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EasyDry M500: The Portable Maize Dryer, Analysis of Commercialization Viability

Implemented by:

Meridian Institute

Connecting People to Solve Problems

Expanding Opportunities Worldwide

In Support of:

I. Introduction

The EasyDry M500 portable batch dryer was designed, manufactured, and piloted by AflaSTOP: Storage and Drying for Aflatoxin Prevention (AflaSTOP) project, which is jointly implemented by Agribusiness Systems International (ASI) and ACDI/VOCA under the direction of Meridian Institute in support of the Partnership for Aflatoxin Control in Africa (PACA) with funding from USAID and the Bill & Melinda Gates Foundation. It was developed as an open source technology that can dry maize in batches of 500kgs in 3 hours, lowering the moisture level from 18 to 20% to approximately 13.5%, which is the ideal moisture level for storing grain. Its simple design allows for local artisan fabrication; its portable nature allows for the dryer to be brought to the farmer, instead of farmers having to move their wet maize to a drying facility; and despite being brought to the farm, the EasyDry M500 is less expensive than commercial dryers in Kenya, making it more accessible to smallholders. More information on the EasyDry M500 can be found at www.easydry.org

This analysis reviews the economics of the EasyDry M500 in conjunction with market pricing and demand factors in order to identify if the EasyDry M500 can provide the economic benefits needed to be adopted in the market without the need for subsidies, and if so, determine the types/categories of potential buyers. This report will then examine the economic drivers and benefits that would warrant their investment in the purchase of the dryer. Please note that all monetary figures presented have been converted to US dollars at current exchange rates in order to provide a common basis for comparison.

II. Economic Overview

A starting point for any economic analysis best begins with an inventory of the associated costs and benefits. With respect to the EasyDry M500, this inventory includes the following:

Costs		**Benefits (depending on target audience)**	
Upfront costs	Purchase price charged by a vendor or the cost to have the EasyDry M500 dryer manufactured.	**Lower costs**	This is the critical factor that will determine adoption of the dryer. It is also the one that is universal to all potential participants. Farmers looking to purchase drying services from a local provider, traders/aggregators, those operating commercial dryers, and farmer groups will all look to this as their first, and main, criteria.
Variable costs	As related to operating the dryer, i.e. Labor Expenses; the wage paid to the operator of the dryer.	**Alternative market**	Where a buyer pays a premium over the cost of drying and weight loss for dry maize (13.5% moisture content)
	Petrol; fuel needed for the engine that powers the fans.	**Time Savings**	The EasyDry M500 is much faster than traditional methods of drying. This is primarily focused at farmers who see economic value in having their time freed to do other activities often off farm
	Maintenance; expected costs related to normal wear and tear. E.g. grease for bearings, spark plugs, belt replacement etc. or annual maintenance such as grate replacement, ripped material, and engine servicing.	**Profit Potential**	This only applies to those looking to provide drying services to farmers via the EasyDry M500.
	Transportation; cost of moving the dryer to/from drying locations		
	Cobs; cobs are critical as they are the heating source. While cobs do not have either an explicit or implicit value, a market price exists & they do have a		

	replacement value to the farmer since less cobs means purchasing more charcoal or finding more wood.		

a. General Comments Regarding Capital Equipment vis-a-vis the EasyDry M500

The economics of any capital asset are highly dependent on its utilization rate and throughput capacity (think of the airline industry working to keep planes in the air versus sitting on the ground and filling as many seats possible). From this perspective, the EasyDry M500, and any specialized agricultural equipment, face the constraint of a short window of operation – the seasonal period that the technology is needed – e.g. ploughing before planting. Narrowing that window further for small batch maize dryer are regional specific climatic conditions that allow for sun drying thus making any mechanical drying unnecessary, or at least a potentially a higher cost alternative.

b. Farmer Perspective

The EasyDry M500 is not targeted to smallholder farmers be purchased directly as their production levels and actual drying volumes would never justify the cost. Nonetheless, potential farmer demand is one driver that factors into the determination of commercial viability. For the farmer (including farmer groups/associations/co-ops), the cost/benefit comparison can vary dramatically by region. In some areas, farmer do not dry their maize (with the exception of that held for family consumption), simply because the market trades only in wet maize and there is no market premium to be gained. In these areas the EasyDry M500, or any other drying method, are simply irrelevant. These “immature” markets are shrinking as knowledge of end user premiums for higher grade product gets transmitted down the supply chain.

It is in the areas where price differentials exist between wet and dry maize that the EasyDry M500 has a chance to compete. Farmers in these regions will judge the EasyDry M500 on the cost of drying versus other available options. An additional, non-explicit factor that can work in favor of the EasyDry M500 is its faster drying time versus traditional methods, and this timesaving allows the farmer to engage in other productive activities.

c. Dryer Owner Perspective

Several categories of potential owners have been identified. Each has its own set of evaluation criteria.

Service Provider, Entrepreneur Model	Traders	Village aggregation centers (VACs)	Farmer groups, Associations, Cooperatives
For those providing drying as a service to farmers, an attractive operating profit versus the initial purchase price will be the key driver.	For traders that buy, collect and dry maize, a lower overall cost of the EasyDry M500 versus their current drying alternatives would be their measure of value.	For entities that operate commercial dryers and organize village aggregation centers (VACs), the benefit would be seen as a lower cost alternative to utilizing their commercial dryer.	Purchase of the EasyDry M500 by individual farmers, does not make economic sense. However, these types of groups could form a strong buying base; their interest in the EasyDry M500 would be based on its cost versus their current drying alternatives.
It needs to be noted that such service providers do not exist in all areas. While this network is well developed in North Rift, Kenya, it is absent in Eastern Uganda and spotty in the Tanzanian maize belt. Thus, the potential market size is a subset of the principal maize growing regions.	This would include the transport savings of drying at the source and being able to deliver straight to the end buyer, rather than have to transit the maize through a processing center.	Potential savings would factor in the transportation and handling costs saved by hauling dry versus wet maize.	Most utilize aggregation centers where a dryer, or dryers, could be located. This would reduce dryer transport costs and help to ensure that the dryers were fully utilized.

d. Estimating the Key Operating Variables

Obtaining accurate estimates of the dryer's operating parameters is required as they form the foundation of the economic analysis. Two categories of variables are present in the analysis of the EasyDry M500:

- Operating Variables: These are constant across all users and regions. Examples would be fuel consumption and drying times.
- Cost Variables: These vary by country and even region. Examples would be fuel cost, and labor rates.

In obtaining the raw data needed to estimate the variables, three methods were employed:

- Controlled tests by EasyDry M500 staff.
- Data from test units placed with service providers, and
- Data collected from a formal pilot testing program utilizing service providers

The cost variables below relate to Kenya since it is the location where the vast majority of controlled and field testing was done. Therefore the purchase price of the EasyDry M500 was $833 (Ksh85,000) when this analysis was completed. All money figures have been converted to US dollars.

Bag Weight (kg)	90	Petrol Usage/Hour	0.5
Bags/Batch	5.5	Utilization: Days per Year	40
Kilograms/Batch	495	Petrol Cost/lt.	1.0
Moisture Drop	4.0-4.5%	Transport Cost (to/from Site)	3.6
Dry Time/Batch (hours)	3.0	Operator Salary	7.8
Work Day: Drying (hours)	9.0	Cost of Dryer	833
Batches/Day	3.0	Annual Maintenance (% of cost)	8.7%

III. Economics of the EasyDry M500

EasyDry M500 Kenya SME Model Analysis – below are the economics of EasyDry M500 use on a per day basis using the parameters given above.

Days of use per year	40
EasyDry Purchase Cost	833
Years to pay back	2.0
Amortized Purchase Cost	10.4
Operating costs	
Maintenance	1.8
Transport	3.6
Operator Salary	7.8
Petrol	4.8
Total Daily Costs	28.5
Drying Cost per Bag	1.7
Drying Cost per mt	19.19
Drying Cost per kg	0.019

The cost per unit will be the critical point of comparison in examining how the EasyDry M500 compares with other drying alternative and thus its commercial viability.

a. Cost Sensitivity Analysis

As seen in the analysis below, the largest impact on drying cost is the assumed amortization period. Depending on the scenario, this can either be interpreted as the required payback period or the useful life of the machine. The machine is estimated to last between 4 – 5 years if well maintained. The longer the period to repay the machine the lower the cost of offering the service to the farmers.

Payback in years	2	3	4
Price per day (40 days per year)	$10.40	$6.94	$5.21
Price per 90 kg bag	$0.63	$0.42	$0.31
Price per mt	$7.00	$4.78	$3.44

In order to demonstrate cost sensitivities, the table below shows the marginal impact of a 10% increase in the cost elements versus a one year change in the amortization assumption. As can be seen, the amortization (useful life/payback) assumption is most critical. Of less, but significant impact, are the purchase cost and operator's salary. The remaining variables, while not unimportant, are of lesser consequence. For instance, a 10% increase in the cost of the dryer only adds $0.06 to the cost of drying a bag ($0.67/mt).

	Cost Impact per Bag
1 Year Increase in Amortization	-0.21
10% Increase in:	
EasyDry Purchase Cost	0.06
Maintenance	0.01
Transport	0.02
Operator Salary	0.05
Petrol	0.03

IV. Comparison of the EasyDry M500 with Existing Alternatives

Farmers wishing to reduce the moisture levels present in their maize and increase its dryness have three categories of options:

Sun Drying Using Tarpaulins	Commercial Dryers	Portable Devices - A New/Emerging Category
This is the traditional and most widespread, improved alternative and large tarpaulin can take about 1.8mt and the tarpaulin lasts about 2 years.	Not practically available to all smallholder farmers, but can be found in some primary trade areas of many "maize belt" cities. These may be operated by governmental entities or private companies either millers (e.g. Kenya) and or traders (e.g. Uganda). BrazAfric and Cimbria offer varying sized batch dryers from 3 – 12mt.	In addition to the EasyDry M500, GrainPro is marketing two new products, which have a batch size of 1mt. One in an enclosed device using solar power to run a fan, the other a simpler tarp-like device.

a. Sun Drying

While this is the traditional method and may appear to be "no cost" on the surface, it does have costs and disadvantages. First, in areas that are rainy during harvests it may not be viable, or at a minimum take much longer, to dry in the open air. If the farmer is drying on a tarpaulin, this needs to be purchased or hired. Additionally, tarpaulins have short life spans and of course there is the size limitation. Other factors working against sun drying are the longer time needed, which can lead to losses due to theft, consumption by animals, having to pay and feed laborers, uncertainty as to the level of moisture attained, uneven drying and the opportunity cost of spending 5-7 days drying one batch instead of doing other productive activities.

b. Commercial Drying

Although potentially available to some smallholder farmers, it has some negative aspects. First, the quantities needed for a batch are large, thus the identity of the maize is lost, which is viewed negatively by many smallholders (they want to give and receive "their" maize). Also, the logistics and costs of transporting the maize can be difficult for a farmer to coordinate with others, and if there is a long wait to access the dryer, truckloads of maize can start going 'off'. When transporting and handling the wet maize, there are costs incurred on a volume of maize which ultimately shrinks but about 5%. Finally, the costs can be high and unless there is a transparent market for dry versus wet maize, it can be (or be perceived as) not worth the cost.

c. Portable Devices

This being an emerging area, there is little/no data as to farmer adoption and opinion regarding this alternative. The only statement to be made is that to be commercially viable any such device will need to be competitive with the other alternatives.

d. Results of Comparison

For the analysis below, the sun drying alternative was assumed to have no direct ("out of pocket") labor cost (i.e. family contributed labor). Sun drying data is from Kenya and has been split into two scenarios, sunny and rainy. For the commercial drying alternative presented, the posted rate structure of the three providers was used, including any mandatory handling fees. For the portable devices, data on actual performance was used. For the GrainPro Solar Bubble Dryer, company claimed performance is much better than feedback received by actual users. However, it is important to note that this was antidotal and informal estimates based on limited user data. With respect to the GrainPro "enhanced tarp" product, we excluded it given its cost of US$ 600 and very little benefit over using the

traditional “generic tarp”. In short, we determined that this was not a viable product from the perspective of potential commercial demand.

	Costs for Achieving a 4% Moisture Drop						
	Traditional Methods		Farm-Based Devices		Commercial Dryers		
	Sun Dry (Sunny Weather)	Sun Dry (Wet Weather)	Easy Dry[1] (Base Case)	GrainPro Solar Bubble[1,3]	AgroWays	EAX	Kenya Cereals Board[2]
Source Info Location	Kenya	Kenya	Kenya	Rwanda	Uganda	Rwanda	Kenya
Drying Cost/Bag	0.22	0.75	1.73	5.17	1.30	2.74	1.98

[1] Assumes 2 year purchase cost amortization

[2] Handling charges not disclosed/included

[3] Manufacturer claimed performance (user feedback gave much worse performance)

As a final note, if average labor usage rates and times are factored into the traditional drying methods, the increase to the cost per bag show above would be in the range of 44 cents/bag under dry conditions and $1.02/bag under wet conditions.

e. Comments and Observations

- The high cost per bag of the GrainPro Solar Bubble dryer is due to its high purchase cost of US$3,500. From a commercial perspective it would not compete against the EasyDry. Even assuming a longer amortized life it is hard to imagine a scenario in which it could be competitive against the EasyDry.
- Sun drying costs are lowest, as expected. However, this does not include the opportunity cost of the farmer spending five to seven days, or more, working on this process. Additionally, in the wetter areas sun drying is not a realistic option, or at best it is a very risky one. And, as mentioned above, when hired labor is required, the cost gap is quickly reduced or eliminated.
- Commercial alternatives show a fairly wide range in price. This can be due to many factors including initial equipment age and cost, amortization assumptions used, variable (fuel, power) costs, fuel/power consumption and local market factors. While speculative, the high cost seen at EAX Rwanda may be a “barrier” price since their focus in on merchandizing (buying/selling) and storing grains i.e. they want to discourage drying at the facility. AgroWays’ Uganda low price could be due to their receiving a significant subsidy (33% of cost) when purchasing their commercial drying unit.
- The EasyDry M500 cost is within the range of commercial drying services and thus appears to be competitive from a cost perspective. However, it must be noted that many users of the commercial dryers are commercial farms and individual farmers with much larger areas growing maize than the typical smallholder. For smallholders that utilize the commercial dryers, this group would be an obvious target market. However, it appears that most smallholders do not use commercial services since it involves additional transport and handling costs/logistics. Having access to a nearby EasyDry would minimize this cost/logistic disadvantage.

V. Market Practices and Their Influence on EasyDry M500 Viability

In many regions, the current practices related to the purchase of maize from farmers work against all drying methods, by creating and sustaining an “opaque” market price. Various methods are used by local buyers to create a gap between the “stated price” and the actual price received by the farmer, and to keep market-pricing data hidden. Some of the commonly found techniques are:

Lack of Explicit and Transparent Pricing for Grades	Lack of Affordable, Reliable Moisture Meters	Lack of Scales
In very few instances are there buyers who offer explicit price differentials for specifically defined grades. This lack of demand results in a "lowest common denominator" market price where the farmer has no incentive to incur costs to improve his/her product above what is fair average quality in the market since there is no offsetting revenue gain. At its core is the constraint that instead of a relatively small number of traders delivering into a graded market system, there are a multitude of farmers delivering different 'grade' products to a multitude of traders services numerous different market outlets. The trader buys the average – some bags are good, some bags are not so good, but the average of the lot fits some where into a market not driven particularly by grades – but good enough acceptance. These small traders visiting many farmers to fill the truck cannot differentiate within the truck good maize, and poor maize – so it's all bulked together. Larger, better-connected traders servicing better-priced markets use this lowest common denominator buying to keep the price for high-grade product from farmers. It is interesting to note that where a large buyer of high-grade product exists with limited supply (e.g. brewers), they work to publicize that price and the quality standards quickly filter to the farm level. This gives the farmer access to this premium price if (s)he is willing to deliver the quality.	This makes any negotiation regarding moisture content a subjective discussion. Even if clear moisture content grades and pricing exist, they cannot be validated in the field.	This allows buyers to "short weigh" quantities before even getting to the moisture content negotiation. Once the moisture content negotiation begins, it normally takes the form of a "penalty weight" amount applied to each bag. Thus if the agreement is, for example, a 4kg penalty/bag there is no way to precisely weigh this. The normal outcome is for the farmer to be on the losing side of the weight determination process. Farmers try to mitigate this by slipping in 'rubbish' to make up the weight.

The above elements work together to create a market environment where the true premiums for dry maize are hidden from the farmer. Since the "benefit" is difficult to determine, there is no firm value that can be used for comparison against the cost of drying. In this situation, most farmers default to subjective opinion of what seems "expensive" and/or use a non-related comparison such as the cost of shelling.

VI. Situational Analysis

a. SME Service Providers Model

From interviews with local service providers (primarily shelling/threshing) the average consensus was that they would expect a piece of machinery to have a payback of two years and daily profit thereafter at least equal to the wage paid to the operator. The EasyDry M500 base case generally meets these standards vis-à-vis the other "non-tarp" alternatives, but the open question is the number of smallholder farmers that would be willing to pay the per

bag price. Without doubt, this demand would only exist in regions with wet harvest climates. Unfortunately, the pilot in such region experienced it driest harvest in ten years, thus resulting in insufficient data to base any conclusions. Farmer interviews indicated a willing to pay from 50 cents/bag to $1.80. Such interview data is notoriously bad and biased to the downside. While it is safe to say farmers would value the service in a range of 80 cents to $1.20, demand to use the SME model scenario of $1.75 is probably a stretch where drying is not difficult. In those areas where explicit moisture and quality price differentials exist and or weather conditions at harvest preclude sun drying it may be viable, with adoption being led by those who have other economic activities and therefore valuing rapid drying services.

Based on known operating costs this means that the SME operator would need to dry a **minimum 1.5MT/3 batches of maize per day at a cost to the farmer of ~$9.60/batch** each batch is 500kgs **(drying cost of $19.20 / mt).** 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.

There are other elements that work against the service provider model, at least on a wide-scale basis. The most prominent being:

- The majority of service providers do not have the cash or credit resources needed to purchase an $800+ piece of equipment. For this type of purchase, they normally would save for a year or two and then borrow the remaining funds needed from relatives.
- Service providers would be hesitant to make such a large financial commitment on an untested product and unseen market demand.
- The market is narrow because such service providers (tractor, shelling etc.) do not exist in many regions. Additionally, the only regions where the dryer concept works are “wet harvest” ones. This makes the pool of potential buyers in this category fairly limited.

Variation on this model. It is possible to operate three EasyDry’s at the same time in the same location. One operator keeps all three furnaces burning and turns the maize. Even he gets a low wage assistant (around $2 / day) the volume trebles and the labour cost remains the same or increases only by $2. There may also be cost savings on transport where you can reduce the number of motorbikes from 6 to 5 possibly 4. This larger volume service would be aimed at farmers with at least a minimum of 4.5mt to dry per day, and probably enough to spend 3+ days in one location (further transport savings) and could cost as little as **$8.15 per batch per dryer (16.30/mt)**.

b. Farmer Organizations, Groups and or Cooperatives Service Provision Model

This group represents another source of potential buyers that should be pursued. Instead of the drying being owned by an individual entrepreneur the farmer group would invest in the EasyDry to provide services for their members. Repayment of group owned assets is normally over a longer time period, and given the EasyDry M500 is expected to last between 4 – 5 years (if well maintained) modelling the repayment on investment over 4 years is a reasonable assumption. Often when a group decides to invest in an asset each member puts in small deposit which allows a shorter period of time between making the decision to invest and having the equipment available for business. With all other factors remaining the same (operating costs, working days per year) a farmer group can afford to offer **drying services to members at $8.25 / batch ($16.50 / mt)**.

c. Trader Aggregation Center Model; Owners of Commercial Dryers that Utilize VACs as Collection Points (e.g. Uganda)

This category of potential buyer is perhaps the most fruitful to pursue. Briefly stated, the concept would be to put dryers at their VAC locations and dry locally versus shipping wet maize to their commercial drying unit. For this to be viable, the per-unit drying cost of the EasyDry M500 would need to be in range of their commercial dryer's per-unit cost. There are additional factors that work in favor of this approach:

- Drying at the source of the product saves transport costs to the main drying facility. Assuming a 4% moisture loss, this translates to a 4% savings on the existing transport and handling expenses.
- Additional transport and handling savings would be made if the dried product could then be shipped directly from the VAC to the end buyer.
- Such entities have the cash and/or credit resources to purchase dryers if convinced that the economics make sense. Thus, in contrast to service providers, lack of cash flow should not stand in the way of making a good business decision.
- A single VAC site would need more than one EasyDry M500. Operationally, a single operator should be able to cover three dryers. This reduces output cost per-unit by spreading the labor over a larger production volume.
- Most commercial dryers are located in regional trade center towns where labor costs are normally higher than rates in the outlying rural areas. This should further reduce labor expenses.
- Businesses in this category will view the EasyDry M500 from the perspective of its useful life versus a quick payback period. This reduces the annual amortized cost of the dryer.

The model output below combines the above factors resulting in a four-year amortization period where one operator manages three machines. All other parameters remain constant. As can be seen, the cost per-bag drops considerably from the base case scenario of $1.7 to $0.9 ($9.83/mt). Most of this drop being related to the longer amortization period. The Uganda Scale Out Report explains how **the EasyDry M500 trader model** could cost as little as $**7.05/batch ($14.10/mt)** to an aggregating trader compared to their current drying costs of $14.45/mt plus transport and handling of 'waste' water which is probably around $1/mt.

Days of use per year	120
EasyDry Purchase Cost	2,500
Years to pay back	4.0
Amortized Purchase Cost	5.2
Operating costs	
Maintenance	5.4
Transport	10.9
Operator Salary	7.8
Petrol	14.4
Total Daily Costs	43.8
Drying Cost per Bag	0.9
Drying Cost per mt	9.83
Drying Cost per kg	0.010

The most common size truck in Uganda from aggregation center to the dryer is a 10mt truck, if the wet maize was bought at the low price of $120/mt – at 18%, the 4% saving of $4.80/mt. This makes drying at the VAC look very attractive.

Cooperatives running aggregation services for members could also fall into this group. The one exception would be that of access to cash and/or credit. Here, some farmer

organizations might struggle to raise the funds needed to by three or more dryers and may want to use a shorter than four year pay-back period. Nonetheless, their main driving determinant will be the drying cost per-unit of the EasyDry M500 versus the drying method currently employed. For example, the left table below shows the economics of such a group buying one dryer. Assuming group provided labor and a stationary location, the drying cost per mt is $7.90. Including operator and transport costs raises the per bag cost to about $15.80/mt as seen in the table on the right.

Days of use per year	40
EasyDry Purchase Cost	833
Years to pay back	4.0
Amortized Purchase Cost	5.2
Operating costs	
Maintenance	1.8
Transport	0.0
Operator Salary	0
Petrol	4.8
Total Daily Costs	11.8
Drying Cost per Bag	0.7
Drying Cost per mt	7.961
Drying Cost per kg	0.008

Days of use per year	40
EasyDry Purchase Cost	833
Years to pay back	4.0
Amortized Purchase Cost	5.2
Operating costs	
Maintenance	1.8
Transport	3.6
Operator Salary	8
Petrol	4.8
Total Daily Costs	23.4
Drying Cost per Bag	1.4
Drying Cost per mt	15.773
Drying Cost per kg	0.016

d. Grain traders/aggregators

Some traders and aggregators operate VACs in a manner that is quite similar to commercial dryer owners. Since they have a more “trading profit” perspective, they look to sell their inventory in a way to maximize profit. This means that if the price for clean and dry maize is higher than their cost of buying wet maize then drying and cleaning it, they will go this route. If that dry and clean price does not cover those costs, they will sell “as is” wet and with high contents of trash and broken grains. Thus their demand for drying is market dependent and they are customers of the commercial dryers when they need the service. Some traders/aggregators will also speculate in the grains markets by purchasing at harvest and storing the grain in anticipation of price increases. Any such maize held would need to be dried. Whether holding for speculation or drying to achieve a higher profit, the decision criteria will be the EasyDry M500 cost versus the alternatives. While the demand for drying maize may be spottier and more market dependent than others, this group also represents a source of potential demand. Like the commercial dryer owners group, the entities in this classification also should have no problems purchasing dryers if they see a profit to be made.

Expanding the technology into other East African countries (Activity 5):

In 2016 and 2017, AflaSTOP conducted market research in Tanzania, Rwanda, and Uganda to identify whether there was potential to introduce the EasyDry M500 throughout the region. This included a preliminary assessment of the potential demand for drying, the cost of manufacturing, the ideal service delivery model and associated costs, and consumer price points. The following table summarize the key findings.

Table 4: Summary of potential for the need of drying services in 4 East African countries

EasyDry M500 Feasibility Factors				
	Kenya	**Tanzania**	**Uganda**	**Rwanda**
Problems drying maize	Most years for certain areas	No	Yes	Yes
Price premium in the market for dry maize	For limited commercial buyers	Not a true premium	For commercial buyers	For a limited number of commercial buyers
Drying services already present	Limited to NCPB (government), Lesiolo Grain Handlers, Nakuru	Very few commercial operations	Multiple commercial operators; most drying own needs	Yes, for cooperatives
Drying services used by SH	No	No	No	Cooperatives
	Good potential	***Challenging***	***High potential***	***Potential***

Uganda: There was considerable interest in the drying services by a number of companies in Uganda, including both cooperatives and traders running aggregation centers such as Kapchorwa Commercial Farmers Association (KACOFA), Agroways, Adula Enterprises, and Opportunity Bank. Over 300,000 mt of Ugandan maize moves to Kenya each year and the highest prices in the Kenyan market are normally found in May through August, with Uganda starting harvest in June. That said, the maize can be too wet to transport over long distances, necessitating the need for the EasyDry M500. As discussed earlier, the drying costs based on the trader model are very competitive.

Kenya: Kenya has a well-developed service industry, with SMEs providing tractor, shelling and other services to farmers. In areas of high productivity and rains after harvest, there are both farmers who will pay to dry their maize quickly so they can move onto other economic activities, and farmers who simply want to ensure their maize is preserved well for marketing later. Drying services are likely to be either offered through SMEs or farmer groups.

Rwanda: In Rwanda, everyone harvests at the same time and it is all wet. For this reason, the new market player, 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 to provide services on farm or at the cooperative. There are also other private sector players in the market that are already using dryers (e.g. ENAS Ltd., Prodev-Rwanda Ltd.) in order to onward sell to a limited number of millers who offer higher prices for dried maize, rewarding the seller for their drying efforts plus additional profit. Government policy is aggregating maize production and sales through cooperatives, whose marketing abilities are still weak – these cooperatives prefer to sell wet maize to traders rather than dry it and market it further down the supply chain.

Tanzania: Tanzania has the weakest incentive signals to dry maize, and most buyers do not pay a premium for dried maize. Furthermore, given the rolling nature of the harvest throughout the country, there always seems to be some area offering maize that is dry enough for buyers.

That said, Tanzania is vast and there may be areas where there are significantly higher problems in drying maize, which would allow such an EasyDry M500 service to be deployed.

Table 5: Estimated fabrication cost of either the informal sector or the semi-formal sector

EasyDry M500 Estimated Fabrication Costs by Country					
	Kenya	**Tanzania**	**Uganda**	**Rwanda (semi formal)**	**Imported from Kenya to Rwanda**
Materials	$511	$630	$688	$1,027	$796
Labor	$140	$251	$195	$341	
Transport	$15	$15	$17	$15	$200
VAT, withholding & fees					$183.08
Profit*	$130	$176	$177	$274	
Total cost	**$796**	**$1072^**	**$1,077**	**$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.					

While it is possible to build the EasyDry M500 in all four of the countries surveyed, it is worth noting that the most cost effective service will be provided in Rwanda if the machines are imported from Kenya rather than being manufactured in Rwanda. The two key reasons for this are that while all of the parts are available in all countries, many of the less common ones are considerably more expensive in Rwanda where transport and low turnover inflate the cost. Secondly, Rwanda has no real informal fabrication industry and therefore the local formal company will be obliged to pay VAT, and other taxes on the dryers sold. The additional cost in Tanzania and Uganda are also around increased part costs specifically the petrol engine, pulleys and the material for the plenum.

Expanding the technology to other crops

In its current configuration, the EasyDry M500 can dry maize, wheat, paddy, sorghum and millet (though millet and sorghum may need a layer of shade netting on the bed to prevent the grains falling through). The volume on the bed will vary by commodity and can be determined using the A4 floating paper test, and drying times for each commodity will need to be established through batch testing. The only constraint is the furnace, which currently uses maize cobs as the main fuel source - these will need to be available if other commodities are dried. To use alternative biomass as the source of the heat will require redesigning the furnace and possibly including a feeding mechanism if the material is small – e.g. rice husks.

AflaSTOP, stimulated by discussion with the Clinton Foundation Malawi, has established that the EasyDry GS600 (GS ground nuts in shell and 600 as in 600kgs) is feasible and since ground nut farmers normally also grow maize, rendering the fuel source a non-issue. For groundnuts, the dryer's bed and plenum have been expanded and the pulley sizes reduced in

order to speed up airflow, which reduces air temperature to below 50 degrees centigrade, which is the most suitable for drying ground nuts.[1]

AflaSTOP has had discussions on whether the dryer could be used in the coffee industry. It is certainly possible and there are commercial dryers drying maize particularly in Rwanda, but care will need to be taken to ensure the temperatures remain low (similar to ground nuts) and some investigation will be needed to ensure the quality of the coffee dried is as good as sun drying.

VII. Conclusions and Recommendations

The EasyDry M500 appears to be a viable product if marketed to the right niche. From a marketing perspective, prioritization of potential buyers would be:

- Owners of commercial dryers that utilize VACs as collection points
- Grain traders/aggregators that dry purchased maize
- Farmer organizations, groups and/or co-ops that currently dry their maize and/or have access to markets that pay a premium for low moisture content
- Service providers

Finding entities in the top three categories above that are willing to run some trials at VAC sites should be done as soon as possible. This will confirm or deny the viability of the dryer for these categories of potential buyers. First order geographic prioritization for the EasyDry M500 should be on regions that have:

- A wet climate at harvest;
- Market price differentials for dry versus wet maize; and
- Higher cost commercial drying alternatives

Scaling out the EasyDry M500 will require additional support to solidify commercial viability and ensure the development benefits of the dryer are sustained. A future focus by donors should be around off-setting the initial costs of broad product promotion of the EasyDry M500. This will be critical to the commercial viability of the EasyDry M500, since the current pricing structure for the dryer does not allow for demonstrations and marketing to smallholder farmers, which are key to driving demand and adoption. Aside from this, the technology is economically viable – i.e. fabricators and service providers (in both the SME and farmer group models discussed above) both have acceptable profit margins, and a reasonable proportion of consumers (smallholder farmers in Kenya, aggregate traders in Uganda) accept the service fee. While USAID and BMGF have supported the development of the technology, there is no plan to support the scale out of the technology, and this will require additional support to solidify commercial viability and ensure the development benefits of the dryer are sustained.

To scale out the EasyDry M500, AflaSTOP suggests a follow-on, donor-funded program, preferably in Kenya and Uganda, and potentially in Rwanda. The program would have three main activities:

1. ***Demonstrate and sell drying services*** to smallholder farmers generating demand for dryers among farmer groups and SMES
2. ***Train and performance-test certified EasyDry M500 fabricators*** in demonstration areas to ensure well performing machines from the beginning
3. ***Buy down the risk of early adopters*** buy offering discounts on the dryer cost and potentially utilize pull mechanisms to offer prizes to businesses/farmer groups. In Uganda, a program would offer a phased approach to buying down risk. In phase

[1] *EasyDry M500 Portable Maize Dryer Adaption for Drying Groundnuts*. AflaSTOP 2016.

one, the project would potentially offer a rent-to-own model to farmer groups and trader aggregators to try out the dryers at relevant locations. In the second phase, the project would move to pull mechanisms based on the volumes dried.

Thus, as elaborated, scaling out and fully commercializing the EasyDry M500 will require demonstrations, capacity building of informal fabricators, and potentially buying down some of the initial risk so that entrepreneurs invest more quickly. 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 quickly and to a moisture content that allows for better and longer storage, reducing post-harvest loss and increasing the opportunity for smallholder farmers to make a profit.

Full details of AflaSTOP's findings can be found in the series of country-specific reports on the *Feasibility of Up-scaling the EasyDry M500,* available for Kenya, Uganda, Tanzania, and Rwanda and posted to www.acdivoca.org/aflastop-publications.

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

VIII. Annex

Table 1: Estimated fabrication cost of either the informal sector or the semi-formal sector

EasyDry M500 Estimated Fabrication Costs by Country					
	Kenya	**Tanzania**	**Uganda**	**Rwanda (semi formal)**	**Imported from Kenya to Rwanda**
Materials	$511	$630	$688	$1,027	$796
Labor	$140	$251	$195	$341	
Transport	$15	$15	$17	$15	$200
VAT, withholding & fees					$183.08
Profit*	$130	$176	$177	$274	
Total cost	**$796**	**$1072^**	**$1,077**	**$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.

Table 2 Cost of drying services by country; Kenya & Tanzania service provider model, Uganda aggregate trader model and Rwanda cooperative model

Country and machine cost	**Kenya**	$850	**Uganda**	$1070	**Tanzania**	$1070	**Rwanda**	$1180
Repayment period in years	2	4	2	4	2	4	2	4
Daily repayment of initial investment cost	10.63	5.31	13.88	6.69	13.88	6.69	14.74	7.38
Daily operating costs	18.41	18.41	14.96	14.96	18.84	18.84	15.2	15.2
Service cost per $ / mt	**19.36**	**15.82**	**19.22**	**14.43**	**21.81**	**17.02**	**19.96**	**15.05**