profitability for all, the EasyDry M500 will ideally be owned by a business service provider or a farmer group. The business service provider would run a similar business to mechanical maize shellers, and would visits different farmers every day of the drying season. As stated in the EasyDry M500 Pilot Section, our research found that entrepreneurs in Kenya 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 meet this target within a 1.6km radius. However, it generally takes such an entrepreneur two years to raise such an investment sum. In terms of lead-time, first they need to see the technology, recognize the business opportunity, save to invest before the service can be offered to the smallholder farmer.

The farmer group model similarly provides drying services to both members and non-members in the community. It assumes the farmer group will hire an operator to run the dryer, but either the group will provide the operator a list of farmers to service each week, or will let the operator find customers. In terms of investing in the technology, asking every group member to provide Ksh2,850 to 4,250 (20 to 30 members in the group) particularly when timed before harvest when the service will be needed and maize is available to sell is potentially viable within a short period of time. The profit drive of a group is often less strong and the group is happy to recoup their initial investment in a 4 year period rather than 2 years. This reduces the cost of drying to around $1.50/90kg bags versus $1.75, other variables remaining the same, and allows the group to offer members the lower price and non-members a higher price. Often, it is also easier for groups to access finance, so if there is plenty of potential demand in their area they can leverage their investment capital and buy additional machines – either to have individual operators, or a single operator managing three machines in one location per day. One constraint is ensuring that the farmer group understands the economics behind the drying service and the importance of drying the minimum batches per day to recover all costs.

**CONCLUSION**

Post-harvest losses due to poor drying practices are not easily solved at the smallholder farm level. They are related to spillage, animal consumption, insect infestation, and ultimately mould. The EasyDry M500 naturally fits into the farmers’ drying cycle, reducing the days needed from around five in the sun to one day mechanically. Certain areas of Kenya struggle to dry their maize – but not necessarily every year as
experienced when piloting the EasyDry last year in Turbo, an area which traditionally struggles to dry maize in the sun just after harvest.

The technology will only be adopted if the cost of using it either increases the value of the maize being sold, or reduces the farmer’s costs so he/she makes more money selling at the same price. The EasyDry M500, whose performance has been tested and validated by the Kenya Agricultural & Livestock Research Organisation (KALRO), IFPRI, and WFP, provides multiple advantages:

- Guaranteed dried maize when weather conditions are challenging;
- Reduced drying time;
- Reduced or similar costs for farmers using paid labour to help dry their maize, the cost of using the dryer, which in Kenya is around $1.50 to 1.75 per bag;
- Grain dried to 13.5% will not develop visible mould, and if put into a hermetic bag, will not drop a further 1.5% of its moisture as it equilibrates with the environmental conditions over time leaving the farmer more to sell or eat;
- Off farm job opportunities for the youth;
- Finally, since the technology is portable and can be moved on motorbikes, farmers and traders do not incur the additional cost of transporting excess water to points of drying, which are generally more expensive than commercial dryers.

Thus, the prospects for commercialization of the EasyDry M500 in Kenya are good, but not without some challenges. To provide the most realistically affordable service the dryer needs to be manufactured in the informal sector and be retailed around $800. To build awareness that dryer services are available and viable, the technology needs to be demonstrated. The informal sector, whether the manufacturer or the businessman, is currently unable to cover this cost. While the informal sector can manufacturer the EasyDry M500, there is need to do the job well or the machine will not perform well. This is especially important when first introducing the technology, which requires that every machine sold needs to meet certain specifications. This will entail capacity building and monitoring of the informal sector.

In addition, whether the EasyDry M500 will bring about improved income for the smallholder farmer, rather than improved income for the trader, depends on the selling decision of the farmer, as well as improved information flows and farmer awareness of market pricing, and premiums for dry maize.