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Feasibility of Up-scaling the EasyDry M500 Portable Maize Dryer to Tanzania

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In Support of:

PACA

Partnership for Aflatoxin Control in Africa

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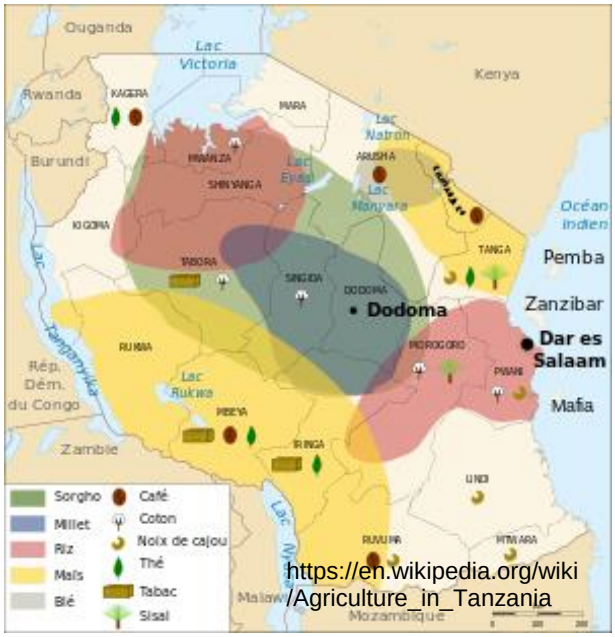
Additional documentation, videos, and training guides are available on;
www.easydry.org

*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.*

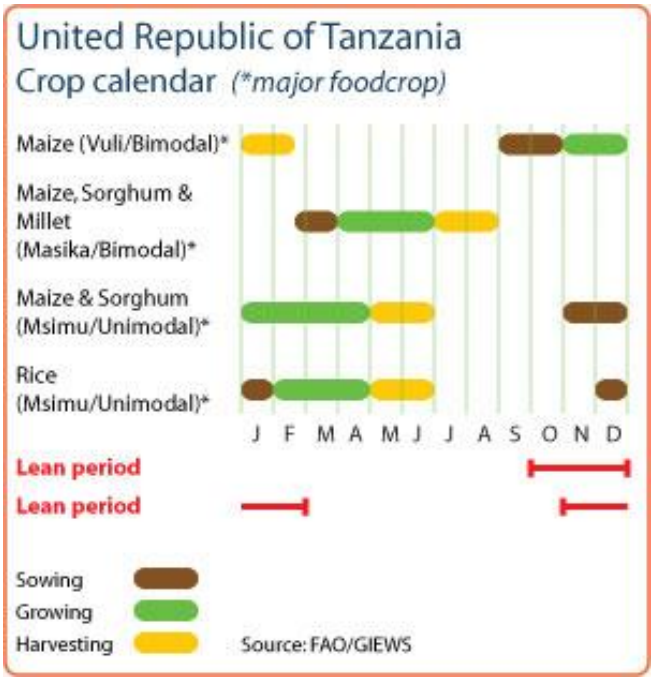
TANZANIA BACKGROUND INFORMATION

Tanzania is vast and has a wide range of climatic conditions. Therefore, what looks to have potential – or lack of potential in one region - does not necessarily apply to another region. Tanzania, like Kenya, also has a rolling harvest, meaning that the maize harvest happens at different times across the country, so an earlier harvesting region can be supplying drier maize to the market as another area delivers wet maize.



https://en.wikipedia.org/wiki/Agriculture_in_Tanzania

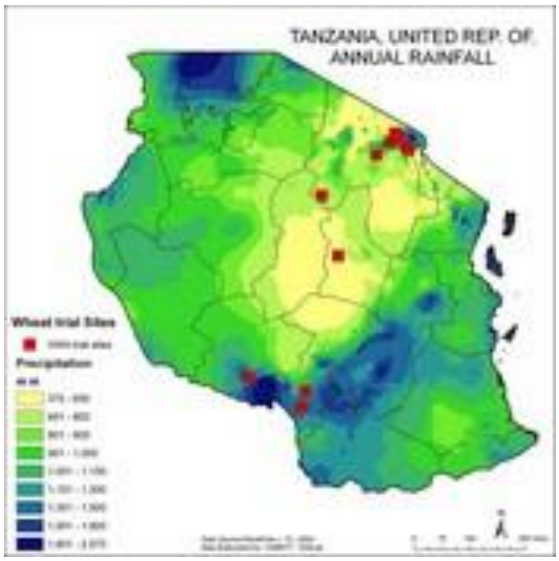
The majority of maize production in Tanzania is rain-fed through two rainfall seasons, *Masika* and *Vuli*, accounting for 41% and 47% of production respectively. Maize is mainly grown in three regions – the southern highlands (one main harvest per year), the Lake zone, and the northern zone – as depicted in the yellow areas in the image above. Harvesting happens in January and February in the *Vuli* season with a second harvest around August and in July and August for the *Masika* season, as shown to the left but continuing through to November in areas further south.



The southern highlands alone account for 45% of production, followed by the Lake zone, which produces 25 to 30% of Tanzania's annual maize production. The production in these areas is supported by historically higher levels of rainfall, especially the regions of Iringa and Mbeya, as shown in the rainfall map on the next page.

In terms of land, Tanzania dedicates over 4 million hectares of to white maize cultivation, with smallholders growing 85% of the total production. However, maize yields have remained low, between 1 and 1.5 MT per 2.5 acres, while the potential is closer to 4 to 5 MT. Compounding this low productivity is the fact that post-harvest losses can at times amount to 15 to 20% in terms of the cumulative weight loss occurring during harvesting,

http://maizeatlas.cimmyt.org/country/environment_maps/TZA/0



drying, handling, farm storage, transport, and market storage.[1] The presence of the larger grain borer can, when conditions are favourable to the insect, also cause significant post-harvest losses. Recently, there has also been a growing awareness that certain parts of the country have an aflatoxin problem and in 2016 there were 14 reported deaths and 53 suspected cases of aflatoxin poisoning; the eastern and western zones of Tanzania represent the two areas where aflatoxin contamination is a major concern.[2]

Finally, crop production seasons have also been plagued by the late onset of rains, prolonged dry spells, and poor rainfall distribution, which all increase susceptibility of maize to aflatoxin contamination.[3] The unpredictability of rainfall after harvest also brings about more challenges in drying maize in the sun.

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.

[1] http://www.aphlis.net/?form=losses_estimates&c_id=324

[2] http://allafrica.com/stories/201607290685.html and http://abtassociates.com/AbtAssociates/files/fa/facafce3-af77-4c5a-a3d5-a27198d619f1.pdf

[3] http://reliefweb.int/sites/reliefweb.int/files/resources/rvac-tanzania_2015.pdf

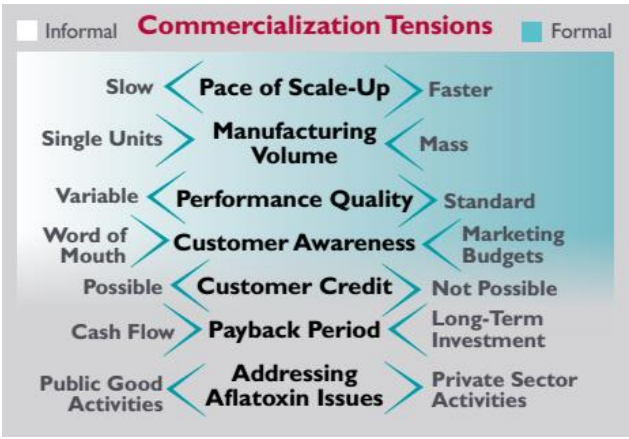
With regard to logistics, it has been designed to be transported easily and can be loaded onto two motorbikes. It has a small petrol engine, which uses about half a liter of petrol per hour to power two fans, and burns about 11kgs of maize cobs per hour to provide the heat, which dries the maize. The 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 over all the price would be about $0.25 lower. In Morogoro about 53% of the farmers had access to electricity.

MANUFACTURING OF EASYDRY M500

The EasyDry M500 is not a difficult machine to manufacture and therefore fabrication in the informal sector 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, the formal sector has higher costs both in manufacturing but also in investing in marketing and customer support. This, of course, increases the price of the end product. While initially they may be able to make 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 right summarizes the success factors, risks



and possible mitigation issues to consider.

A final consideration as related to manufacturing is finance. The formal sector generally has access to financial instruments, which ease both their own cash flow constraints, and those of potential investors by enabling the latter to spread payments over a number of years. Moreover, potential investors have the ability to leverage the original cash available to purchase additional machines (e.g. if a buyer has $900 through financing that could be used to purchase three machines putting a 30% deposit on each machine, rather than buying a single machine outright for $900). 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 Tanzania to estimate the cost of manufacturing the EasyDry M500 informally in Iringa, Tanzania (part of the southern highlands) as compared manufacturing the same dryer informally in Kenya. This price was also compared to the price provided by Intermech, a formal manufacturer based in Morogoro, who built 10 machines for the Tanzanian Smallholder Maize Dry Project sponsored by WFP and AflaSTOP.

For the most part, it was found that materials needed for building the dryer could be sourced in Iringa, and if not, from Dar es Salaam worst-case scenario. Nevertheless, as compared to building the dryer in Kenya, initial analysis indicates that the manufacturing costs in Tanzania would be approximately 20% more expensive, mainly driven by higher costs for the engine and the canvass work.

Intermech, a Tanzanian agricultural machinery producer based in Morogoro, was contracted by AflaSTOP to fabricate 10 EasyDry M500s in Tanzania at a cost of USD$1,040 per dryer. The machines were built to specification, along with a few small modifications. In terms of quality, when the Tanzanian dryers were tested alongside the Kenyan machines, which had been transported to Tanzania, there were no significant differences in performance in terms of heat production, pressure of airflow, etc. The Tanzanian built machines appeared to be more robustly built and the finishing was a degree better than those produced by the informal sector in Kenya.

Informal Manufacturing Costs for EasyDry M500 by Country

	Kenya	Tanzania	Uganda	Rwanda	Ex-Kenyan machine to Rwanda
Materials	$511	$630	$688	$1,027	$796
Labor	$140	$251	$195	$341	
Transport	$15	$15	$17	$15	$200
VAT, Import duty					$183
Profit*	$130	$176	$177	$274	
Total cost	**$796 / 850**	**$1072**	**$1077**	**$1,657**	**$1,179**

*Presumes 20% profit margin, however individual manufacturer profit requirements may vary.
^Initial quotations received support these numbers.

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

Through this field research and testing, it has been shown that Intermech can manufacture the EasyDry M500 for a cost of $940, not including the canvass plenum and engine, which was supplied from Kenya and costs around $100 but in Tanzania may cost an additional $200. Furthermore, given that the total material costs in Tanzania are about 30% higher than Kenya, the informal fabrication of the machines results in a retail price about 20% higher than in Kenya, between $900 to $1000.

MARKET DEMAND FOR DRYING SERVICES

As with Kenya, there is a two-tiered market for maize in Tanzania – the predominantly informal market where maize is processed in small toll mills at higher moisture levels, producing a short shelf life maize flour, and the formal market where buyers require 'dry, better quality' maize sold in branded packets with a much longer shelf life (more common in urban supermarkets). Unless the farmers are working together on aggregated sales to the larger buyers, traders simply buy what is available at the informal market price, and then if there is an opportunity, differentiate quality for sales to different markets further along the supply chain.

While manufacturing costs are within a reasonable range, the potential demand for maize drying services in the Iringa area gas been found to be low due to little, if any, price differentiation on the market for dry maize. Furthermore, the profitability of farmers in farmers in Iringa (northern area of southern highlands) according to the local extension officer is minimal and the normal weather patterns permit field drying, shelling and tarp drying without much risk.

Moreover, when speaking with small traders in Upper Kilolo and Iringa, they indicated that farmers do not directly see a price distinction for dirty and or wet maize. Instead, farmers have to provide additional volume for these types of maize, which they doubted the farmers translated into a cost. At the formal buyers warehouses, maize is either accepted or rejected based on the moisture level of less than or equal to 12% with a few exceptions where moisture levels of 12 to 14% are accepted, but at a discount.[4] For example, one of the main buyers in the region, Silverlands, does differentiate between maize at 14% and maize at 12% and there is a 1.5% price discount for the wetter maize. However, this price difference only really covers the loss in weight Silverlands experiences when maize loses moisture in store, rather than any additional costs associated with actually drying maize. Thus, if a farmer's/trader's

[4] This makes sense given that maize buyers are buying maize to store and want to minimize their losses. Thus, if maize in their area equilibrates at about 12%, they can put maize at 14% into their store, and after 3 or more months the moisture content will be 12%. This, in turn, means that their books will balance financially, i.e. loss in weight will be recovered in the price differential.

maize is rejected for being too wet, the incentive is to simply take the maize back and dry it further outdoors, which is relatively easy to do and is the most cost effective option for the supplier of maize. Therefore, the Iringa area appears to hold little potential for the EasyDry M500.

That said, as we mentioned before Tanzania is vast and neighbouring areas experience different conditions. The Njombe area (southern part of the southern highlands) may have more potential for dryer deployment given that it experiences wetter conditions and that farmers experience significant post-harvest storage losses. There are also no commercial dryers available in the area – all drying is done manually. Although given the low profitability of maize production for smallholders currently, it may be better to market a dryer to maize buyers (traders, millers, etc.) first, as they have more incentives to ensure that the maize they store is dry. Another area where their might be potential to offer drying services is in the more rural areas around Mbeya.

THE COST OF THE DRYING SERVICE

The cost of the drying services is determined by 3 key factors:

- How many years the business expects to pay off the initial investment cost of the dryer;
- The number of days the dryer will be used in a year;
- The number of bags dried per day.

SMEs in Tanzania appear to expect to repay an investment around USD$1,000 within 2 years, whereas a bigger investment (e.g. tractor) in up to 5 years.

The costs fall into two categories:

- Fixed costs
    - Repayment of the investment;
    - Daily wage of operator;
    - Daily transport costs.
- Variable costs
    - Petrol used per hour;
    - Maintenance costs (a product of how many hours worked).

In the scenarios in the table below, the assumption has been that the dryer will be able to work 40 days per year. If the dryer is able to work more days per year, then the ultimate cost to the farmer goes down. If the dryer is not able to get 40 days work per season, then the repayment of the investment cost will go up.

Sample Viability Scenarios for Tanzanian EasyDry M500 Operators (TSH)				
	1 Operator, 1 Dryer	1 Operator, 1 Dryer	1 Operator, 2 Dryers	1 Operator, 3 Dryers
Transport[5]	12,000	12,000	24,000	36,000
Operator	20,000	20,000	20,000	20,000
Fuel	10,700	6,420	21,400	32,100
Maintenance (10% purchase cost)	5,083	3,050	10,165	15,248
TOTAL COSTS	**47,783**	**41,470**	**75,565**	**103,348**
Bags Dried	**15**	**10**	**30**	**45**
Cost per bag	3,186	4,147	2,519	2,297
Cost per mt in USD	14.64	19.07	11.58	10.56
Profit needed to repay the machine in 2 years, cost per bag	**4,880 ($2.24)**	**6,689 ($3.07)**	**4,214 ($1.93)**	**3,991 ($1.83)**
Profit needed to repay the machine in 3 years, cost per bag	**3,186 ($1.46)**	**4,148 ($1.90)**	**3,637 ($1.67)**	**3,415 ($1.57)**

This clearly shows how variables such as repayment of investment expectation and the number of bags dried per day will significantly effect the price needing to be charged to the farmer. In Morogoro in 2016 from June to August, a limited number of farmers were willing to pay between Tsh2500 and 3000 ($1.15 - $1.38) per bag. Of this limited number of farmers, one had 20 bags to dry, while the rest had around 5 to 6 bags. The operators did not use the higher, recommended price because they felt that as a first test of the new technology there was a need to reduce the cost.

A further complication is the table above is based on bags weighing 100kg, but In Tanzania, the weight of a “bag” can vary between 100 to 135kgs. If too much maize is loaded onto the bed, the drying times slow down and the number of batches per day may end up being reduced, which significantly affects profitability.

The best case scenario from the above is the following:

- A dryer operator dries for 40 days per year;
- Is happy with recovering the investment over three years; and
- Charges TSH 3,200 ($1.47) per 100kg bag loaded onto the bed.
- Conversely, the farmer in this scenario has 15 bags to dry each day, and his/her maize started at 18% moisture content.

[5] The transport cost is based on the small pilot in Morogoro and will vary by region, availability of transport (in this case predominantly tuk tuks) and distance to farmer.

This means that out of each 500kg batch, the farmer will lose 4.5% in water alone, which is equivalent to 22.5kg. In terms of per 100kgs sold this equates to an increase in costs of TSH3351.

Cost incurred per batch	3200 x 5 = 16,000
Cost per kg dried	16,000 / (500-22.5) = 33.51
Cost per 100kgs sold	33.51 x 100 = 3,351 ($1.54)

Thus, in order for the farmer to be motivated to change his/her current drying behavior, there needs to be one or more of the following influencing factors:

- The price paid for dried maize compared to wet maize at the farm gate needs to be at least TSH 3351 ($1.54) per 100kg more;
- The cost of maize per 100kg bag being lost solely due to being wet is more than Tsh 3351 (at a harvest price of TSH 50,000 per 100 kg bag this represents 6.7kg);
- The current cost of drying the maize in the sun needs to be more than TSH3,200 ($1.47) per 100kg of wet maize; or
- Concerns over the increase in aflatoxin levels in poorly dried maize either encourage farmers to dry maize for home consumption on the dryer, or the market provides a premium for maize dried on a mechanical dryer, which passes sufficiently hot air through the maize to deactivate the *aspergillus* spores.

Without further investigation it is unclear what the moisture level of maize is in the informal market in Tanzania. Since farmers already have to dry their maize sufficiently to meet the informal market requirements (and their own storage requirements) its not necessarily reasonable to think the formal sector will pay the whole premium to dry maize given that it is a normal post-harvest cost. However, if the informal market accepts 15.5% moisture content and the formal market wants 12.5%, there should be a premium of at least $0.75 per 100 kg bag, or $7.50 / mt to provide an incentive for the farmer to make extra effort to supply this market.

CONCLUSION

To be able to determine whether mechanical drying services directed at the smallholder farmer or first aggregator level are viable in Tanzania, the following questions need to be answered:

- First, are the factors, which will influence farmers to adopt mechanical drying in place (price premium for dry maize, lower cost of drying than current practices, prevention of loss)?
- Second, are there sufficient volumes of at least 15, 100kg bags of maize to be dried per day, and at least 40 days work per year within a serviceable area?
- Third, are SMEs willing to accept repayment of their initial investment over 3 years, as opposed to 2?

If these conditions are in place, then there may be more potential for successful introduction and adoption of the EasyDry M500 technology, which can easily dry maize on farm, and be transported easily from farm-to-farm.

In addition, to be able to build the dryer well, the informal sector does require some training on how to build the dryer, and there should be performance testing of the machines at the beginning in order to ensure that the technology performs as it should and that the reputation of drying services is not tarnished by poor performing machines.

Finally, for farmers to adopt a new technology, such as drying (and SMEs to buy drying machines), there also needs to be sufficient demonstration of the technology so that farmers can see for themselves that the dryer does not damage their maize in any way which would prevent them selling it at the highest price possible.