WORLD BANK GROUP

INNOVATIONS IN FOOD TRADE

RETHINKING AFLATOXIN MANAGEMENT IN EAST AFRICA

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SYNOPSIS

The high prevalence of aflatoxins in maize and other staple foods in the EAC is an important obstacle to domestic and regional food trade. Current regulatory approaches rely on expensive testing and border controls that are easily circumvented. New technologies may have the potential to transform these conditions and send market signals upstream to framers and primary offtakers where improvements to reduce aflatoxin risks are needed most. Deployed along the chain of custody these technologies could be used to make better-informed buying decisions and potentially for regulatory certification. Moving beyond the current paper, a detailed project proposal could be developed by EAC governments and private sector to test these systems in real trade situations. If successful, such an approach could have far reaching implications for donor engagement on trade capacity building and sanitary and phytosanitary management.

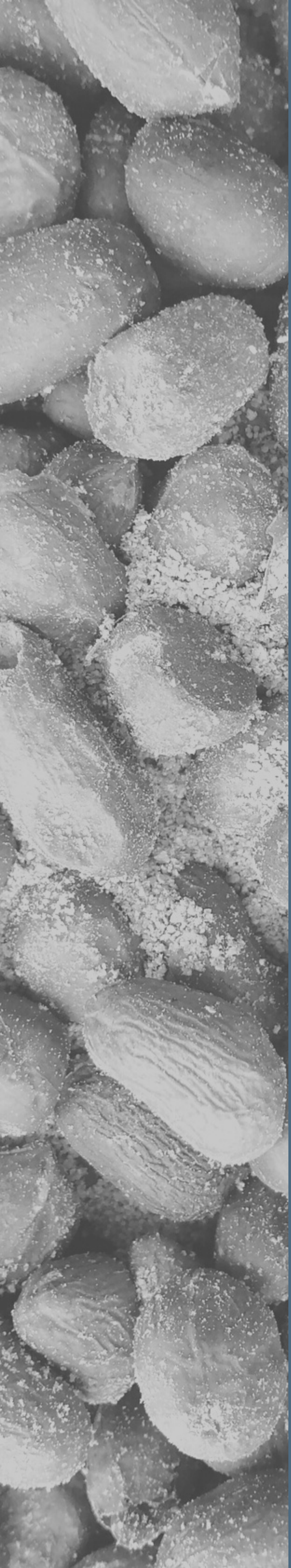

Image: *Groundnuts affected by aflatoxins*

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Executive summary

i. **The high prevalence of aflatoxins in maize and other staple foods in the EAC has become an important obstacle to domestic and regional food trade.** While EAC Member States have made good progress in promulgating regionally harmonized standards that include mandatory upper limits on aflatoxins, the high cost and complexity of meeting these standards has led to a large share of food being traded outside the regulatory framework thereby distancing poor producers from the market and undermining the prospects for regional value chain development. Especially as EAC countries look to recover from COVID-19 and build resilient food systems for the future, minimizing the cost of market transactions is more important than ever.

ii. **The need for aflatoxin management begins at the farm level where fundamental challenges with smallholder agriculture make crops highly susceptible to contamination.**[1] Bimodal rainfall across much of the EAC make sun drying and storage difficult and poor post-harvest practices such as hand shelling of grain and drying of crops directly on the ground compound the problem. Simple improvements in these areas are possible but add to cost so can be difficult for poor farmers and traders to justify without adequate incentives. As awareness of aflatoxins grows in the EAC, many farmers are adopting improved practices on crops saved for family consumption but not for market sale.

iii. **Current regulatory approaches to managing aflatoxins in the EAC rely on expensive testing and border controls that are easily circumvented.** In Uganda, SPS procedures now require exporters to submit a certificate of aflatoxin analysis from one of three nationally recognized laboratories for every consignment. Throughout the EAC, tests happen far away from the main production areas and only large firms have the wherewithal to comply. Similarly, at the consumer end of domestic and regional value chains, only large industrial mills perform regular tests and are subject to routine inspection. Meanwhile, small traders and SMEs can navigate around the regulatory system since borders are porous and small mills are rarely inspected. This situation not only leaves the EAC with little to no effective control over aflatoxins but precludes the payment of premiums to small farmers and offtakers that are needed to reward improvements at upstream stages of the value chain where aflatoxin problems begin.

iv. **New technologies may have the potential to transform these conditions and significantly reduce aflatoxin risks in domestic and regional trade.** Lateral flow test strips can be used to measure aflatoxins without a laboratory setting and are known to produce very accurate results. Test strips have been around for many years but can now be machine-read using a smartphone or other mobile device with ICT connectivity thereby greatly improving precision and accessibility. Traditional laboratory tests easily cost US$50-70 or more excluding the time and cost of transporting samples. By comparison, material costs with mobile-readable test strips are on the order of US$5-6 per test. Moreover, aflatoxins naturally fluoresce and all that is needed for a rough first assessment of contamination is to put a sample of grain

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[1] Aflatoxin is a toxic metabolite of certain molds in the genus *Aspergillus.* Aflatoxins are a global problem and affect a wide variety of crops including maize and others that are grown and traded in East Africa. Long-term exposure to aflatoxins is widely associated with cancer, nutritional interference, and immunological suppression. While rare, very high exposure to aflatoxin can be life-threatening. Aflatoxin are highly resistant to processing. In animal feed aflatoxins have a significant effect on livestock productivity and contamination can be transferred up the food chain to humans particularly through milk.

in a box with a UV bulb and look for blue or green spots. UV boxes do not provide an accurate reading but can provide an immediate first indication of the presence of aflatoxins even in remote rural areas.

v. **Deployed along the chain of custody, these technologies could help large and small traders make better-informed buying decisions and potentially be used for regulatory certification as part of a systems approach.** With only modest investment and training, for example, village offtakers could use UV boxes to make better-informed buying decisions that are immediately communicated to farmers. Rural aggregators and warehouse managers could, in turn, use UV boxes, test strips, and other analytical kits for more accurate analysis. From there, it is not difficult to imagine such traders developing improved relations with large exporters and millers that require low-aflatoxin maize and already perform routine tests at final stages of the chain. Some end-buyers do pay premiums, but even without premiums upstream use of these technologies could minimize the risk of rejection and help save on transport and logistics costs. With ICT connectivity, data could even be shared with agriculture officers and health officials to map the prevalence of aflatoxins and help plan community outreach and extension programs.

vi. **From a regulatory perspective, these systems could be a practical route to the use of national quality seals in regional trade of food staples as an indication of quality.** EAC countries have made substantial progress with the harmonization of regional standards and mutual recognition of national quality marks yet, so far, these seals are used mostly for manufactured items and not with unprocessed grains or other bulk staples. A proven model for the use of quality seals in cereal trade comes from the U.S. state of Texas where private silo operators and mills can be accredited to issue official certificates for commercial and regulatory purposes using approved test kits. The EAC could develop similar guidelines for accreditation of authorized users of approved kits including mobile-readable test strips as an acceptable basis for regional trade.

vii. **Under such an arrangement, the exporter/producer/grain handler's accredited management system would serve as regulatory analysis for the purpose of trade using a seal or tag that is affixed to the load or grain bag.** Combined with record keeping and buying from sellers known to use good aflatoxin management, it is likely such a system would be far more effective in reducing aflatoxin risks and incentivizing farm-level upgrades compared with current regulatory systems. Standards bureaus and other regulatory officials would have an important role in performing unannounced spot checks to review the records, test the proficiency of accredited individuals, and perform tests to verify compliance with the standard. Like other certified goods, use of national quality seals on unprocessed commodities would provide an opportunity for small traders and SMEs to handle bags that bear the seal or tag even if they themselves do not perform any tests. Such a system could therefore be an important step towards bringing cross-border traders into compliance with regulatory requirements helping to create new jobs and opportunities for regional value chain development.

viii. **A project proposal to trial these concepts could be developed.** Unanswered questions remain as to whether the benefits of such a system outweigh the costs, whether it results in safer food trade, and whether small farmers and traders would see enough benefit to drive participation. Moving beyond the current paper, a detailed project proposal could be developed by EAC governments and the private sector to test the use of performance-based management systems in real trade situations. Traditionally, the focus on institutional reform and trade capacity building is on improving hard infrastructure and training. However, in the current case we are proposing to use new technologies to revise the overall approach to regulatory management. Long-term this could provide a useful framework for government and donor engagement on SPS matters in the EAC and far beyond.

List of abbreviations

AC	Aflatoxin-compliant
APTECA	Aflatoxin proficiency testing control in Africa
AT	Aflasafe-treated
EAC	East African Community
EAGC	East African Grain Council
ELISA	Enzyme-linked immunosorbent assay
FSNWG	Food Security and Nutrition Working Group
HACCP	Hazard analysis and critical control point
HPLC	High performance liquid chromatography
IITA	International Institute of Tropical Agriculture
ML	Maximum limit
NPPO	National Plant Protection Office
OTSC	Office of the Texas State Chemist
PC	Phytosanitary certificate
ppb	Parts per billion
ppm	Parts per million
PVoC	Pre-export verification of conformity
SME	Small and medium enterprise
SPS	Sanitary and Phytosanitary
STDF	Standards and Trade Development Facility
SQMT	Standardization, Quietly Assurance, Metrology, and Testing
UBOS	Uganda Bureau of Statistics
UGAL	Uganda Government Analytical Laboratory
UGC	Uganda Grain Council
UNBS	Uganda National Bureau of Standards
USDA	United States Department of Agriculture
UV	Ultraviolet
WFP	World Food Programme
WHO	World Health Organization
WITS	World Integrated Trade Solutions (online trade data)
WTO	World Trade Organization

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Innovations in Food Trade: Rethinking Aflatoxin Management in East Africa

1. Introduction

1. **The East African Community (EAC), comprised of Burundi, Kenya, Rwanda, South Sudan, Tanzania, and Uganda attaches great importance to regional trade.** The EAC transformed from a customs union in the mid-2000s into a common market in April 2010. While each country's trade has traditionally been geared towards import and exports outside the region, intra-regional trade has grown significantly over the past several years. Especially as EAC countries look to recover from COVID-19 and to build trade and food security systems that are resilient to future shocks, minimizing the cost of market transactions and otherwise improving the efficiency of regional food trade is more important than ever.

2. **Agriculture accounts for a large share of intraregional trade in the EAC and has important direct links to poor producers and poor consumers.** Kenya is structurally deficit in its staple food, maize. It routinely imports several hundred thousand tons of maize annually much of which is grown by small farmers in neighboring Tanzania and Uganda. According to customs data reported by WITS, from 2014 to 2019, Kenya imported an average of US$192.3 million of maize annually including US$17.5 million (9.1 percent) from EAC neighbors. At world prices, this would be around 920,000 tons of global imports annually and 85,000 tons of imports from the EAC.[2]

3. **Formal trade data, however, are widely known to understate the true extent of intra-regional trade since large volumes of maize and other staple foods move across African borders outside the regulatory system.** According to the Food Security and Nutrition Working Group (FSNWG, 2019) which monitors small-scale cross border trade at 15 EAC border sites, Uganda exported almost 98,000 tons of maize to Kenya in 2019 and 115,000 tons to South Sudan through informal channels while Tanzania exported 114,000 tons of maize to Kenya and 20,0000 tons to Rwanda through these routes. Similarly, the Uganda Bureau of Statistics (UBOS) has been monitoring small-scale cross border trade at bus stations and 19 land and lake borders since 2005 and reports that 39 percent of Uganda's total exports of maize, groundnuts, and sorghum is by small-scale traders who do not use formal regulatory channels (UBOS, 2019).

4. **One reason for the high degree of informality in intra-regional food trade relates to the challenges with food safety aspects of sanitary and phytosanitary (SPS) management.** EAC Member States have made good progress in promulgating regionally harmonized standards for agriculture and food products that include mandatory upper limits of 10 parts per billion (ppb) for total aflatoxins and 5 ppb for aflatoxin B_1 in cereal grains and flours (EAC 2013, 2017, 2017a).[3] While these levels address the human health risks of long term chronic exposure, the standards give rise to technical challenges and high

[2] Based on the average "pink sheet" price from 2014-2019.

[3] The EAC standard for groundnuts (EAC, 2000) specifies an upper limit of 10ppb total aflatoxin only.

costs that are difficult to meet particularly by small scale farmers and traders who account for a large share of intra-regional food trade. Even large firms face difficulties in demonstrating compliance with the regional standards which lead to substantial extra costs that undermine competitiveness and take away from total profits available to flow up the chain to farmers and primary offtakers where SPS problems typically begin.

5. **Managing the high prevalence of aflatoxins in EAC food supply is a good example of these SPS challenges.** Aflatoxins affect crops all over the world and are a serious food hazard (see Box 1). Developed countries largely manage to protect consumers from exposure to aflatoxins through systematic, standardized testing at critical control points and by use of modern good farming practices, processing and storage techniques. Such capacities, however, are mostly absent in the developing world and it is estimated that some 4.5 billion people in developing countries worldwide are chronically exposed to uncontrolled amounts of the aflatoxin in their diet (Williams and others, 2004; Strosnider and others, 2006). Aflatoxins are a particularly common in East Arica where bimodal rainfall and prevailing farm and market conditions provide an ideal environment for toxigenic mold spores to thrive (IITA, 2015; Hoffmann, Mosier, and Herrman, 2018).

6. **New technologies may have the potential to transform EAC trade procedures and significantly reduce aflatoxin risks in domestic and regional food supply.** Lateral flow test strips can be used to measure aflatoxins without a laboratory setting are known to produce very accurate results. Test strips have been around for many years but can now be machine-read using a smartphone or other mobile device with ICT connectivity thereby greatly improving precision and opening new potential for data to be transmitted to regulators and private participants in the supply chain. Moreover, aflatoxins naturally fluoresce and all that is needed for a rough first assessment is to put a sample of grain in a box with an ultraviolet (UV) bulb and look for blue or green spots. UV boxes do not provide an accurate reading but can provide an immediate first indication of the presence of aflatoxins even in remote rural areas.

7. **Deployed along the chain of custody, such technologies could help large and small traders make better-informed buying decisions and potentially be used for regulatory certification as part of a systems approach.** A proven model for the use of quality seals in commercial trade comes from the U.S. state of Texas where private silo operators and mills can be accredited to issue official certificates for commercial and regulatory purposes using approved test kits. The EAC could develop similar guidelines for accreditation of authorized users of approved kits including mobile-readable test strips as an acceptable basis for regional trade. By making regulatory controls more affordable and easier to access, such a system could potentially make a significant contribution to East Africa regional integration and regional value chain development. It could also be an important step towards bringing small-scale cross border traders into compliance with the regulatory system thereby helping to create new jobs and opportunities for small and medium size enterprise (SME) development.

Box 1: Aflatoxins are a serious health and economic risk

Aflatoxin is the toxic metabolite of certain molds in the genus *Aspergillus* and is a global problem that affects a wide variety of crops. Pre-harvest contamination with aflatoxins is mainly limited to maize, cottonseed, groundnuts, and tree nuts. Post-harvest contamination can be found in a variety of other crops such as coffee, rice, and spices (WHO, 2018). Sorghum, wheat, soybeans, and sunflower are also frequently affected by *Aspergillus* spp. (WHO, 2018a). Visible mold may be an indication that aflatoxin is present, but very high levels are possible without any noticeable effect on taste, smell, or appearance (Hoffmann, Mosier, and Herrman, 2018). Aflatoxins are highly resistant to processing (Kumar and others, 2017).

Fungal growth depends on conditions during farm production and post-harvest handling and storage. During cultivation, drought, planting in infected soils, and pest infestations can lead to fungal infection of maize and groundnuts. After harvest, inadequate drying, length of storage, and poor storage conditions contribute to aflatoxin growth (Gnonlonfin and others, 2013; Hoffmann, Mosier, and Herrman, 2018). Aflatoxin can be highly localized to the point of affecting individual grains and easily multiply during storage if the crop is moist. Even sufficiently dried foods can develop pockets of contamination during storage in the presence of insects, which can increase moisture through respiration (Williams and others, 2004).

Climate change may also affect the occurrence and prevalence of aflatoxins. Increases in rainfall, changes in temperature and prolonged droughts favor increased incidence of aflatoxin. Collier and others (2008) have indicated that in eastern Africa, including the Horn of Africa, and parts of central Africa average rainfall is likely to increase by 15 per cent or more. Furthermore, in some parts of Africa drought conditions and increased desertification is likely. This will drive reduced yields and encourage greater dependence on staples which, if these have circumvented regulatory controls, are likely to present even greater risks.

Very high doses of aflatoxins can lead to acute poisoning known as aflatoxicosis which is a life-threatening condition. While rare, one of the largest and most severe outbreaks of aflatoxicosis ever recorded occurred in Kenya in 2004. The outbreak covered more than seven districts in Eastern and Central Provinces and resulted in 317 case-patients and 125 deaths. The maize implicated in the outbreak was harvested in February during off-season early rains. It is believed the maize entered the distribution system while containing high moisture and aflatoxins that continued to grow because of poor handling and storage. Aflatoxicosis is believed to occur at concentrations above 1,000 parts per billion (ppb) and, during the outbreak in Kenya, concentrations in maize were measured at up to 4,400 ppb (Kilonzo and others, 2014).

While deadly in high concentrations, chronic exposure to sub-lethal doses is far more common and a much greater threat to public health than acute aflatoxicosis. Long-term exposure to aflatoxins is widely associated with cancer, nutritional interference, and immunological suppression. Aflatoxin is best known as cause of liver cancer but has also been linked to lung cancer in people handling affected grain. Moreover, because aflatoxins affect protein synthesis, they are known to cause and exacerbate stunting in children and to compromises the immune system especially in the young and elderly (Williams and others, 2004).

The presence of aflatoxins in animal feed also has important economic costs and can lead to health risks for humans. While the susceptibility of individual animals to death from aflatoxins varies widely depending on species, age, sex, and nutrition, chronic exposure to aflatoxin in feed, silage, and hay can impact on growth rates and reproduction. Poultry are especially vulnerable with significant impact on egg production and feed conversion if there is high aflatoxin in the diet. From a human health perspective, aflatoxins can be transmitted through milk. Dairy cows and other milk producing animals do absorb some aflatoxin in their own bodies, so transmission is not direct. Nevertheless, aflatoxin B_1 in feed is metabolized as aflatoxin M_1 in milk and is very resistant to both pasteurization and freezing (Alvarado, Zamora-Sanabria, and Granados-Chinchilla, 2017).

8. **During this project, we have sought to evaluate the potential of digital technologies to address critical impediments associated with current regulatory processes in mitigating the risk of aflatoxin contamination in trade.** We also sought to analyze the issues associated with formal and informal trade

and how a simplified regulatory regime may improve value chain performance and lead to improved compliance. To achieve these objectives, we completed a desk review of relevant technologies and met with regulatory officials, regional trade associations, farmer representatives, private firms, and academics in Kenya and Uganda who are involved in regional trade and otherwise working on aflatoxin management.

9. **A project proposal to trial the concepts explored in this paper could be developed.** While the concept is promising, unanswered questions remain as to whether the benefits of a systems-based approach to aflatoxin management outweigh the costs, whether it would result in safer food trade than current systems, and whether small farmers and traders would see enough benefit to drive participation. Traditionally the focus on institutional reform and trade capacity building has been on improving hard infrastructure and training. In the current case, however, we are proposing to use new technologies to revise the overall approach to regulatory management. Long-term this could provide a transformative framework for public-private partnerships and donor engagement on SPS matters in the EAC and far beyond.

10. **This paper is organized in seven sections.** Following the current introduction, Section 2 looks at existing trade conditions in the EAC and describes the need for systemic change to deliver incentives that farmers and primary offtakers require for real improvement in aflatoxin levels. Section 3 then describes the value proposition of new technologies and how these could be used as part of a systems approach for certification of trade procedures. Section 4 looks at the different ways of testing for aflatoxins using laboratory and field-based systems, and Section 5 describes how the different methods could be used in a chain of custody approach to regulatory management. Section 6 outlines a set of important questions that need to be put to practical trial before deciding if the concepts described in this paper are right for the EAC. The discussion concludes in Section 7 with a summary of the main points and recommended next steps.

2. Current trade conditions in the EAC

11. **Dialogue on maximum limits for aflatoxins in the EAC dates to at least the early 2000s with calls for countries to set harmonized regional standards (RATES 2003).** Presently, EAC partner states use a maximum limit (ML) of 10 ppb for total aflatoxins and 5 ppb for aflatoxin B1 in most cereals, cereal flours, and oilseeds including maize, maize flour, groundnuts, and sorghum with further specifications for maximum limits of aflatoxin B1 and fumonisin which is another type of mycotoxin (EAC 2000, 2013, 2017, 2017a). An ML of 0.05 ppb is set for aflatoxin M1 in milk. The development of common standards in the EAC stems from the Standardization, Quality Assurance, Metrology, and Testing Act (SQMT) Act of 2006.[4]

[4] By comparison, the United States (U.S.) sets the safe upper limit for aflatoxin in cereals for human consumption at 20ppb. CODEX Alimentarius sets a maximum of 15 ppb for total aflatoxins for a number of nuts but has only identified a proposal for cereal grains (Codex, 1995). Where maize is consumed as the primary staple, however, more demanding limits on aflatoxins can be justified to protect from chronic exposure as is the case in East Africa. In Kenya, maize provides nearly one-third of total calories with per capita annual consumption between 98 and 103 kg (World Bank, 2015; CIMMYT 2015). In Tanzania, per capita consumption of maize is around 33 kg per year and in Uganda it is 31 kilos. In the U.S. per capita consumption of corn products is only around 16 kg per year (Conway, 2019).

12. **While EAC countries have done well in agreeing on harmonized regional standards for staple foods, putting these standards to practical use has been a significant challenge.** A myriad of government agencies with overlapping responsibilities for product certification and inspection creates confusion and unnecessary cost that are a particular burden to small traders. In Kenya, for example, the Ministry of Health, Kenya Bureau of Standards, the Agriculture Food Authority of the Ministry of Agriculture, and county-level public health agencies all have varying and sometimes conflicting roles in managing aflatoxins in production, storage, grading, transport, and other stages of the value chain. Similar conditions exist in other EAC countries and has led to problems throughout the region with requirements for product sampling and testing that are difficult and costly even for large traders to meet. National quality seals have been used to speed the trade of manufactured goods but are not presently used on unprocessed bulk staples.

13. **Taken together, the reliance of EAC regulators on document checks at borders for food staples and sampling of milled flours and other manufactured foods has done little to facilitate safe trade or promote regional integration.** Not only are current rules easy to circumvent, resulting in a large number of informal transactions, but the very nature of aflatoxin as a SPS risk demands incentives for improvement at upstream stages of the value chain that current regulatory approaches cannot provide. Rather than focus only product certification, the introduction of systems for certification of trade procedures could be one way to deliver these incentives and build a more inclusive framework for regional market integration.

2.1 Real improvement requires upstream incentives

14. **The steps to minimize aflatoxin contamination are not technically demanding but do require improvements in on-farm management and early postharvest handling so necessitate market signals that reach to farmers and primary offtakers.** Research in Tanzania by Seetha and others (2017), for example, shows that training of small famers in simple on-farm mitigation methods can have a significant long-term impact on aflatoxin levels measured at the household level. However, when it comes to marketed foods, Hoffmann and Jones (2018) found that Kenyan farmers who produce for cash sale are less willing to pay for simple improvements such as use of mechanical dryers or even plastic sheeting so that crops can be dried safely on the ground than are households that produce crops for their own consumption. When the same households had the opportunity to sell a limited amount of aflatoxin-safe maize for a premium a few months after harvest, however, the authors found that uptake of improved technologies greatly increased.[5]

15. **Thus, while aflatoxins are often looked at only as a postharvest issue, they begin as a preharvest problem.** Aflatoxins occur naturally in soils and original contamination takes place when crops are still in the field. The fungi continue to produce aflatoxin spores that can spread during postharvest handling and storage but preharvest management is critical for preventing contamination and reducing the risk of cross-contamination later on (IITA, 2017). Basic improvements in crop husbandry such as adequate plant

[5] Farmers had the opportunity to sell up to 45 kg of maize at the prevailing market price plus KES 15 per kg (a price premium of approximately 50 percent) if the maize tested below the regulatory standard for aflatoxin. Tests were performed off-site using laboratory equipment.

spacing, good weed control, and crop rotation that minimize plant stress reduce vulnerability to aflatoxin and can lead to higher yields so have direct benefit to farmers beyond aflatoxin safety. Other measures such as use of mechanical shellers and dryers or even plastic sheeting to avoid contact with toxigenic spores on the ground, however, require additional expenditures so can be difficult for any farmer, let alone a poor farmer, to justify or afford on marketed crops without a clear financial incentive.

16. **A good example of these challenges relates to the product known as Aflasafe**. Originally developed by the United States Department of Agriculture (USDA) and adapted to Africa by the International Institute for Tropical Agriculture (IITA), Aflasafe is the registered trademark name of a biological control agent farmers apply to their crops two to three weeks before flowering (i.e. tasseling in maize).[6] In field trials, Aflasafe has been shown to reduce aflatoxin contamination by 80 percent or more under a range of growing conditions (Bandyopadhyay and others 2016; Senghor and others 2020). In Kenya, Aflasafe is manufactured at a government-owned facility and sells for KES 200 per kg (US$2.00). At the required application rate, this works out to US$20 per hectare or about US$10-15 per ton of maize based on average yields reported by FAOSTAT over the past several years. Even with a doubling of yield, the cost of Aflasafe works out to US$5-7 per ton harvested so is not a trivial matter particularly given that the product must be applied before flowering and has no value if the crop fails.

2.2 Current regulatory controls focus on product certification

17. **A specific challenge in relying on product certification to manage aflatoxin risks is that safety from aflatoxin is largely invisible.** Even very high levels of contamination are possible in raw materials and finished products without any noticeable effect on appearance, smell, or taste (Hoffmann, Mosier, and Herrman, 2018). In a part of the world where most farmers sell just one or two bags of surplus food per season, conformity assessment of everyone's product using traditional laboratory methods is never going to be feasible or economically viable. With the current regulatory approach, supply chains must price the risk of product rejection into the transaction and is little reason or scope to pay premiums at upstream stages of the chain that are needed for real improvement.

18. **With the current emphasis on standards enforcement, some large regional traders and commercial mills do increasingly perform laboratory analysis in their own facilities for quality control purposes.** Grain traders including large silos use these tests to manage their stocks and ensure their holdings meet cross border trade requirements and, eventually, buyer demands. Even further along the chain, flour mills and other food processors that test do so largely because they are required to participate in mandatory national quality seal programs operated by standards bureaus. These programs involve regular analysis of factory samples and samples drawn from shops during market surveillance. With heavy sanction for non-compliant products, use of these seals give participating mills and the traders who supply these factories good reason to conform to the regional aflatoxin limits.

[6] The product consists of spores of non-toxigenic strains of the same fungal species that produces aflatoxin but are known to out-compete the toxigenic strains. Versions of Aflasafe have since been developed and released for use in seven African countries including Kenya and Tanzania. Work to identify and test non-toxigenic strains for Uganda was completed some years ago and approval is now in the legislative process.

19. **Even though there are incentives for conformity with aflatoxin standards at the end of some market chains, commodities that exceed the regional standards can be sold to buyers who do not test.** There have been some highly publicized cases of non-compliant maize originating outside the EAC being destroyed (EAC Aflatoxin and Control Project, 2017), but for the most part, when a consignment is rejected sellers within the EAC can take their supply to another buyer who is known not to test. In this way, some have observed that the present emphasis on product certification can lead to higher rates of aflatoxin contamination in lower-value market segments favored by the poor (Hoffmann and Moser, 2017; Hoffmann, Moser, and Herrman, 2018).[7]

20. **According to the East Africa Grain Council (EAGC), rules have been proposed to allow for the automatic seizure and destruction of any commodity that does not comply with the EAC standard.** While the Kenya Crop Production and Livestock Act (CAP 321) gives the Minister authority to declare the destruction of a crop without compensation (Kang'ethe, 2011), widespread implementation of such a heavy-handed measure would create substantial risks all along the value chain for producers and traders who have no way of testing for aflatoxin or otherwise demonstrating compliance with the standard before it is too late. Far from provide EAC farmers and traders the kind of positive market signals the region needs for genuine aflatoxin mitigation, this approach would likely provide a strong disincentive to sell to commercial buyers and drive an even greater price wedge between producers and consumers.

21. **Already, in fact, product certification in the EAC requires a large number of laboratory tests and other costs that small millers and traders cannot afford.** The use of quality seals on maize flour and manufactured foods is mandatory in the EAC, yet there are many small firms that do not participate in these programs because of high costs. In Uganda, for example, use of the national quality seal requires firms to pay for quarterly analysis of all parameters set out in the standard using high-performance liquid chromatography (HPLC) and other advanced methods at a cost of UGX 220,000 (US$58) per test parameter. With multiple test parameters, the total cost of routine analysis for a single type of flour works out to more than US$1,600 per year. On top of the of lab work, large firms pay US$220 per product per year to cover inspections and SMEs pay U$95. Because SMEs are required to pay the same for lab work, the Uganda National Bureau of Standards (UNBS) has called on government to subsidize the cost of HPLC analysis for small firms. While subsidies may help draw in more firms in the short run, discounts on product certification are unlikely to drive compliant behavior especially when other systemic challenges remain. Further, there are many quicker and cheaper test methods than full HPLC analysis that can equally demonstrate compliance with aflatoxin standards without necessarily having to turn to subsidies.

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[7] Hoffman, Moser, and Herrman (2018) observe that: "Maize in Kenya can be categorized into three groups: subsistence maize for home consumption, informal market maize, and formal market (branded) maize flour. The informal market can be defined as the market for loose, whole grain maize sold in open-air markets and small shops throughout the country. Consumers take this maize to small, local hammer mills to be ground into flour. Increasingly, informal maize millers are also procuring maize grains themselves and selling flour to consumers. The market appears to be highly segmented; based on the nationally representative Household Consumption and Expenditure Survey (HCES) survey conducted in 2006, Fiedler et al. (2014) find that only 4 percent of consumers who purchased branded flour in a given week also purchased grains from the informal market; conversely, only 10 percent who purchased maize on the informal market also purchased branded flour."

22. **Further challenges with product certification arise when raw commodities are shipped across regional borders.** There have long-been strict requirements for pre-export verification of conformity (PVoC) assessment of commodities originating from outside the EAC.[8] Through mutual recognition of each other's national quality marks, EAC countries have largely avoided pre-shipment inspection of manufactured goods yet, presently, quality seals are not used for raw commodities that are directly important to small producers and small traders. In principle, this means that pre-shipment conformity assessment is required whenever maize grain or similar commodity is traded across an EAC border. In practice, enforcement of these rules has been spotty with quality assessments mostly treated as part of phytosanitary certification. Large and small exporters have been able to obtain phytosanitary certificates (PCs) at the border supposedly on the basis of physical inspection including inspection for aflatoxins even though border agencies in the EAC do not have aflatoxin testing equipment except at large international seaports. Moreover, the purpose of phytosanitary certification is to confirm conformity with plant health and disease requirements prescribed by the importing country not to provide assurances on food safety. In international trade, food safety assurances are generally provided on separate food safety certificates.

23. **Now with the introduction of automated systems, these lax procedures appear set for change.** As EAC countries roll out electronic National Single Windows for customs clearances, demonstration of compliance with food safety requirements is set to become an automated border procedure that demands enforcement. New guidelines issued in September 2019 by the Uganda National Plant Protection Office (NPPO), for example, state that wherever compliance with the EAC standard is listed as a declaration condition, a full certificate of analysis from an officially recognized laboratory shall be required to upload the PC in the Single Window. The Uganda NPPO currently recognizes just three laboratories for this purpose including the Uganda National Bureau of Standards (UNBS), the Uganda Government Analytical Laboratory (UGAL), and Chemiphar a private lab.[9] Thus while the cost of the PC itself may be modest in Uganda, the cost of laboratory analysis can be significant. As described above, UNBS currently charges UGX 220,000 (US$58) per test parameter and, with multiple parameters, the total cost of standards certification can work out to well over US$120 per certificate excluding the cost of transport and sampling.

24. **Given that many small traders only carry a few tons at a time, the high cost and complexity of these procedures provide strong reason to avoid regulatory procedures.** Small cross-border traders are not subject to the same regulatory controls as large traders and can easily walk consignments across regional borders using a bicycle or handcart. To avoid the cost and complexity of regulatory compliance, many medium and even some large traders are known to divide truckloads at the border into small loads that are walked across by porters to be reassembled on the other side. Finding ways to simplify the

[8] To prove compliance with the regional standards, imports from non-EAC countries must be accompanied by a PVoC certificate from an internationally accredited testing facility. Even with the PVoC, imports arriving by sea are retested by the national standards bureau using HPLC equipment in Mombasa or Dar es Salaam. Imports from other African countries that arrive by land must also be accompanied by a PVoC certificate and are subject to re-inspection at the first port of entry to the EAC.

[9] UNBS and UGAL are not internationally accredited for aflatoxin analysis; Chemiphar is.

procedures for quality control and SPS compliance could therefore make a significant contribution to both the efficiency and safety of regional food trade.

2.3 There are other good reasons to look for reform opportunities

25. **Taken together, there is good reason to say that the EAC's current approach to enforcement of aflatoxin standards is ill-equipped to deal with important trade challenges.** All EAC countries are afflicted by aflatoxin and, from a food safety point of view, national border lines are not a useful critical control point and the resources used for border checks and pre-shipment inspection could be better focused at other points in the supply chain. This is especially true considering that consignment specific testing is part of what drives large volumes of staple food to pass through informal channels where there are no regulatory controls at all.

26. **In terms of price premiums, only a few specialist buyers in the EAC currently pay extra for low-aflatoxin maize.** The World Food Programme (WFP) is one of the largest grain buyers in East Africa and was said to pay US$220 to US$230 per ton for aflatoxin free maize for school feeding and refugee relief programs at a time when other buyers were paying US$160 to US$190 per ton. Similarly, Africa Improved Foods (AIF) in Rwanda manufactures high nutrition foods targeted at pregnant and breastfeeding mothers, infants, and young children and was said to pay US$20-40 more per ton for zero aflatoxin maize compared with other commercial buyers.[10] Compared with specialist buyers like WFP and AIF, however, all other commercial buyers met for this study claimed to pay the "standard market price" without any specific premium for aflatoxin compliance.

27. **Even when premiums are available from end-buyers, the risk of rejection imposes a high cost on upstream suppliers.** While most rejected grain can still be sold to others unless visibly rotten, looking for new buyers involves additional time and logistics costs that can be especially high in long-distance trade between countries. Without an effective way of testing for aflatoxins when purchases are made, attempting to target formal sector buyers that adhere to the standard effectively becomes a game of chance. Moisture meters, for instance, are widely used in the EAC including at rural buying platforms but only test for one of many conditions that can give rise to aflatoxins, not for the presence of toxigenic spores themselves. Traders at all levels therefore must factor in the risk of rejection and have little scope or incentive to pay premiums that are needed to reward good on farm management or improved storage that are ultimately needed to solve the EAC's aflatoxin problem.

3. The value proposition of new SPS technologies

28. **Use of rapid test technologies could be a practical way to transform regional food trade and potentially send market signals to upstream stages of the chain where aflatoxin problems begin.** Lateral flow test strips are capable of producing a very accurate measure of aflatoxin contamination in about 10-15 minutes and can now be machine-read using a smartphone app or other mobile device.[11] Good results

[10] AIF is a joint venture of the Government of Rwanda and a consortium of Royal DSM, the Netherland Development Finance Corporation (FMO), DFID Impact Acceleration Facility managed by CDC Group, and the International Finance Corporation (IFC).

[11] See, for example: https://mobileassay.com/ and https://www.neogen.com/solutions/mycotoxins/raptor-solo/

still require careful sampling yet test strips do not need sterile laboratory conditions so can be used in almost any location. Material costs with these systems are around US$5-6 per test so much less than a traditional laboratory analysis currently used for trade certification and end-product conformity assessment. At this price point, test strips could possibly be used for routine sampling of deliveries from farmer groups and for quality management at warehouses at other relevant critical control points that current systems cannot easily touch. With internet connectivity, mobile systems also have the potential to record and transmit test data to commercial parties and regulatory authorities and, at scale, could lend themselves to blockchain or other real-time data transfer technologies.

29. **Other even simpler technologies for aflatoxin management are available.** Aflatoxins naturally fluoresce and all that is needed for a rough assessment of contamination is to put a sample of grain in a box with a UV bulb and look for blue or green spots.[12] While these devices are not capable of accurately determining the level of contamination and generally will not indicate contamination at very low levels which may still not meet regulatory requirements, this method does provide an immediate first indication of the presence of aflatoxins so can be used to make better-informed buying decisions that send immediate market signals to farmers. A large silo in Nakuru is already using UV boxes during receipt of grain before spending time and money on more detailed analysis. Compared with moisture meters that only check for one condition gives rise to aflatoxins and cannot tell whether a crop was dried on the ground where exposure to aflatoxin can easily occur, UV analysis is likely to provide a much better initial screening of actual aflatoxin contamination.

30. **In principle, systematic use of these technologies along the chain of custody to certify trade procedures could be an effective route to use of national quality seals in domestic and regional food trade.** Combined with buying from growers who are known to use good agricultural practices, it is not difficult to imagine a situation where village offtakers and warehouse managers use UV boxes and lateral flow test strips to make better-informed buying decisions and to manage their grain stocks. It is also not difficult to imagine these aggregators developing trading relations with large exporters and millers that demand low-aflatoxin maize. Under this kind of systems approach, the firm's own quality management system of buying from trusted suppliers and own test results at genuine critical control points could replace the need for consignment-specific laboratory analysis for trade certification. A proven model for this type of arrangement comes from the U.S. state of Texas where private silo operators and mills can be accredited to use any test kit from an approved list of kits and issue official test certificates for use in commerce.[13] The EAC could develop similar guidelines for accreditation of authorized users of approved test kits as a basis for regional trade.

31. **Under such an arrangement, the grain handler's accredited management system would serve as regulatory analysis for the purpose of trade using a seal or tag that is affixed to the load or grain bag.** Combined with record keeping and buying from sellers known to use good aflatoxin management, it is likely that such system could be more effective in reducing aflatoxin risks and incentivizing farm-level

[12] Aflatoxin B1 and B2 fluoresce blue; aflatoxin G1 and G2 fluoresce green.

[13] This is the One Sample Strategy for Mycotoxin Risk Management run by the Office of the Texas State Chemist. Further details are provide later in this note or see: https://otscweb.tamu.edu/risk/OneSample/SampleAbout.aspx.

upgrades compared with current regulatory approaches. Standards bureaus and other regulatory officials would still have an important role in performing unannounced spot checks to review the records, test the proficiency of accredited individuals, and perform tests to verify compliance with the standard. Use of national quality seals on unprocessed commodities would also provide an opportunity for small traders and SMEs to handle bags that bear the seal or tag even if they themselves are not accredited to perform aflatoxin tests. Such a system could be an important step towards bringing cross-border traders into compliance with regulatory requirements helping to create new jobs and opportunities for regional value chain development.

32. **National bureaus of standards could also use rapid tests strips as a way to make their services much more affordable and accessible.** Test strips could be used for quarterly product inspections, when performing unannounced spot checks, and in market surveillance work that would save considerable time and cost compared to current laboratory methods. Without having to fund subsidies, this would make participation in a quality assurance program much more affordable and attractive to SMEs. The delivery of immediate results to these users could go a long way in raising awareness of aflatoxin problems and importance of upgrading food systems.

4. Aflatoxin testing

33. **There are many ways to test for aflatoxins and is worth reviewing some of the main features of different test methods.** This will help understand the potential uses of different analytical methods in EAC regional trade and the strategic role each method may play in helping to send improved market signals and reduce aflatoxin risks in the food supply. Each method has advantages and disadvantages in terms of up-front and recurrent cost, skill requirements, time requirements, parameters covered, upper and lower limits of test reading, and accuracy among others. Some tests must be performed in a laboratory setting while others can be performed in the field and potentially even at a buying platform. All tests require good sampling to produce reliable results. Without good sampling, even the most advanced and expensive method is no better than a very simple, rough-and-ready system.

34. **Choosing the right test method for real trade situations therefore requires a balancing of priorities**. Laboratory testing can be the most accurate and versatile over a large range of upper and lower parameters but is typically expensive; the location of test facilities is often distant from producers and traders, and the test often requires long processing times. Shipping and transportation of samples and collection of hard copy documentation is time-consuming and not practical for producers or traders. By comparison, rapid test strips that produce binary results are much simpler and less expensive to use. With the advent of machine reading using a smartphone or other mobile device, rapid tests strips can now also be used to give very specific results measured to parts per billion for much less cost than traditional laboratory methods.

4.1 Laboratory methods

35. **Broadly, the two main methods of analyzing for aflatoxins are high performance liquid chromatography (HPLC), and enzyme-linked immunosorbent assay (ELISA).** HPLC is a technique in

analytical chemistry that is used to separate, quantify, and analyze each component in a mixture. It relies on pumps that are used to pass pressurized solvents containing the sample mixture through test columns filled with adsorbent material. The method can produce very accurate and detailed results over a wide spectrum of test parameters (specific compounds being identified). HPLC machinery costs upwards of US$350,000 and must be used by skilled technicians in a laboratory setting (see Figure 1). From start to finish, the lab work for an HPLC test can take from two to three hours. The Uganda National Bureau of Standards (UNBS) in Kampala charges UGX220,000 (US$58) per parameter tested by HPLC analysis. Although it is common practice to test only for total aflatoxin, the EAC standards specifies upper limits for total aflatoxin (10ppb) and aflatoxin B_1 (5ppb) meaning that full HPLC analysis of both parameters according to the regional specification costs UGX440,000 (US$116).[14] Private companies sometimes charge more for HPLC analysis. SGS in Nairobi, for example, reported charging US$69 per test parameter plus US$150/day excluding travel costs to draw a sample. The Kenya Bureau of Standards also has capacity for HPLC analysis.

Figure 1: Typical HPLC device and HPLC test columns

36. **ELISA is another method in analytical chemistry in which the test material is passed over adsorbent material that catch toxins.** There are different ways of performing an ELISA test including methods in which a laboratory technician first grinds and dilutes the sample using methanol and other reagents. The diluted sample is then cleaned by passing it through a series of columns treated with different antigens that bind with the toxins. Next, the prepared sample is transferred to an electronic reader that measures aflatoxins by their fluorescence (see Figure 2). These systems produce results over a narrower range of upper and lower limits than HPLC methods and new test columns must be used for each test and for each type of aflatoxin tested (i.e. separate columns are required to analyze total aflatoxin, and aflatoxin B_1). The main advantage of a laboratory-based ELISA system over HPLC is cost savings. Electronic readers for ELISA-based fluorometry analysis are available for around US$30,000 and kit materials cost from US$12-50 per sample analyzed. ELISA systems are also simpler to use than HPLC and, depending on the system, test results can be achieved in about 40-60 minutes including time required to prepare the sample. ELISA kits are marketed by different companies under brand names such as VICAM, CHARM, and Veratox among others.

[14] Alternatively, a test result for total aflatoxin at 5ppb or less would also confirm adherence to the standard. As noted, however, most people spoke of testing only for total aflatoxin at 10ppb implying the aflatoxin B_1 is often (or at least sometimes) overlooked.

Figure 2: Typical equipment used for laboratory-based ELISA analysis

4.2 Field methods

37. **ELISA methods have also been adapted for use on lateral flow test strips that produce results very quickly and do not require a laboratory setting.** In this case, the ground and diluted sample is simply filtered then dropped in a well with adsorbent material at the far end of the well. The solution moves toward the adsorbent material through a preloaded antigen of the toxin and, if the toxin is present, a colored band is produced on the test strip. Some systems are intended to be binary - i.e. to produce a yes or no answer to whether aflatoxins are present above a preset level. Standardization of color bands, however, has allowed developers to build innovative ways of using mobile devices to produce detailed, non-binary results from quick-use test strips that can be read down to the parts per billion (see Figure 3).[15] Test strips produce results in about 10-15 minutes and cost around US$5-6 per strip.

Figure 3: Lateral flow test strips and mobile test strip readers

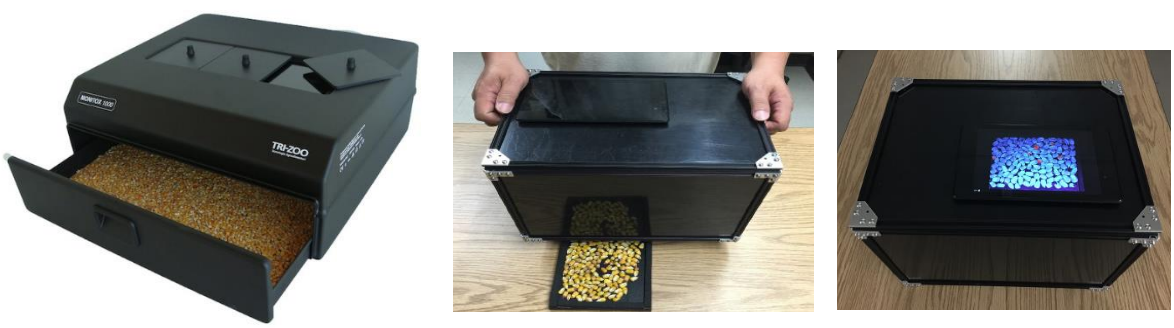
38. **Other than savings in cost and time, the main advantage of lateral flow test strips is that they can produce results rapidly and cheaply without the need of a laboratory setting.** Moreover, with mobile connectivity, test results have potential to be sent between parties in a trade deal and even to regulators potentially for regulatory certification and/or to speed border procedures. Additionally, some firms are

[15] See, for example: https://mobileassay.com/ and https://www.neogen.com/solutions/mycotoxins/raptor-solo/

marketing cloud storage as a secure way to share and store test data. Test results can be tracked in real time and used to create internal and external compliance reports. Data can also be shared with agriculture officers and health officials to map the prevalence of aflatoxins and help plan community outreach and extension programs A single test strip can analyze only one type of aflatoxin and generally produces results over a narrower range of upper and lower limits than other, laboratory based, ELISA systems. If practical interest revolves solely around knowing whether the sample conforms to the EAC standard of 5ppb aflatoxin B_1 and 10ppb total aflatoxin, however, just one to two test strips could be used in field setting to demonstrate conformity for trade purposes.[16]

39. **Even simpler methods of testing for aflatoxin are available.** Just as lab-based ELISA methods use the natural fluorescence to provide very accurate measures of aflatoxin, near instant readings are possible just by looking at a sample of grain under UV light (see Figure 4). UV boxes can be very inexpensive to make and involve practically zero operating cost other than electricity (or even solar panels) and, eventually, replacement bulbs. At least one large grain handling company in Kenya is already using these boxes in a triage-type approach, before it spends money on ELISA analysis. Looking forward, it is possible to imagine UV boxes being used at buying platforms as a first line of compliance validation and to send immediate market signals that reward producers for on-farm mitigation. Conceptually, such a system could be particularly effective if combined with buying from farmer groups that are monitored throughout the season.

Figure 4: UV light boxes used for aflatoxin identification



40. **Another set of simple tools used to manage aflatoxin and other quality risks at the buying platform is the so-called "Blue Box" develop by WFP.** The Blue Box contains a variety of tools used for sampling and grading of grains including a sampling spear, a riffle divider, grading sieves, and a digital moisture meter (see Figure 5). Through its Purchase-for-Progress (P4P) program WFP aims specifically to source food supplied by smallholder farmers so developed the Blue Box as a tool for on-the-spot grading of crops for quality and to help minimize aflatoxin risks. The Blue Box was first developed in Guatemala and has since been used in many other parts of the world including conflict zones and other areas without

[16] If a first reading for total aflatoxin were below 5ppb, this would be an automatic pass since total aflatoxin and aflatoxin B_1 must, by definition, be below the EAC upper limit. If, however, the first result was greater than 5ppb but less than 10ppb, a second test for aflatoxin B_1 could be used to verify compliance with the specification for aflatoxin B_1.

basic infrastructure to monitor quality and permit WFP to procure locally. In addition to testing for moisture, which helps to assess aflatoxin risk, some Blue Boxes include binary test strips that produce a positive or negative reading for aflatoxin according to WFP requirements (Méaux, Pantiora, and Shneider, 2013).

Figure 5: The WFP Blue Box

Source: WFP, 2014.

5. Opportunities for systems reform

41. **Addressing aflatoxin contamination in marketed crops is not easy and may be better managed through a systems approach.** Contamination can occur throughout the value chain where poor production techniques, handling, or storage conditions permit fungal growth. Thus, aflatoxin contamination can easily occur downstream of a regulatory test. Moreover, contamination can be concentrated in specific locations within a lot meaning that poor sampling procedures can result in a false reading. Even with good sampling, testing of the same lot twice may produce different results. Challenges of porous borders and small-scale traders in Africa that do not follow regulatory procedures provide an additional means in distributing risky commodities.

42. **Such challenges necessitate that regulators reconsider the current regulatory approach including whether regulatory testing as practiced now is achieving the objective of risk reduction.** Establishment of a systems approach that incorporates good management and makes testing more affordable and available throughout the value chain, could not only be more attractive to producers and facilities along the chain, but has potential to provide the EAC with greater risk reduction.

43. **Choosing the right test method for commercial trade largely depends on balancing cost against the range of results required and time taken to produce the results.** Standards bureaus favor full HPLC analysis as the most definitive scientific measure of aflatoxins at extremely low and high levels of concentration. In a more practical sense, however, when the interest is to know whether a product complies with the EAC standards of 10ppb total aflatoxin and 5ppb aflatoxin B_1 specific results at extremely low and high concentrations is not required. All that is needed is to know whether the supply

is above or below the regulated limits. The EAC Standard for test methods on cereals and pulses (EAC, 2017b), provides for analysis of aflatoxins using either HPLC or ELISA methods.

44. **UNBS says that it has ELISA readers but that it ran out of test kits some time ago so stopped using the machine.** Furthermore, UNBS also pointed out that its main business is to sample and certify products under the national quality seal which presently leaves out bulk staples. Testing manufactured goods can require analysis of many parameters that UNBS says is better done through HPLC. However, simple ELISA testing may be more in keeping with managing aflatoxin risks in bulk staples and is important for EAC standards bureaus to consider the practicalities associated with each commodity group rather than focusing on a one-size fits all approach.

5.1 A model for public-private partnerships comes from the USA

45. **The Texas One Sample Strategy is a voluntary public-private partnership to reduce aflatoxins in traded grains.**[17] The strategy administered by the Office of the Texas State Chemist (OTSC) provides a standardized quality system for managing aflatoxin through the chain of custody. The program supports compliance with regulatory requirements for aflatoxins as well as testing crop insurance that used to be managed separately. The reduction in independent testing has increased efficiencies and reduced the number of discrepancies in sample results that existed prior to implementing the One Sample Strategy (Herrman and others, 2010). Similar to a Hazard Analysis and Critical Control Point (HACCP) plan, the One Sample program is a quality system in which standardized methods of sampling and testing, standardized training of analysts, verification of performance, and implementation of documented plans that together serve to reduce market and food safety risk.

46. **The One Sample program provides for official certification of commercial grain lots by registered silo operators, feed mills, traders, and others participating in the program.** Participating firms must meet a minimum set of conditions for record keeping and food safety planning. They nominate a minimum of two staff members to be trained in grain sampling, testing and analysis who must then pass a test set by the Office of the Texas State Chemist. Once registered, the licensed employee(s) of the firm may use any test kit from a list of USDA-approved kits for aflatoxin analysis. To be approved, the kit must produce results in 30 minutes or less within a range of acceptable tolerances generally +/- 15 percent. Many of the approved test kits recognized by the One Sample program are lateral flow ELISA tests read by portable readers. Once a sample has been tested by a participating firm, the firm may affix an official state certificate of conformity to the grain bag or other container as proof of conformity. No further testing is required for trade purposes since the firm's certificate is recognized as an official state seal.

47. **Firms that participate in the Texas One Sample Strategy are automatically enrolled in a program of proficiency testing.** These performance checks involve periodic unannounced inspections by state regulators to check records and core competencies of authorized participating firms. File samples are collected by OTSC inspectors during routine monitoring visits and the samples are analyzed using HPLC.

[17] See: https://otscweb.tamu.edu/risk/OneSample/SampleAbout.aspx

5.2 Could a such a system work in the EAC?

48. **The Agriculture and Mechanical College of Texas (Texas A&M) has established proficiency testing in Africa to support the adoption of a quality system approach for aflatoxin management**. The Aflatoxin Proficiency Testing Control in Africa (APTECA) program is a public-private partnership that works with smallholder farmers, grain handlers, informal and formal traders to mitigate aflatoxin risks through affordable testing. The APTECA program was established by Texas A&M in partnership with OTSC, the University Nairobi, and other regional partners. The APTECA strategy is built on the same principles as the Texas One Sample Strategy and the program handbook is almost identical. The program has had strong uptake by Kenya's large-scale millers having trained over 200 millers and government laboratories to provide proficiency testing. APTECA is engaged with Kenyan government authorities to adopt the co-regulation strategy including proposing that test kit manufacturers offer free readers and kits priced comparable to those in the United States. APTECA is also seeking to develop a third-party monitoring scheme.

49. **A recent evaluation of APTECA (Herrman and others, 2019) shows that the program's approach to quality management has improved food safety for 16 million Kenyans served by large industrial mills.** While there is indeed compelling evidence that a quality system modeled on APTECA can reduce aflatoxins in downstream stages in formal maize mills, upstream problems with inconsistent supply and with aflatoxins in regional trade are far from resolved. As described in this note, when test kits are used only at downstream locations, the signals from the results of testing do not reach farmers or primary offtakers where aflatoxin problems begin. Important unresolved questions remain as to whether technologies that simplify testing can be used at upstream stages to send clear market signals to farmers and village aggregators. Questions also remain as to whether the new technologies can be used in a practical sense to speed border procedures and make regulatory compliance easier through self-certification. Trials to test these concepts in real trade situations with public and private sector are needed to determine how best new technologies could improve regional trade and to identify specific types of policy, institutional, and material support that would be required to introduce these systems at scale.

5.3 Experiences with self-testing in the EAC

50. **Some large companies that use quality seals on manufactured commodities in the EAC can self-certify for routine trade purposes.** UNBS cited Brookside Dairy and the Uganda Coffee Development Authority as two examples. Brookside operates a quality control program for smallholder milk based on HACCP principles of record keeping and testing at key points in the supply chain including at milk buying platforms (Jensen and Keyser, 2012). Since UNBS quality seals are not used on maize or groundnuts, however, UNBS said that new protocols would be needed to specify procedures for self-certification by grain handling companies. Cereal grains are a lower value product than dairy and do not have the same urgent need for processing as milk. Grains also have many more buyers competing for supply that makes compliance with standards less critical for the producer.

51. **As described, some industrial mills and grain handling companies in the EAC do already test for aflatoxins and reject supplies that are contaminated above the allowable level.** One large mill in Nairobi that participates in the APTECA program, for instance, described how it tests every delivery two times

before paying the supplier using a fluorometry-based ELISA system. First it tests the load outside its gate on bags at the top and sides of the load and then again after partial unloading on bags underneath. Each test was said to take 40 minutes and cost US$60 which works out to almost an hour and a half of testing and a material cost of US$120. For a standard 30-ton load, this works out to US$4 per ton excluding the fixed cost of lab technicians. Use of lower-cost rapid test strips as part of this system could be one way to save considerable time and money.

52. **Similarly, a large exporter in Uganda described how it uses laboratory-based ELISA tests at its own private facility just outside Kampala.** The firm said it sometimes shares test results with the buyer as part of contract negotiation and claims that before the Single Window it was able to use its own test results for phytosanitary certification. In terms of upstream supply, the firm buys much of its supply from traders who come to its factory gate and said that it tests all deliveries on arrival. As a member of the Uganda Grain Council (UGC), the firm also explained that it has been working with farmer groups organized around buying hubs and claimed to pay group members 7-12 percent more than the usual "village price" because of the convenience of buying large quantities at a single time. However, because the firm only tests for aflatoxins when the grain reaches its Kampala-based laboratory, the firm also said there is considerable risk of wasted transport costs if the grain fails to meet the standard. The firm was therefore interested to learn of mobile kits and UV boxes, which it said would reduce the risk of transporting non-compliant grain and allow even greater price premiums and immediate price signals to be sent to farmers.

53. **As part of its G-SOKO electronic trading platform, the EAGC has at times used ELISA test strips and mobile readers for private transactions.** G-SOKO is an electronic clearing house for regional grain deals. Through the platform, buyers deposit their money in an escrow account managed by G-SOKO as a guarantee of compliance with the regional standard. Sellers provide a test certificate on dispatch as proof of conformity and the buyer tests again on arrival. Terms can vary, but the basic idea is that G-SOKO will only release payment to the seller if the commodity conforms to the standard on arrival. Digital readers have been used in these transactions with photos of test strip readings sent back and forth between buyers and sellers and G-SOKO managers using mobile phones. While this has worked at times, it has also led to controversy with buyers sometimes reporting vastly different results than the ones provided by sellers that likely point to variation in sampling or testing techniques. Aflatoxins can continue to grow and may be one reason for this outcome but sampling consistency, sample size, and other factors can also explain the differences in high variability of aflatoxin within the load.

54. **Another model for use of new technologies comes from a commercial silo in Kenya that buys grain from smallholder farmer groups participating in an EAGC-led warehouse receipt program.** The silo operator tests all deliveries for aflatoxin. To achieve an acceptable economy of scale, the silo has set 10 metric tons as the minimum delivery which the operator and EAGC say works well for group deliveries. The silo first examines the maize using ultraviolet light then performs its own ELISA-based laboratory test to measure total aflatoxin. Members of groups that successfully deliver low aflatoxin maize then receive a bankable receipt they can use to buy crop inputs or to make other purchases with the crop held as collateral. The receipts are fully tradable and allow grain to be sold later in the season as prices rise in the

months after harvest. Silo operators say the attention to aflatoxin measurement at reception is needed to protect other stocks from cross-contamination and helps improve the competitiveness of their holdings when looking for buyers later. With broader use of the technologies, such an approach could be expanded to other warehouses and even to primary offtakers as part of a commercial strategy to improve quality and make immediate price incentives available to farmers.

6. Putting these concepts to trial

55. **New lateral flow technologies and screening tools offer EAC countries faster and cheaper test results and have the potential to be used along the entire chain of custody.** In comparison to traditional regulatory inspection, sampling and testing, which focuses on per consignment approach, a cheaper, more reliable and assessible test regime is increasingly likely to meet the needs of large and small players throughout the value chain. Aflatoxin contamination can occur at any stage and there are good reasons to believe that a more comprehensive approach to aflatoxin management would result in better outcomes from a food safety and regional integration perspective than the current regulatory approach. The reduced costs of these tests, if incorporated into a quality assurance scheme, could facilitate regional trade and drive upstream improvements where aflatoxin problems begin. The simplicity of the testing procedure and the potential to share test results electronically between large and small private firms and between the private sector and government creates an opportunity for the use of third-party accreditation systems or public-private partnerships which could further reduce costs.

56. **We propose that building off the Texas One Sample Strategy, regulators in the EAC could implement an accreditation program as a replacement to current testing regime.** Under the program, producers, accredited storage facilities and processors would be required to maintain best practices in aflatoxin management and to incorporate field testing at various critical control points throughout the trading chain. Each producer or offtaking facility would be trained and a level of proficiency testing incorporated into supervision. Commodities produced under the system would move through the chain identified by tags or self-issued certificates. Such programs are successfully used in developed countries for managing a variety of regulatory standards. Regulatory agencies could reduce monitoring and testing of individual consignments in favor of performance monitoring of accredited facilities which we believe would garner improved performance, increased uptake, and better utilization of regulatory resources in facilitating trade.

57. **Specific elements of a comprehensive strategy for aflatoxin management using the new technologies include:**

- **(i)** Broad consultation with producers, traders, and regulatory officials to develop a bilateral or regional regulatory approach built around good management practices that is backed by routine monitoring of farmers, storage facilities, offtakers using approved test kits, digital readers, UV light boxes, and other technologies.

(ii) Recognition of test results produced by accredited users of kits, including lateral flow test strips, as an acceptable way to demonstrate compliance with EAC aflatoxin standards for regional trade of cereals grains and other at-risk commodities.

(iii) Use of national quality seals or tags issued by authorized private agents to indicate compliance with the EAC aflatoxin standards and full acceptance of these seals for purpose of border movements.

(iv) Recognition of quality seals on bags carried across borders by small traders as a legal basis for trade.

(v) Development of national programs for proficiency testing and spot checking of authorized users of approved test kits including inspections of records and sampling methods.

(vi) Development of national programs for training and licensing of grain analysts in grain sampling and use of test kits.

(vii) Performance validation of regulated parties through laboratory testing of collected samples at regular intervals until confidence is achieved.

(viii) Use of test results to identify production and storage sites and where extension messages and other outreach strategies could be used to address contamination including a more targeted use of Aflasafe thereby reducing non-conforming products.

58. **A detailed proposal to trial these concepts could be developed by EAC countries in cooperation with the World Bank, the Standards and Trade Development Facility (STDF) of the World Trade Organization and/or with other development partners.** The STDF, for example, provides grants to countries and organizations up to US$1 million to test the feasibility of initiatives that improve safe food trade and has undertaken previous projects related to aflatoxin management in Africa.[18] The strategy proposed here would complement these existing projects and advance an improved regulatory framework for aflatoxin management. There is significant maize trade between Kenya and Uganda which have both expressed a strong desire to the World Bank in improving food safety management and improving regional food trade and would make these countries a good focal point for this kind of pilot project.

59. **Field trials would put the use of a performance-based systems to practical test in at least five important respects.** First, field trials would serve to understand whether a comprehensive performance-based approach would be used by private traders to send improved price signals up the chain of custody to smallholder farmers and village offtakers. This would involve working with groups such as the Uganda

[18] For example, a project preparation grant (PPG) was provided to the Ministry of Trade, Malawi in 2013. The PPG helped the Ministry of Trade develop a strategic framework, improve awareness and to bring together regional partners in the strategy. A current project in Burkina Faso is targeting increased awareness and training of the private sector and regulatory agencies in managing aflatoxin through good management practices, laboratory testing techniques; field demonstrations and to promote increased returns for safe aflatoxin maize. A new PPG approved in October 2020 will fund a project to test the potential for mobile labs to be used for SPS certification in SADC.

Grain Council, East Africa Grain Council, and others to introduce new testing methods at the first point of ale and to document the experience and lessons learned including the response of farmers. Gender related questions including the impact on household income marginalized households would be studied at this stage.

60. **Second, and closely related, field trials would serve to understand whether and how a performance-based approach improves the competitiveness of grain exports and confidence of buyers at the receiving end.** Do the technologies enable participants in trade deals to negotiate more favorable terms and eliminate uncertainty associated with current trading arrangements? What are the potential benefits of using performance-based management in domestic food trade and do these benefits outweigh costs?

61. **Third, the project would look at the potential cost savings in meeting food safety objectives.** How do the costs of operating a performance-based certification system compare with current arrangements for product certification? What are the practical requirements to use self-certification as a basis for mutual recognition of EAC quality seals on unprocessed grains and are the potential savings enough to drive the participation of large and small firms? Who would benefit most and who would miss out from such a system?

62. **Fourth, field trials would help identify required institutional and regulatory changes and financial implications of such an approach.** Investigations at this level would look at the capacity of national standards bodies and other SPS intuitions to implement a chain of custody approach and in turn identify development needs and areas for policy and regulatory reform needed for such a system work at scale.

63. **Cutting across these areas of investigation, a pilot project would also look at the role of the public and private sector in managing aflatoxin risks and whether the approach is attractive and practical for small firms and small traders to use.** As described, small traders who operate outside the formal regulatory system account for a large share of regional food trade and the field trials would need to assess the potential uptake and role of new systems for testing aflatoxin as a route to formalization of EAC regional food trade.

64. **The lessons learned from such a project would provide important insight to how the WBG and other donors can support countries to better manage SPS risks and pursue their regional integration objectives more generally.** Beyond traditional forms of support to central laboratories, which the analysis here suggests would only address a portion of trade, a more comprehensive and resilient approach to SPS management and regional integration more generally could be to initiate a dialogue on regional protocols for use of best management practices, mobile testing systems, and for mutual recognition of national quality seals backed by these systems. Pending proof of concept, development of new institutional capacities including establishment of training manuals and systems for registration of authorized users of rapid test technologies would be required as would investments to develop supporting legislation and improve the capacity of regulators to perform monitoring of the system. Engagement with the private

sector on the use of rapid test kits and other new technologies for their own quality control purposes and in warehouse receipt programs would be another important dimension to rolling this concept out at scale.

7. Conclusions

65. **By nature, managing aflatoxin risks requires a supply chain perspective**. In both developed and developing countries the best approach to managing aflatoxin risks requires an analysis of agronomic data from farmers, data from warehouses, and testing at critical control points using standard sampling methods. Farmer and warehouse data do not have to be complex but should provide assurances that basic procedures were followed. Equally, producers and warehouses need clear and transparent specifications of buyer requirements so they know what is expected and what the reward will be.[19]

66. **New technologies have the potential to make this kind of systems-based management easier than ever before.** At the start of the chain, primary offtakers equipped with UV boxes could establish supply arrangements with warehouse managers and commercial exporters who use test strips and digital systems to manage their stocks. Already the Uganda Grain Council, an exporter's association, is working to train farmers in aflatoxin mitigation and to develop buying relations with farmer groups known to follow good management practices. UV boxes would strengthen these offtaking relations and provide a way to reward farmers known to use mitigation methods.

67. **Further along the chain, test strips and digital readers could be used to manage supplies and for self-certification by accredited exporters and milling operations.** Like other users of national standards, regulators would have a role in performing unannounced spot checks to review records and perform tests to verify compliance with the standard. The exporter's own test results, however, would supplant the need for routine third-party analysis for phytosanitary certification. A proven model for this type of arrangement comes from the U.S. state of Texas where silo operators and mills can be accredited to use approved aflatoxin test kits and issue official test certificates for use in commerce.

68. **While these concepts still need to be put to practical trial, it is likely that a performance-based approach could facilitate safer, lower-cost trade of food staples and, in turn, help drive EAC regional integration**. Presently, the risks of rejection and costs of testing largely end up being passed up the chain in the form of lower prices rather than as incentives for compliant products needed to encourage aflatoxin mitigation. During meetings with farmers and farmer representatives in Kenya and Uganda, the most common and vociferous complaint heard was that aflatoxins are "used as an excuse by unscrupulous traders to drive prices down". Smallholder producers are already the poorest participants in East African food chains and is unrealistic to expect improvement if small producers are made to bear the financial cost of aflatoxin management alone. There needs to be improve efficiencies in chain of custody that reduce risk and make regional trade more secure and rewarding for all participants.

[19] Among others, these principles have been used by Mars to manage supply chains for groundnuts in both Africa and the United States (Crean, 2013).

69. **The kind of comprehensive "gate to plate" approach proposed here should simplify the sampling and testing methods.** The current system's mix of disconnected sampling and testing procedures and poor communication of risks leads to high costs and strong incentives for informal trade. With improved systems, identification of high-risk points along the supply chain could help prioritize those areas where market participants and public authorities could best intervene to reduce the incidence of aflatoxins. The WFP's Purchases for Peace program has a simple approach: introduce basic grain quality evaluation tools at key input points. These tools can be seen as an essential building block, providing the foundation for quality assessment and evolution toward improved supply chain management.

70. **The proposed strategy for a systems-based approach to aflatoxin management in the EAC could provide useful lessons for addressing SPS challenges in other parts of Africa and the world.** Often the focus on SPS reform in development projects is on improving hard infrastructure and increasing capacities through training. However, in the current case we are proposing to revise the overall approach to regulatory management. Aflatoxins are a global problem and, if feasible, this strategy of using new technologies for rapid testing and self-certification could provide a useful framework for World Bank and other donor engagements on SPS matters in many parts of the developing world. The high prevalence of aflatoxins in groundnuts in Malawi, for example, has long been significant problem that undermines potential for exports and value-added processing.

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