Malawi Programme for Aflatoxin Control (MAPAC)[1]

Advancing Collaboration for Effective Aflatoxin Control in Malawi

Effectively controlling aflatoxins can dramatically change the landscape of human health and nutrition in the country, improve market opportunities for Malawian farmers and facilitate the achievement of greater agricultural development.

September 2013

Lilongwe, Malawi

[1] This document was prepared under an STDF Project Preparation Grant (STDF/PPG/400), approved by the Working Group of the Standards and Trade Development Facility (STDF) in October 2012, and implemented from February to August of 2013. The document was prepared by Luz Diaz Rios, International Agriculture Consultant, in collaboration with a national team made up of: Isaac B. Gokah and Bridget Chifundo Kauma (Ministry of Industry and Trade), Limbikani Matumba (Department of Agriculture and Research Services), Samuel Njoroge (International Crop Research Institute for the Semi-Arid Tropics—ICRISAT-Malawi) and Aubrey Chinseu (National Smallholders Farmers' Association of Malawi—NASFAM).

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- Washington University in St Louis. Peanut Butter Project in Malawi.

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ABBREVIATIONS

AATF	African Agricultural Technology Foundation
ADMARC	Agricultural Development and Marketing Corporation
AIDS	Acquired Immunodeficiency Syndrome
AICC	African Institute of Corporate Citizenship
APPSA	Agricultural Productivity Program for Southern Africa
AUC	African Union Commission
BIF	Business Innovation Fund
CAAREA	Capacity and Action for Aflatoxin Reduction in Eastern Africa
CARS	Chitedze Agricultural Research Station
DARS	Department of Agriculture Research Services
DCAFS	Donor Committee on Agriculture and Food Security
DFID	Department for International Development (United Kingdom)
DHS	Malawi Demographic and Health Survey
ELISA	Enzyme-Linked Immunosorbent Assay
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FAS	(United States Department of Agriculture) Foreign Agriculture Service
FSCBRC	Food Safety Capacity Building on Residue Control
GAIN	Global Alliance for Improved Nutrition
GAP	Good Agricultural Practice
GDP	Gross Domestic Product
GFSP	Global Food Safety Partnership
HACCP	Hazard Analysis and Critical Control Points
HBV	Hepatitis B Virus
HCC	Hepatocellular Carcinoma
HIV	Human Immunodeficiency Virus
HPLC	High-Performance Liquid Chromatography
IAAE	International Association of Agricultural Economists
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDEAA	Initiative For the Development and Equity In African Agriculture
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
ISO	International Organization for Standardization
MoAFS	Ministry of Agriculture and Food Security
MAPAC	Malawi Programme for Aflatoxin Control
MBS	Malawian Bureau of Standards
MCDA	Multi-Criteria Decision Analysis
MDGS	Malawi Growth and Development Strategy
MICF	Malawi Innovation Challenge Fund
NARS	National Agriculture Research System
NASFAM	National Smallholder Farmers' Association of Malawi
NECS	Nutrition Education and Communication Strategy

NES	National Export Strategy
NNPSP	National Nutrition Policy and Strategic Plan
PACA	Partnership for Aflatoxin Control in Africa
PMIL	Peanut Mycotoxin Innovation Lab
PQE	Productivity and quality enhancement
PSD	Private sector development
SADC	Southern African Development Community
SATH	South African Trade Hub
SPS	Sanitary and Phytosanitary
SQAM	Standardization, Quality Assurance, Accreditation, Metrology
SSA	Sub-Saharan Africa
STDF	Standards and Trade Development Facility
SUN	Scaling-Up Nutrition
TWG	Technical Working Group
UNDP	United Nations Development Program
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WB	World Bank
WFP	World Food Program
WG	working group
WHO	World Health Organization

Malawi Programme for Aflatoxin Control—MAPAC

1. Aflatoxin Risks in Malawi: A Call for Concerted Action

Malawi has set ambitions economic growth goals for the next decades, with GDP per capita expected to double by 2020, on the basis of achieving an annual economic growth rate of nine percent. To achieve this, Malawi needs to address its unsustainable trade balance by strengthening the productive base and reducing dependence on tobacco, as the main export crop. Addressing barriers to accessing potential remunerative regional and international export markets, including trade logistics, tariffs and sanitary and phytosanitary (SPS) issues has become a priority of the Malawian government.

In order to understand the main SPS market access issues limiting export opportunities for the country, in 2012, with the support of USAID and under the leadership of the Ministry of Industry and Trade (MoIT), an assessment was conducted on the basis of the application of a Multi-Criteria Decision Analysis (MCDA) framework. Improved aflatoxin mitigation, management and control for groundnuts was identified as one of the top four issues that the country needed to address in support of export growth. The Ministry of Industry and Trade (MoIT), with the support of the Standards and Trade Development Facility (STDF), initiated a consultative process to develop a program for the control of aflatoxins in groundnuts to facilitate export development. The program was expected to take stock of existing government and donor-supported initiatives to address aflatoxin contamination in the country, address outstanding gaps and priorities, and to promote coordination and synergies between the relevant stakeholders.

However, as a result of the initial consultations with stakeholders, recommendations were made to expand the scope of the program from the trade perspective to cover the domestic food safety dimensions of aflatoxin contamination, with important implications on health, nutrition, agriculture and food security.

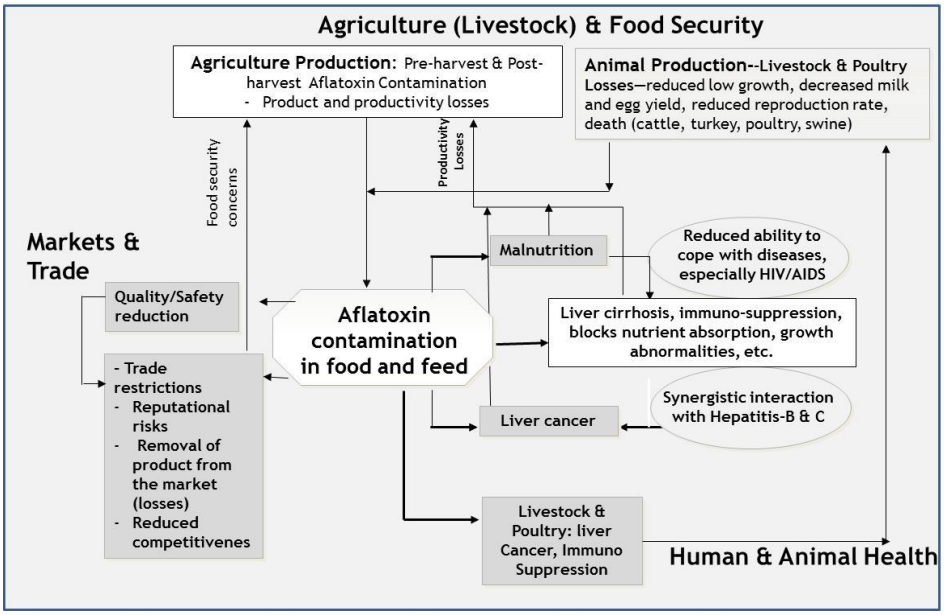
Thus, the acknowledgment of the three critical dimensions of the aflatoxin problem, as represented in Figure 1, implies the adoption of a multidisciplinary and multisectoral approach, and therefore, a broader effort to bring together concerned national and regional stakeholders across different industries, across government ministries and agencies, and with the involvement and support of development partners. At a national level, an important challenge is to be able create effective mechanisms enabling relevant parts of the government, industry and civil society to collaborate, build a shared vision, and create incentives to work horizontally.

Undoubtedly, for Malawi to achieve significant gains in the fight against aflatoxins, the establishment of effective institutional arrangements on the basis of strong public-private sector collaboration is fundamental. This often means public-private collaboration on the implementation of specific projects and initiatives, however, it should go beyond collaboration on specific projects to really institutionalize collaboration as an instrument for collaborative advantage. The country has made significant progress in this regard, through the several public-private coordination frameworks that have been established for the implementation of sectoral policies and approaches.

The Malawi Programme for Aflatoxin Control (MAPAC), developed in this document, represents an initial effort to create a shared vision, prioritize entry points and create mechanisms for effective coordination and collaboration of aflatoxin control in the country. The program is proposed as a tool for collaborative advantage in the fight against aflatoxins in Malawi, contributing to the achievement of established nutrition and health; trade; and agriculture and food security objectives.

This initial proposal for the MAPAC is to be viewed as a living document to be shaped and informed by further consultations with relevant actors/stakeholders, growing synergies among organizations, and new developments that emerge at the regional level, particularly within the context of Partnership for Aflatoxin Control in Africa (PACA), in terms of strategic direction, approaches to control aflatoxins, and

Figure 1. The Dimensions of Aflatoxin contamination in crops and food/feed



emerging technologies and practices. MAPAC is proposed as the national platform/forum on which collaboration and synergies among government agencies and relevant stakeholders can be built upon. It is also a channel/conduit to facilitate the implementation of regional strategies and aflatoxin-related efforts in the country. This proposal analyses key capacity needs and gaps (based on existing government and development partner programmes / interventions), identifies critical components of a collaborative programme for aflatoxin control, and outlines implementation strategies and recommendations for follow-up by various stakeholders. This initial proposal gathers the views of several stakeholders consulted during the preparation phase (see Annex 1). It is the result of a preliminary, concerted effort towards advancing collaborative advantage for aflatoxin control in the country. But, while MAPAC is a response to the need for concerted action, it is at the same time a call for it.

2. Extent of the Aflatoxin Problem in Malawi

2.1 The Trade & Market Access Implications of Aflatoxins

For decades, aflatoxins have been recognized as a threat to Malawi's trade development, specifically, trade in groundnuts. Farmers throughout the country recount, with nostalgia, the time when groundnut exports were a pillar of the Malawian economy. The 1980s saw the collapse of the groundnut export sector—the share of groundnut exports of total production declined from 64 percent, early in the 1980s, to only 0.2 percent later that same decade (Babu *et al*, 1994). Although the decline in exports was attributed to several factors, including reduction in production, declining world prices, and increased competition from other country-suppliers (such as China and Argentina) and alternative oil seed crops, it is also acknowledged that aflatoxin contamination beyond stringent levels imposed by the main export destination countries, played a pivotal role in the collapse of the Malawian groundnut trade.[2] The

[2] Different maximum accepted aflatoxin levels for groundnuts are applied by countries. For example, total maximum aflatoxin levels for ready to eat groundnuts/peanuts applied by the USA, the EU and South Africa are 20, 4 and 10 ppb, respectively. The EU applies a level of 15 ppb for groundnuts intended for further processing; similar level is applied by Codex Alimentarious. There is currently a proposal under consideration by Codex for the establishment of maximum levels for ready-to-eat groundnuts/peanuts.

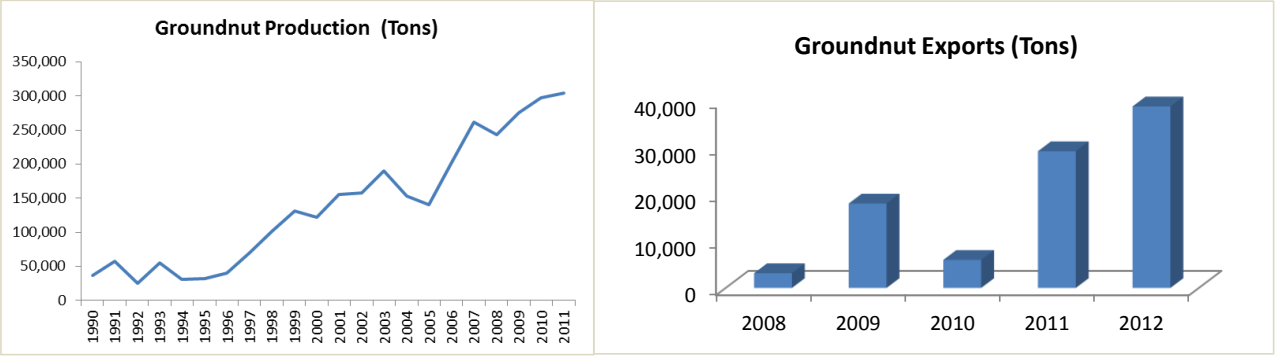
subsequent decades have seen a recovery of production and recently exports have also been increasing. Production has grown at an average annual rate of eight percent since 2000, and was estimated at about 300,000 tons in 2011 (COMTRADE). About 40 percent of groundnut production is commercialized through formal markets with exports representing between 10-15 percent of total production, and reaching about US$42 million in 2012.

Aflatoxin contamination has remained a critical challenge to sustained groundnut export expansion into markets with stringent aflatoxin regulations, such as the EU, but also important regional markets such as Tanzania, Kenya and South Africa (which enforce less stringent standards)—Malawi supplies 64.5 percent of South Africa's groundnut market (NES 2012). Direct exports to the EU have been reduced to a small niche (fair trade) market and have continuously been subject to notifications by the European authorities—a total of 11 notifications were issued by the EU during the period 2005-2008. Thus, the interest in consolidating and expanding exports of groundnuts have, through the years, resulted in various, scattered initiatives (normally independently-conceived and implemented) at the level of research, mainstreaming good practice implementation, or supply-chain coordination, aimed at identifying and applying effective ways to control aflatoxin contamination (See Annex 2). This is a task that has become very challenging within the context of fragmented production and a wide set of production and marketing constraints.

The impact of aflatoxins on Malawi's groundnut trade is difficult to estimate. Some evaluations estimated the value of annual losses during the 1980s, as a percent of the country trade balance, as high as 1.77 percent per year—in 1988/89 losses due to aflatoxin were estimated at US$1.6 million. In more recent years, direct losses associated with the value of trade that has been intercepted, for example in the EU, relate to the costs associated with redirecting consignments to less stringent destinations and/or the costs associated with further treatments in the destination markets. Generally, a total loss of consignments is rare. However, the deterrent/indirect effect in relation to the amount of trade that is not happening due to lack of compliance with aflatoxin requirements can be very significant. A recent report projected the deterrent impact of aflatoxin contamination on groundnut exports at nearly US$11 million in year 2017 (MCDA, 2012).

However, in Malawi, groundnut trade problems are not entirely due to lack of compliance with aflatoxin requirements in export markets. Low productivity, poor quality and broader constraints in relation to, for example, drying, storage, processing and transportation costs are important bottlenecks to be resolved. Furthermore, the future of groundnut trade is highly determined by the successful development of coordinated supply chains to address problems of aggregation, quality and safety and consistency of supply, along with logistic and market issues.

Figure 2. Groundnut export and production performance



Source. COMTRADE data

At the level of domestic markets, aflatoxins are playing an increasing role, as well. For example, the efforts to develop local production of ready-to-use therapeutic foods (RUTFs—small packets based usually on groundnuts, fortified with minerals and vitamins, that can reverse severe malnutrition) to

satisfy demands of UNICEF and other nutritional programs (including regional) are accompanied by raw and end-product testing to ensure that products with safe aflatoxin levels are reaching domestic and regional consumers (10 ppb).[3] However, these efforts have been constrained by difficulties in sourcing local raw groundnuts that are in compliance with defined standards. Furthermore, aflatoxins are also a threat to the efforts of the local groundnut processing industry (e.g., peanut butter and snacks) to expand in regional markets. The management of aflatoxins to avoid reputational risks and reduce potential losses is of critical importance to this industry.

Overall, less than 5 percent of the groundnuts produced in Malawi are subject to aflatoxin end-market controls, the remaining groundnuts are reaching domestic and regional consumers. Lack of quality management in these chains often mean formal chains with stricter requirements struggle to compete when purchasing groundnuts from smallholders. Thus, the lack of quality and safety management implies important health risks which are determined by level of exposure. The results from recent studies are indicating these levels can be very high.

2.2 Aflatoxins and Health Impacts in Malawi

The aflatoxin problem in Malawi has often been considered primarily within the trade barrier context, whereas the domestic market, and the associated public health effects of aflatoxin exposure, have received much less attention, in spite of the negative health effects being known for years (Box 1).[4] Conclusive evidence of the negative health impacts of aflatoxin is well-established, including as a cause of liver cancer (hepatocellular carcinoma (HCC)). However, recent studies have shown that aflatoxins can affect other organs as well. Furthermore, studies have shown the association of aflatoxin intake with growth stunting in children,[5] and its effects on increasing the severity of other opportunistic infections in HIV-positive individuals, principally tuberculosis. It has also been postulated that a synergy exists between HIV and AFB_1 in AIDS development (Jiang et al., 2008).

Box 1. Aflatoxins: A public health concern in Sub-Saharan Africa (SSA)

Aflatoxins are mycotoxins that are acutely and chronically toxic, immunosuppressive, mutagenic and carcinogenic compounds, produced by the mold *Aspergillus flavus*, which produces only B aflatoxins, and *A. parasiticus*, which produces both B and G aflatoxins. Aflatoxins M1 and M2 are oxidative metabolic products of aflatoxins B1 and B2 produced by animals following ingestion, and so appear in milk (both animal and human) and can pass through the placenta. Acute exposure to mycotoxins can be lethal, as exemplified by more than 150 deaths due to aflatoxin poisoning in Kenya in 2004 and 2005. Chronic exposure is more pervasive. Epidemiological studies carried out in China, Kenya, Mozambique, the Philippines, Swaziland, Thailand, and South Africa have shown a strong positive correlation between aflatoxin levels in the diet and the development of cancer. The synergy between exposure to aflatoxins and infection with hepatitis B virus (HBV) substantially increases the risk of carcinoma. Every year, around 100,000 new cases of hepatocellular carcinoma, practically always fatal, are attributable to aflatoxin exposure (from Liu Y et al;, Env. Health Perspectives 2010, 118: 818). Most cases of HCC occur in sub-Saharan Africa, where populations suffer from both high HBV prevalence and largely uncontrolled aflatoxin exposure in food.

Aflatoxins are also associated with growth retardation and immunosuppression. In Benin and Togo, children in high aflatoxin exposure zones were found to gain 22 percent less height than children in low-exposure zones. Childhood exposure to aflatoxin in The Gambia was also associated with immune suppression. Growth and immune impairment are critical in predisposing children to the infections that result in the high morbidity and mortality in African populations. The animal health implications of aflatoxins are also very significant: these contaminants

[3] 10 ppb is the maximum accepted aflatoxin level applied by Humanitarian Agencies in Malawi in relation to RUTFs.
[4] In 1988 the International Agency of Research on Cancer (IARC) placed the aflatoxin B1 in the list of human carcinogens.
[5] A study by IITA and the University of Leeds has shown that 99 percent of children at weaning age in Benin and Togo are highly exposed to serious health risks linked to aflatoxin, leading to reduced growth or stunting.

results in reduced productivity and fertility, higher susceptibility to infectious diseases, and increased costs of health management.

Source. WHO 2005, Myco-Globe 2005

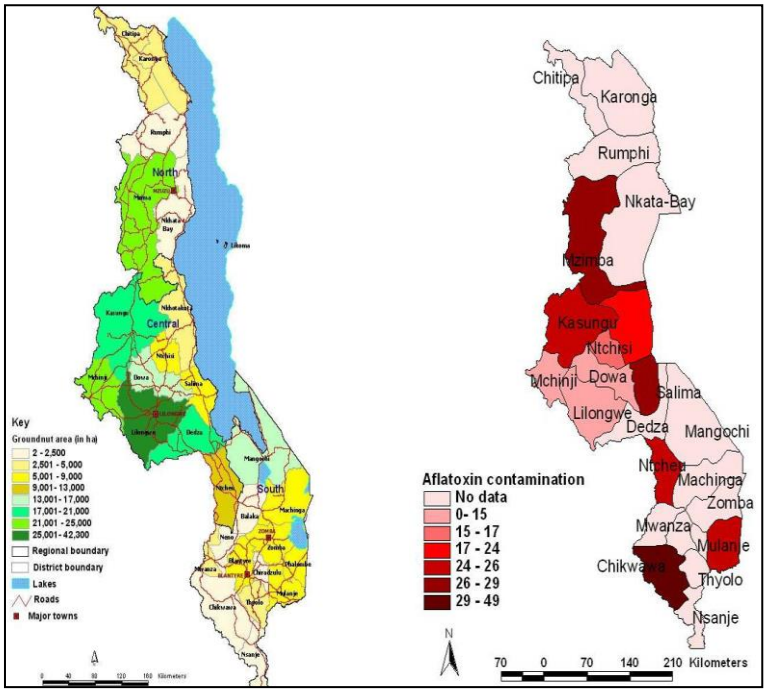
The health impacts of aflatoxins are a result of exposure, which is determined by the relation between the level of food contamination, consumption rates and also influenced by an individual's weight. In Malawi (and across SSA), results have shown the potential interaction of these three factors in determining high levels of exposure.

Aflatoxin contamination is widespread and non-crop specific

Assessments of the distribution/occurrence of aflatoxins undertaken by ICRISAT in 2008-2009 (Box 2) have provided an indication of the extent of the aflatoxin problem in Malawi. Results revealed aflatoxin contamination in groundnut samples ranging from 0 ppb to as high as 3871 ppb. Soils samples showed high infestation with *A. flavus*, with the highest infested lots found in the drought prone districts of Chikwawa and Salima. By sample category, groundnut powder presented the highest levels of contamination, with approximately 25 percent of all market samples of powdered groundnut having contamination well above CODEX safety levels. Maps indicating the distribution of aflatoxin, as well disposition to aflatoxin contamination by region, have been produced. Surveys carried out in end markets have also provided important indications of high levels of contamination in processed food and final products in retail markets (Matumba, et al, forthcoming).

Box 2. Assessment of the Occurrence and Distribution of Aflatoxin in Groundnuts (2008 and 2009)

Main groundnut producing areas and distribution of aflatoxin contamination



The assessment was carried out by ICRISAT, and covered eleven major groundnut producing districts of Malawi: Lilongwe, Mchinji, Kasungu, and Mzimba, but also high altitude areas of Phalombe and Ntchisi and the low lying areas of Salima, Nkhotakota and Chikhwawa. Sample collection was undertaken from February–March, 2009 targeting samples harvested from the previous (2007/08) season and stored for 8–11 months under different conditions. A total of 1708 samples of groundnuts and maize, inclusive of grains and processed foods, were collected from farmer households, local market vendors, shops, supermarkets and warehouses. Likewise, 1053 soil samples were collected from the farms where grain samples were obtained.

Areas with the highest grain contamination were: Chikhwawa, Salima, Mzimba, Kasungu, Ntcheu and Mulanje. Areas with the highest soil contamination were: Chikwawa, Lilongwe, Salima, Ntcheu, and Kasungu. Chikwawa, Salima, Ntcheu and Kasungu have high *A.flavus* loads and are exposed to drought-induced pre-harvest contamination. Mzimba and Mulanje have low *A. flavus* loads, but are predisposed to late-season rains, which create conditions for post-harvest contamination.

Source. Monyo et al, 2009

Preliminary efforts are also underway to better understand population exposure to aflatoxins through the use of human blood biomarkers[6]. A pilot study is being implemented by ICRISAT in collaboration with the Kamuzu Central Hospital, in several districts in Malawi. Preliminary results indicate that more than 50 percent of the samples collected from five districts had aflatoxin- albumin level ranged from 5-600 pg mg-1 of albumin.

Aflatoxins are not specific to groundnuts, however; they contaminate a wide variety of food crops/products, such as maize, sorghum, cassava, macadamia nuts, paprika, melon seed, sesame, yam chips, among others. Also, aflatoxin-contaminated feed (e.g., maize meal) in dairy rations can result in aflatoxin contaminated milk and milk products. In Malawi, three crops: maize, cassava and groundnuts (all of them susceptible to aflatoxin contamination) make up nearly 60-65 percent of the daily calorie intake of Malawians—maize alone represents more than 50 percent (Table 1). The crop supplies about 48 percent of protein consumption of Malawians, and about 45 percent of total food quantity (IFPRI 2012). Malawians' daily consumption of maize has been calculated to be between 353 to 382 grams, one of the highest in Africa.[7]

Table 1. Daily Calorie Intake (FAO, 2009)

Rank	Commodity	Calorie Share (%)
1	Maize	50
2	Potatoes	8.4
3	Cassava	5.8
4	Sugar	5.4
5	Pulses	4.1
6	Groundnuts	3.1
Subtotal Food Crop Share		76.8
Animal Products Share		3.8
Total Calories		2318

Assessments of the occurrence of aflatoxins in maize were undertaken in 2008-2009 and maps highlighting disposition to aflatoxin risk were prepared. However, the overall assessments in maize have been less systematic than in the case of groundnuts. Results revealed aflatoxin contamination of maize ranging from 0-1335 ppb. Aflatoxin contamination in stored maize is widespread, with levels significantly increasing over time. Maize flour, which is prepared by soaking maize in water to pre-ferment the flour, seems to have the highest contamination levels, with values up to 1335 ppb, followed by bran flour up to 805 ppb. Grain held by farmers and vendors also had contamination levels ranging from 0 – 800 ppb.

Recent preliminary work carried out by the Department of Agriculture at Chitedze Agricultural Research Station, has found that traditional processing methods such as soaking and drying, dehulling and sun drying can reduce Aflatoxin B_1 contamination in the final flour and hence in *nsima*. However, the aflatoxin reduction resulting from processing techniques may not necessarily translate into low exposure and risk, especially where the initial concentration is high, and also due to high maize consumption rates. Furthermore, a proportion of the maize is obtained by consumers as unhusked maize, in bulk or semi-processed, increasing risk exposure. Preliminary work being carried-out by Chitedze in Central and Northern regions is also showing that pre-harvesting molding of maize is significant.

The prevalence of aflatoxins in other crops and food in Malawi has not been fully assessed. However, preliminary work indicates risk of aflatoxin exposure from sorghum-based products (e.g., sorghum grain and malt beverages). In the case of milk, consumption rates in Malawi are quite low, but with expected consumption increases as the result of the promotion of dairy value chains, the human exposure to aflatoxins M1 via contaminated feed, would need to be better understood. Furthermore, aflatoxins are only part of a wider range of mycotoxins with potential to affect key crops in Malawi. Fumonisin is

[6] A biomarker is a chemical or biological indicator of a particular disease state, condition or, in this context, the consumption of aflatoxins, which can be detected through analytical testing of body tissues and/or fluids.

[7] Ecker & Qaim from the second Integrated Household Survey (IHS-2) estimates this figure in 353 grams, while FAO estimates indicate a per capita consumption of 383 grams (IFPRI 2012)

another common mycotoxin contaminant. It is produced by *Fusarium verticillioides* and it has been associated with a high incidence of oesophageal cancer among populations with high dependency on maize for food (Shephard et al., 2007) and Malawi is among countries with highest prevalence rate of oesophogeal cancer worldwide— the third-most common cancer among Malawian females and the second most important among men[8]—(GLOBOCAN, 2008; Mlombe et al., 2009; Wapnick et al., 1972, Msyamboza et al, 2012). Although there has not been any systematic study to link the two in Malawi Matumba et al, (in preparation) detected fumonisins in 90% of maize samples and 100% of traditional beers collected from across the country. Fumonisins are also associated with birth defects. Therefore, assessments on the importance of fumonisin contamination in maize in Malawi, and potential health impacts are needed.

Although a comprehensive assessment of the health impacts of aflatoxins and other mycotoxins such as fumonisin, on the Malawian population has not been done, high levels of maize and groundnut contamination and consumption, compounded by high rates of malnutrition, suggest high levels of exposure. The direct links of this high level of exposure to problems such as esophageal cancer mentioned above, to the high levels of stunting among children under five (41 percent) and also to underweight children (17 percent) (DHS, 2010), have not been studied, but it is expected to be significant. Therefore, it is very critical that links can be made between mycotoxin control and nutrition strategies in Malawi. Furthermore, vulnerable populations to aflatoxin contamination also include the almost one million people in Malawi living with HIV/AIDS.

2.3 Links to Agriculture & Food Security

Although the impacts of aflatoxins on food security are poorly recognized, they can be significant. The availability and access to maize, for example, can be seriously affected, if large amounts of product need to be taken away from the market due to unsafe levels, particularly during the hunger season. The stability of maize production could also be seriously affected by the inability to produce maize at safe levels for human consumption during periods of droughts that could severely increase the prevalence of aflatoxins. Independently of whether or not maize or groundnuts are at safe levels for consumption, under poorly regulated systems, most of the maize and groundnuts produced is marketed or consumed, therefore, the major impact of aflatoxins on food security relates to consumption of poor quality and unsafe food, with significant health and productivity implications. Malawi has achieved remarkable success in recent years in reducing hunger via increased maize production. Maize production increased from 1.22 million metric tons in 2005 to 3.7 million tons in 2011. Thus, there is an important opportunity to align ongoing and planned efforts aimed at expanded production/increased productivity with those aimed at reducing aflatoxin contamination.

While aflatoxins are endemic in Sub-Saharan Africa (due to frequent droughts and cultivation under subsistence condition), a good understanding of the factors that facilitate the development of the toxin and subsequent contamination is critical to effectively manage aflatoxin risks. Contamination can occur at pre-harvest and postharvest stages, and can be managed through a combination of measures including: adoption of technologies (e.g., biological control and resistant varieties) and good management practices applied along the chain. It also requires a set of supporting structures to facilitate monitoring and end-product testing. But perhaps most importantly it requires broad awareness about the importance of effective management of aflatoxin risks on achieving trade, health and nutrition, and food security outcomes.

Aflatoxin contamination, as a food safety issue, is everybody's responsibility. While farmers hold a great responsibility for producing safe food to be used for their own consumption and for supplying

[8] A total of 18,946 new cases of cancer were registered in Malawi from 2007-2010. Age-standardised incidence rate per 100,000 population for all types of cancer in males increased from 31 in 1999-2002 to 56 in 2007-2010. In females it increased from 29 to 69. It was estimated that, annually, at least 8,151 new cases of cancer (all types) occur in Malawi (Msyamboza et al, 2012)

domestic and export markets, effective management of aflatoxin risks require the involvement of different agencies, different actors and overall it is the result of a concerted effort. The Malawian Programme for Aflatoxin Control (MAPAC) is both: a response to the need for concerted action and, at the same time, a call for it.

3. Unleashing the Opportunities for Effective Control of Aflatoxins in Groundnuts and Maize Value Chains in Malawi

Malawi is a nation of smallholder farmers—the smallholder sub-sector contributes more than 70 percent to agricultural GDP—with most of the maize and groundnut production undertaken on a subsistence basis. The country has one of the highest population densities in Sub-Saharan Africa, with only 0.23 hectares of land per person living in the rural areas, and a unimodal rainy season, which severely constrains maize and groundnut productivity. Weather events and very limited access to irrigation, compounded by poor agricultural practices (due to lack of access to advice and limited access to farm inputs) translate into low productivity and high risk of product contamination with aflatoxins, in main crops such as maize and groundnuts. Furthermore, poor access to markets (partly due to transport costs and lack of business skills and opportunities), as well as underdeveloped markets, translate into poor incentives for further investments in production and quality improvements.

Undoubtedly, effective management of aflatoxin risks in Malawi will come from combined investments to address production and market constraints along with the implementation of aflatoxin risk-reduction measures. This is a challenging task; however, there are a range of emerging opportunities that hold the promise for achieving considerable success in the efforts to improve the performance of groundnuts and maize value chains, including effective aflatoxin control. It is those opportunities that MAPAC is building upon.

3.1 Policy Direction and Prioritization

In spite of the challenges faced by the agriculture sector in Malawi, there are many positive steps toward the transformation of the sector, including efforts to strengthen the enabling environment to support sector growth and generate opportunities for small-scale farmers. One of the most important achievements of the country in the last years has been the effort to provide policy direction on the basis of prioritization and harmonization of actions and investments. For example, the Malawi Growth and Development Strategy (MDGS II—2011-2016), builds on the success of MDGS I through maintaining the emphasis on Agriculture and Food Security, including support to investments in related areas that are fundamental for the transformation of the agricultural sector, such as investments in transportation infrastructure and irrigation development through the Green Belt initiative.[9]

The Agriculture Sector Wide Approach (ASWAp), formulated in 2010, under a highly coordinated process, builds on the success of the Farm Input Subsidy Program on boosting maize production (and reducing food insecurity), as the basis for the introduction of other policies in support of commercialization and diversification initiatives. ASWAp aims at attaining a minimum of six percent agriculture sector growth. Maize is considered as one of the commodities able to bring sustained growth through increases in maize productivity (doubling of production) and decrease on-farm postharvest losses, with proposed investments aimed at facilitating access (and efficient use) of production inputs, improved on-farm storage technologies (e.g. expand the use of metallic silos)[10] and facilities, and promotion of good agricultural practices. All of these efforts represent critical areas of investment in the fight to reduce aflatoxin contamination.

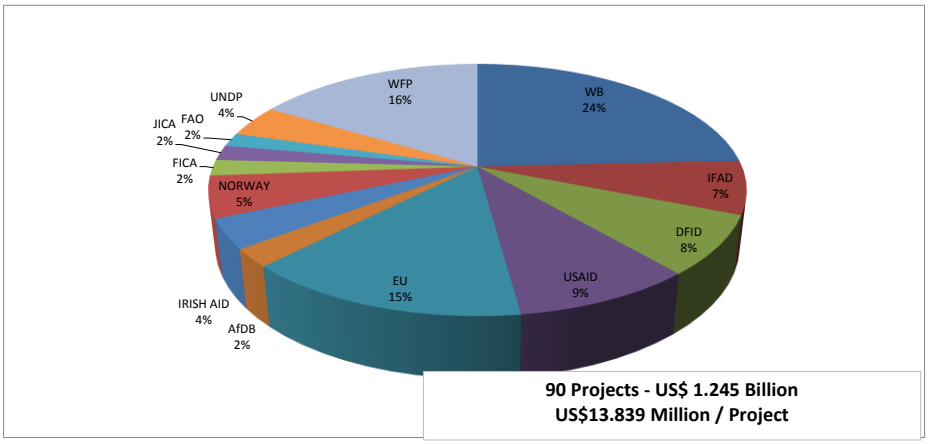
[9] The Green Belt Initiative is led by the Government of Malawi and aims to increase productivity and combat food insecurity by reducing the dependency on rain-fed agriculture through the expansion of irrigation schemes.

[10] For example, the government has been implementing, with technical support from FAO, the "Use of Small Metallic Silos Project", with the target of distributing 8,000 metallic silos of various sizes (500, 900 and 1,800kg) during the period 2010-2016, and investments estimated at US$ 1.86 million (Ministry of Agriculture and Food Security—Project Database).

In the case of groundnuts, the efforts are targeted at improving average productivity (from 0.5 to 1.0MT/ha) to support export growth and nutritional outcomes. As in the case of maize, investments are expected in areas related to variety development, farmers access to production inputs (seed and fertilizers), the development and promotion of GAPs, and the provision of services such as analysis for aflatoxins. These investments are complemented by broad strategies to promote soil and land management, and water management, including rehabilitation and irrigation expansion. The groundnut subsector is also at the core of the strategy to promote agro-processing, specifically in terms of small-scale groundnut crushing for cooking oil.

The implementation of the ASWAp is increasingly supported by development partners. Figure 3 illustrates the percentages of development investments in support of the ASWAp.

Figure 3. Percentage of the Total Donor Projects Budget to the ASWAp



Source. DCAFS, March 2013

Investments in strengthening the productivity base are expected to consolidate opportunities for export expansion. Oilseeds, including groundnuts, have been prioritized by the National Export Strategy—NES (2013-2018)[11] as one of the clusters with potential to generate export growth in the short-term. The expected outcome is to raise oil seed exports from $70m to $227m in 2018 and $600m in 2022. In the case of groundnuts, the strategy prioritizes expansion in regional markets in the short-term, and moving towards consolidating opportunities in international markets, in the long-run, with a detailed set of actions to be implemented in three phases, covering aspects related to productivity, regulatory frameworks and other facilitating factors.

Another important development is the ongoing process aimed at establishing a National Quality Policy. Through it, the Government of Malawi commits to develop and implement a technical regulation framework that will be followed by all the Ministries and their regulatory authorities. The policy is expected to provide the framework to guide investments needed to improve Malawi national quality infrastructure, in terms of standards, metrology and accreditation—capacities that are critical for achieving success on aflatoxin control in Malawi.

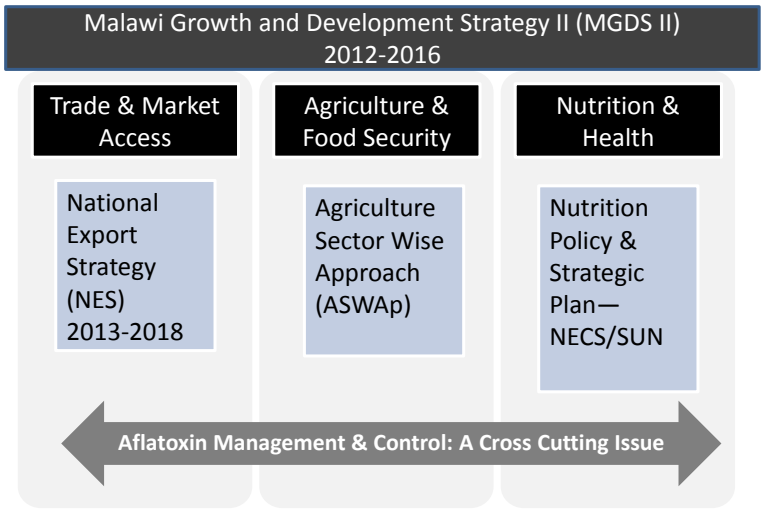
Overall, Malawi is showing exceptional commitment to agriculture development. In addition, based on political commitment to tackle hunger and malnutrition, Malawi ranked among the top countries in the Hunger and Nutrition Commitment Index[12], released on April 2013.[13] The country established a Food and Nutrition Security Policy (2005) and a National Nutrition Policy and Strategic Plan (NNPSP) for the

[11] The NES expects to achieve export growth on a value base of 13 percent per year between 2013-2017.
[12] The Hunger and Nutrition Commitment Index (HANCI) ranks governments on their political commitment to tackling hunger and undernutrition. The index was created to provide greater transparency and public accountability by measuring what governments achieve, and where they fail, in addressing hunger and undernutrition. See: http://www.hancindex.org/
[13] The Presidential Initiative on Poverty and Hunger Reduction (PIP&HR) was launched in Malawi in 2012, and prioritizes legumes as key crops to fight hunger and malnutrition.

period 2007-2012. In line with NNPSP, a number of programs are implemented to address five outcomes, among them improved management of acute malnutrition. The country has engaged very proactively in the Scaling Up Nutrition (SUN) Movement Strategy, and has prioritized the 1,000 Special Days National Nutrition Education and Communication Strategy (NECS)—2012 to 2017—aimed at reducing child stunting among children under two years to under 20 percent, through behavior change and awareness raising at the community level.

Furthermore, the links between sectors are increasingly being recognized. For example, ASWAp includes improving nutrition as a key intervention point, while donor funded projects have been strengthening the links between nutrition and agriculture. The gender dimensions are also addressed through the Agriculture Sector Gender, HIV and AIDS Strategy 2012-2017.

Figure 4. Policy Framework in Malawi



► MAPAC will take advantage of the progress made by the country in relation to the strategic prioritization of actions targeting groundnuts and maize production and commercialization, and will work on increasing the understanding of the importance of aflatoxin control as a crosscutting issue—touching on the dimensions of trade, nutrition & health, and agriculture & food security—and therefore critical to the achievement of established growth and development objectives.

3.2 Coordination of Investments and Alignment of Priorities

A set of arrangements have been put in place to guide the implementation of the policies and sectoral approaches. These implementation arrangements constitute important opportunities for the integration and coordination of aflatoxin-related activities/actions. For example, the implementation arrangements for the ASWAp include the establishment of a Secretariat and Technical Working Groups (TWGs). The TWGs of relevance for aflatoxin-related initiatives include the Technical Working Group Food Security & Risk Management (focusing on maize) and the Technical Working Group on Commercial Agriculture & Marketing (where groundnuts are included).

In the case of the NES, the implementation arrangements also include the formation of TWGs. Of relevance in the case of aflatoxins are the Oil Seed Products and the Market Access TWGs. Also, in the case of the oil seed sector, public and private sector efforts are converging around the Legume Development Trust (formerly known as the legume platform), a body created in order to enhance competitive advantage in the legume industry. The initiative started in 2011, with a strategic plan recently developed for the period 2013-2017. The platform is currently coordinated by the African Institute of Corporate Citizenship (AICC).

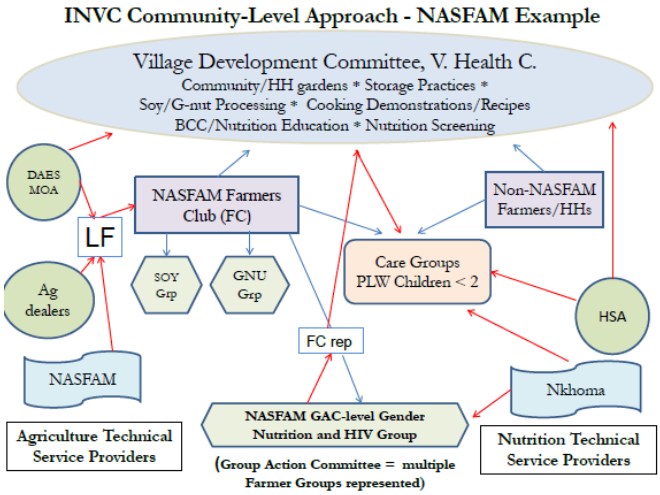
In the area of nutrition, the efforts led by the Department for Nutrition, HIV and AIDS under the Office of the President and the Cabinet, and with the support from development partners led to the development of a standardized framework for the implementation of the Scaling Up Nutrition initiative, which involves local assemblies up to the district and community level. A coverage target of 50 percent of districts has been established for 2012 and 2013. This district and community level approach could

become very instrumental in the efforts to integrate aflatoxin control into nutrition education programs and communication campaigns. Figure 5, illustrates the integration of agriculture and nutrition objectives within the context of value chain interventions.

Furthermore, in Malawi, the Donor Committee on Agriculture and Food Security (DCAFS) provides an exceptional platform for sharing knowledge and coalition building and for harmonization of efforts, and can play a critical advocacy role in the efforts to promote the integration of aflatoxin risk-reduction initiatives within broad agricultural, nutrition and export-related programs.

Figure 5. Community-based approach for integrating agriculture and nutrition interventions

Source. Feed the Future Presentation, March 2013



► MAPAC will leverage opportunities for the coordination and implementation of aflatoxin control-related efforts, through the engagement with current and emerging structures-platforms-committees that have been created to guide the implementation of sectoral policies and approaches. Wherever possible, the implementation of MAPAC's components will make use of existing coordinating structures.

3.3 Increasing Support to Private Sector Development (PSD)

Support to trade, industry and PSD has been limited in Malawi and was estimated to be less than one percent of total donor support in 2010. However, greatly in response to the focus on commercialization and diversification efforts, an increasing number of programs are (or plan to) funding PSD opportunities through value-chain investments, challenging funds or matching grant projects. Examples include DFID's Programme for Malawi Oil Seeds Sector Transformation; the IFAD-funded Rural Livelihoods and Economic Enhancement Programme; the USAID-funded "Integrating Nutrition into Value Chains" project, and challenge funds, supported by DFID, such as: the Malawi Innovation Challenge Fund (MICF), managed by UNDP and funded by DFID, the Business Innovation Fund (BIF), and the Enterprise Development Fund.

Box 3. Efforts to Develop an Integrated Groundnut Value Chain in Malawi

Afri-Nut is a joint venture, financed and co-owned by shareholders from the commercial and development sectors: The National Smallholders Farmers' Association (NASFAM), Twin, Ex-Agris (a commercial agricultural company with interests in Malawi), Cordaid (a Dutch donor organisation) and Waterloo Foundation (based in Wales). The aim of Afri-Nut is to move Malawian smallholder groundnut producers up the value chain and to expand the volume of Fairtrade and other value-added groundnuts produced for international, regional and domestic markets. Afri-Nut is developing new roles in supply chain coordination, facilitating communication and trading between players (producers, processors, other manufacturers, distributors and different types of consumers). The development of integrated supply chains are at the heart of the Afri-Nut strategy. Through working in coordination with farmers and carrying out investments in infrastructure and technologies (e.g. mechanical shelling, blanching) Afri-Nut aims to expand the country's exports of groundnuts in key market destinations.

Source. Twin[14]

Emerging experiences of private sector-led efforts to reduce aflatoxin contamination include those led by AfriNut (Box 3, above) and Ex-gris. Through these initiatives, a range of institutions and collaborative partnerships are built, bringing the complementarities needed to tackle the aflatoxin problem.

►Thus, MAPAC will leverage opportunities for integrating aflatoxin risk-reduction management practices and technologies into current and planned productivity and commercialization efforts, and will strongly support the emergence of coordinated supply chains linking private sector companies and smallholders, to satisfy demands for quality and safe products in domestic and export markets.

3.4 Opportunities to Engage with Emerging and Established Regional and Global Initiatives

Malawi efforts to control aflatoxin have received support from the Standards and Trade Development Facility (STDF),[15] USAID, DFID and several other donors. A relatively new specific aflatoxin risk-reduction initiative is the Partnership for Aflatoxin Control in Africa (PACA), funded by the Gates Foundation and with contributions by several other donors, and which aims at providing consistent coordination and coherent leadership to the continental efforts on aflatoxin control. PACA is operating under the leadership of the African Union Commission (AUC), which is working with a diverse Interim Steering Committee, representing interests across sectors in Africa, to develop structures and approaches for effective functioning of PACA. The partnership is advancing on the development of a concerted strategy for aflatoxin control, with several stakeholder consultation workshops taking place—the last one held in April 2013, in Dar Es Salaam, Tanzania. Proactively engaging with and gaining prominence within the initiatives promoted by PACA, is a priority activity for Malawi.

Another emerging global initiative on which Malawi can draw support from is the Global Food Safety Partnership (GFSP), an initiative led by the World Bank aimed at filling critical capacity building gaps in the area of food safety.

Furthermore, an important regional initiative is the Southern Africa Trade Hub (funded by USAID) which focuses on promoting intra-regional trade in targeted value chains: maize, soybeans and groundnuts, and is implemented in Malawi, Mozambique and Zambia. SATH, together with DFID, is one of the donors supporting the work being done by Twin Trading in coordination with NASFAM and Afri-Nut, in order to develop a coordinated supply chain to supply safe groundnuts to domestic and export markets.

The Agricultural Productivity Program for Southern Africa (APPSA), a multimillion dollar initiative (US$ 96 million), funded by the World Bank and approved in March 2013, aims to increase the availability of improved agricultural technologies in participating countries in the Southern African Development Community (SADC) region. The project is implemented through three components: technology generation and dissemination; strengthening regional centers of leadership; and coordination and facilitation. In Malawi, the program supports the ASWAp, thus offering opportunities to extend support to aflatoxin control initiatives.

► MAPAC will seek alignment with these global and regional initiatives. The programme will advocate for support of aflatoxin research at the national and regional level and will serve as a platform

[14] Twin is a registered charity in the UK and is the sole owner of Twin Trading, a limited guarantee company which trades directly with producer groups in the global south, and reinvests all profits in projects in developing countries. See: http://www.twin.org.uk/welcome

[15] In 2007, the STDF implemented a project preparation grant, focused on post-harvest contamination challenges in Malawi and Zambia. This PPG resulted in a project, entitled "Capacity Building for Aflatoxin Management and Control in Groundnuts in Malawi", which was funded by the ComMark Trust and implemented by UNIDO from Feb. 2009 until Dec. 2010.

for the coordination of efforts, the building of partnerships, and, overall, for advancing collaboration for effective aflatoxin-risk management and control in Malawi and across the region.

3.5 Regional Commitments to Finding Costs-Effective Solutions to Control Aflatoxins

The effective control of aflatoxins is the result of multiple and inter-related areas of action. Research and assessments, for example, provide the foundation upon which science-based interventions are designed and refined. Specifically in the area of assessments, several international efforts are underway to validate approaches for better understanding the extent of the aflatoxin problem at a country level, and for the identification of the most effective solutions to address it. For example, Abt Associates has developed an assessment methodology for the characterization of risks and economic impacts of aflatoxin contamination at the country level.[16] The methodology has been piloted in Nigeria and also in Tanzania.

Other approaches expand the focus to also assess the cost-effectiveness of different aflatoxin risk-reduction solutions. Examples include the work done by IFPRI in Kenya and Mali,[17] and the current work undertaken in Rwanda, with the support of USAID, on the quantification of the problem in maize and cassava in households and markets, and sensitization of targeted stakeholders based on a cost-benefit analysis. In almost all cases, the outcome of this type of work relates to the quantification of the problem in relevant crops, the establishment of prevalence databases, and subsequent risk mapping, and the cost/benefit analysis of the best agricultural intervention areas along the value chain. In Malawi, similar work was done by ICRISAT in 2008/09, but it was done at a smaller scale (particularly in maize) and it did not include cost/benefits assessment of different control interventions, neither for groundnuts nor maize.

Overall, the assessments on aflatoxins proposed by these methodologies have focused on quantification of contamination in the fields and/or on the products in the markets, but they have not yet made use of more specific approaches to assess levels of exposure, such as those available through the use of biomarkers.[18] In Malawi, a pilot project has been initiated which, if expanded, would provide sound evidence of the extent of the health problem among Malawian population when linked to further information about consumption rates and aflatoxin prevalence in maize and groundnuts crops. Furthermore, the information can contribute to building baselines on which the progress made in the fight against aflatoxins could be measured.

In terms of specific technologies, continental efforts are focusing on the promotion of biological control as a cost-effective option to reduce contamination in the field. IITA is leading the efforts with the support of USAID and USDA. In the majority of the cases, the identification of non-toxigenic strains of *Aspergillus spp.* is combined with assessments of the prevalence of aflatoxins in the field. Countries where biocontrol projects have been implemented or are planned include the following: Nigeria, Senegal, Burkina Faso, Kenya, Ghana, Mozambique, Mali, Zambia, and Tanzania. Examples of donors supporting initiatives in several countries are presented below:

- Kenya: Biocontrol product development funded by USDA, Bill & Melinda Gates Foundation and AATF,
- Tanzania: Mycotoxin prevalence analysis and biocontrol product development funded by USAID (Africa Rising) and PACA,

[16] The methodologies can be found at: http://www.aflatoxinpartnership.org/~/media/Files/Projects/Aflatoxin%20microsite/Background/Conceptual%20Framework_Volume%20II_v2.pdf. An example of application is found at: http://www.aflatoxinpartnership.org/~/media/Files/Projects/Aflatoxin%20microsite/Background/Tanzania%20Country%20Assessment.pdf

[17] http://programs.ifpri.org/afla/afla.asp

[18] A biomarker is a chemical or biological indicator of a particular disease state, condition or, in this context, the consumption of aflatoxins, which can be detected through analytical testing of body tissues and/or fluids.

- Zambia: Aflatoxin prevalence analysis and biocontrol product development funded by the USAID-Zambia mission through the Feed-the-Future (FtF) initiative,
- Mozambique: Aflatoxin prevalence analysis and biocontrol product development funded by USDA, USAID and Government of Mozambique.

The AgResults initiative[19]—an initiative focusing on encouraging innovative private-sector distribution of technologies—is implementing a pilot for the private commercial distribution of biological control (Aflasafe) in Nigeria. In the case of Malawi, a draft proposal for the introduction of a biological control has already been prepared by IITA, but it is not yet funded.[20] The Southern Africa Trade Hub is currently supporting trials in Zambia and Mozambique, and is working on a proposal for the possible registration of the biological control product in these two countries that also includes Malawi.

At a regional level, support for the development of low cost diagnostic tests for aflatoxin in maize is provided by the Bill and Melinda Gates foundation, with the initiative implemented by Diagnostics for All. ICRISAT has also developed a simple diagnostic test technology, which is already applied by some players in Malawi.

In East Africa, an initiative on which Malawi can draw experience from is the project 'Capacity and Action for Aflatoxin Reduction in Eastern Africa (CAAREA),'' which is working to establish a regional mycotoxin analytical platform at the Biosciences Eastern and Central Africa - International Livestock Research Institute Hub (BecA-ILRI Hub). The initiative is also linked to the development of maize varieties resistant to *Aspergillus sp*., and overall attempts to become a hub for aflatoxin research and analysis for the region. The initial focus of the efforts is maize in Tanzania and Kenya.

► MAPAC will seek to develop capacities of the National Agriculture Research System (NARS), through increased collaboration with regional and global initiatives. MAPAC will serve as a platform for the coordination of research initiatives, including the piloting and validation of emerging technological solutions in support of an integrated and holistic approach to aflatoxin control in the country.

3.6 Create Momentum for the Implementation of Integrated Approaches to Aflatoxin Control in Malawi

In Malawi, private sector concerns in relation to the negative impacts of aflatoxins in groundnut exports is currently the driving force pushing for improvements at pre-harvest, postharvest and marketing stages, in conjunction with the improved testing capacities and the enhancement of regulatory frameworks. However, awareness is growing on the importance of emphasizing the trade and agriculture & food security dimensions. In the same way, regional initiatives such as PACA, are creating momentum for an integrated approach to the problem. Thus, the convergence of these two factors represents an enormous opportunity for the emergence an integrated and holistic approach to aflatoxin management and control in the country.

4. Capacity Development for Aflatoxin Control in Malawi

[19] AgResults involves donors allocating relatively small amounts of public sector money to leverage private sector research and development on food security challenges that would otherwise go unaddressed due to market uncertainties. The initiative is managed by the World Bank. The initiative aims also at incentivizing the adoption of on-farm storage technology for smallholder farmers, which is also an opportunity for addressing aflatoxin contamination.

[20] The proposal encompasses activities not only in relation to biological control. Thus, it would need to be revised in light of the current set (and past) of activities under implementation in the country, as well as in light of the roles that several actors could play in the implementation of proposed activities. Furthermore, IITA has indicated that synergies can be made in relation to biocontrol projects currently under implementation in Mozambique and Zambia, therefore, reducing costs and increasing effectiveness.

4.1. Building Blocks of an Effective System for Aflatoxin Control

The process of developing capacities for effective control of aflatoxins involves an agglomeration of basic and more sophisticated technical and administrative functions, which would require a broad range of investments to develop human, physical and social capital within the supply-chain, as well as for the development of functional supportive institutions and services. The main capacity development blocks of a system for aflatoxin control are illustrated in Box 4.

Box 4 Capacity Building Blocks of an Effective Aflatoxin Control System

Assessments, evaluations and research activities provide evidence of the extent of the problem and of the most promising solutions. The evidence generated is crucial to support awareness creation efforts; create the political will to support aflatoxin control efforts; and to support the process of developing standards and regulations. But in order to undertake those functions effectively, capacities among research institutions need to be in place.

The process also encompasses, **deepening awareness** among farmers, traders and other supply chain actors about aflatoxin risks and their economic and health impacts. At the farm level, awareness campaigns are accompanied by the **development of production skills and capacities and supportive investments**, to apply good agricultural practices and other specific aflatoxin-risk reduction practices and technologies. New **institutional arrangements** might be required. For example, strengthening farmers' collective action for facilitating the adoption of certain technologies (e.g. mechanical shelling and sorting). In formal markets, traders and buyers are required to work closer with farmers and also adopt specific practices and technologies to reduce aflatoxin risks during processing and marketing stages. The process of capacity development for aflatoxin management and control is facilitated by previous investments made on the development of basic productive capacities and of supply-chain organizations.

Farmers and food enterprises are supported through **qualified extension services** (public and private) and by research and development efforts that are piloting and generating cost-effective solutions, which are widely disseminated and adopted.

Formal buyers adopt **cost-effective diagnostic/screening technologies**. Public or private sector investments in more sophisticated testing infrastructure are made to manage outbreaks, monitor health risks, monitor sectoral improvements, and/or support industry compliance with national regulations/standards or with demands on specific targeted markets. Government capacities to apply **risk–based approaches to standards-setting and regulatory interventions** are in place. If regulations are issued, there are capacities in place for effective enforcement.

As a cross-cutting issue, institutional arrangements to support inter-governmental agency coordination are in place, and public-private platforms (arrangements) for the prioritization of initiatives, coordination of efforts or channeling of resources to support initiatives are effectively operating.

In an effective system, while, farmers and buyers bear the main responsibility of providing safe food and feed products to their families, but also to domestic and international consumers/clients— acting with the support and under the oversight of public and/or private institutions— consumers (rural and urban) bear the responsibility of reducing their exposure to aflatoxin-risks on the **basis of awareness, knowledge and the food-options** available to them. Policy frameworks providing direction and establishing roles and responsibilities are critical to guide and direct public and private investments aimed at controlling aflatoxins.

4.2 Overview of Progress and Capacity Gaps for Aflatoxin Control in Malawi

4.2.1 Awareness Creation/Training

In consideration of the tangible implications of aflatoxin contamination on groundnut exports, efforts to create awareness about aflatoxin risks among groundnut farmers have been implemented in Malawi for several years, particularly in main production areas around Lilongwe and Mzimba (see Annex 1). Maize, also susceptible to aflatoxin contamination and a key component of Malawian's diet, has received much less attention. Studies have suggested that even within groundnut farmers, there is a need to undertake further efforts to deepen farmer and farm household understanding of aflatoxin risks (Box 5). Furthermore, the health implications of exposure to aflatoxin contaminated nuts are also poorly

understood by groundnut farmers. Among those with high levels of understanding, carcinogenic effects are acknowledged, but they are less aware of other health effects of aflatoxins. Also, they show low levels of awareness about the association of the toxins to other susceptible crops such as maize. This is critical, as quite often a groundnut farmer is also a maize producer (or the other way around).

Box 5. Awareness of Aflatoxin-Related Risks Among Groundnut Farmers

In a study undertaken by ICRISAT in 2008-2009, it was found that about 65 percent of surveyed farmers were aware of aflatoxins. Mzimba registered the highest proportion (81%) of farmers indicating that they were aware of aflatoxin. This could be attributed to higher literacy levels among respondents. Even though this is the status, most of the respondents identified aflatoxin-infested nuts as only those that were rotten. This poses a great threat as shriveled and mechanically damaged nuts were considered suitable for consumption. This could have negative implications as household members would be consuming shriveled nuts hoping that it is safe from aflatoxin, therefore increasing the risk of aflatoxicosis. The main identified sources of aflatoxin information were other farmers, as reported by 52.6 percent of surveyed farmers, radio programs (31.9%) and other agricultural institutions. The public extension service was identified as the third most important source of aflatoxin information.

Source. Monyo et al, 2009

Key channels identified by ICRISAT in 2009, for creating awareness and improved communication about aflatoxin-related risks are neighbor farmers, radio programs and extension officers. However, the effectiveness of those channels needs to be well-understood and identified weaknesses addressed. For example, it is apparent that among farmers belonging to groundnut groups or associations, the level of awareness is high, however their role in spreading the message among farmers outside the group/association or among farmers at the village level is more limited. Thus, the effectiveness of extension methods such as farmer to farmer, lead farmers, farmer clubs, farmer field schools, etc., need to be better understood in the Malawi context.

There are emerging experiences aimed at the identification of effective extension methodologies and communication channels for awareness creation/education. For example, ICRISAT is working in the development of communication tools (video, pamphlets, radio messages), and strategies that focus on promoting the understanding among farmers of the "rationality" behind aflatoxin control efforts. The methodology involves periodic stakeholder meetings where actors, such as national producers, entrepreneurs and policy makers are invited to discuss the issues, contribute to design of communication interventions and subsequently participate in evaluation of results and decisions on next steps. Thus, there is an important opportunity to validate these tools through current projects and initiatives and assess their impact on changing farmer perceptions and, ultimately, behavior.

Furthermore, efforts to create awareness and improve the understanding of the risks and implications of food and feed contaminated with aflatoxins among extension officers have been made, but they are not very systematic. A recent effort is the one undertaken by the Agricultural Sector Wide Approach by the team at the Department of Agriculture Research Services at Chitedze research station, to train over a hundred specialists. These specialists are expected to train front line field officers (about 2000, with diplomas and certificates in Agriculture). The team has also developed aflatoxin training manuals, which are expected to be used to train farmers. To date, nearly 2000 copies of the manual have been distributed. These efforts are important initial steps that would benefit from the engagement of private actors, the piloting of extension methodologies, strong monitoring systems, and, overall, they need to become more systematic. In addition, there are several community-based organizations and NGOs, and service providers that are actively engaged in delivering training to maize and groundnut farmers (in some cases including aflatoxin-related training).[21] Therefore, strengthening the capacities of those actors needs to be a priority in the efforts to strengthening the capacities for aflatoxin control among extension services.

[21] In fact, at March 2011, nearly half of the project funds/investments in the agriculture and nutrition sector were managed by NGOs, farm-based or community-based organizations through grants (see Annex 2). (Project Database, Ministry of Agriculture and Food Security, website)

Awareness among traders and other actors is high among formal actors (particularly in the case of groundnuts), but it is not well understood at the level of traditional markets. Another important set of stakeholders that have been poorly targeted are those involved in processing activities. For example, in recent years, a sub-set of development efforts have focused on promoting groundnut crushing for oil on a small scale, but these efforts have lacked complementary measures to ensure that unsafe oil and untreated meal/paste do not reach consumers/markets. Test results of seven groundnut oil samples collected from small-scale processors and analyzed at Chitedze Mycotoxin laboratory showed that all samples were positive (with total aflatoxin levels ranging between 16-271ppb).

Given the multi-dimensional nature of the impacts of aflatoxin contamination, awareness activities should be expanded to actors other than those directly involved in production, processing and marketing activities. It is critical that efforts to create awareness also reach staff in relevant government departments and development agencies.

While most of the efforts to create awareness have been targeted at farmers—viewed as producers—very few efforts have been made to target farmers and farm households viewed as consumers of groundnuts and maize. Established community-based structures have not been proactively used as critical channels to disseminate messages and create awareness about aflatoxin risks and improve understanding of management options. At a broad level, awareness creation among Malawian rural and urban consumers has received little attention.

Conclusively, in consideration to the complexity of the topic, it is clear that awareness creation, training and education cannot be a one-time effort. There needs to be a systematic process built into current public and private extension systems related to agriculture and nutrition. However, given the large numbers of stakeholders involved in the groundnut and maize value chains, from production to consumption, developing training and building broad awareness can be very complex and costly. Therefore, awareness and training efforts in Malawi would need to be properly targeted and sized.

A good understanding of the extent of the problem is a basic preliminary step to inform awareness-creation efforts. In Malawi, valuable preliminary efforts have been made by research institutions to define the scale of the aflatoxin contamination problem in groundnuts, and to a lesser extent also in Maize. These preliminary efforts are providing the basis for supporting targeted and broad awareness efforts.

4.2.2 Management and Technological Options: Productivity Enhancing and Specific Aflatoxin Risk-Reduction Measures

In Malawi, the focus of the efforts to control aflatoxins has been on agriculture-related interventions. Table 2 highlights the range of intervention options being promoted for groundnuts in Malawi, which are highlighted in manuals and documents and/or being piloted in some projects. The exception has been biological control, which has not yet been introduced in the country. Also, diversification of consumption (a core element of the nutrition strategy) is included, because groundnuts are among the legume crops proposed as alternatives for reducing dependency on maize consumption.

An attempt is made in Table 2 to classify the intervention options as aflatoxin risk-reduction-specific and those related more with productivity and quality enhancement (PQE), but which still have associated benefits in terms of aflatoxin reduction/management. It also highlights the challenges related to broad adoption, which generally fall into two categories: lack of awareness/knowledge or lack of incentives for adoption (but also food security considerations). Thus, as illustrated in the table, an important element of an effective strategy to effective aflatoxin control lies in the proper agronomic and postharvest management of the crop, which could enhance productivity (e.g., irrigation) and reduce postharvest losses (e.g., improved storage), therefore, resulting in tangible benefits to farmers. For example, according to some authors, input-related measures such as irrigation and pest control can reduce aflatoxin levels significantly in maize, compared with non-irrigated, non-treated maize.

Table 2. Range of Interventions for Aflatoxin Management/Control in Groundnuts in Malawi

Specificity	Range of Recommended Practices/Management and Control Options	Typology	Challenges associated with implementation/adoption
Agriculture Interventions			
	Pre-harvest		
AFLA risk-reduction specific	Development of aflatoxin-resistant varieties (on-going research)	Input-related Practice	Under development
PQE	Quality seed and planting varieties suited to agro-ecological conditions	Input-related Practice	Availability/poor distribution and costs of seed
PQE	Early planting	Management-related Practice	Weather, lack of knowledge, tradition
PQE	Proper planting densities	Management-related Practice	Lack of knowledge/availability of seed
PQE	Fertilization/including soil amendments	Input-related Practice	Limited access to inputs/knowledge
PQE	Pest Controls	Input-related and Management - related Practice	Limited access to inputs/knowledge
PQE	Irrigation (or water retention practices (tied ridges)	Input-related Practice	Limited access to inputs/knowledge/costs
PQE	Crop rotation	Management-related Practice	Knowledge/land availability
PQE	Cultural practices that reduce weed growth, lower the incidence of soil insects, mites, and nematods	Management-related Practice	Labor shortages/costs
AFLA risk-reduction specific	Application of biological controls (Not yet applied in Malawi)	Input-related Practice	Ensuring commercial production of biological control agents at a low costs/Limited knowledge-acceptance /Cost for farmers
	Harvest		
PQE	Proper harvesting (avoid early lifting)— Harvest the groundnuts at full physiological maturity	Management-related Practice	Lack of incentives/cash presure
AFLA risk-reduction specific	Shake the groundnut plant after lifting to remove excess soil from pods	Management-related Practice	Lack of incentives/lack of knowledge
PQE	Avoid mechanical and physical damage to pods at all stages of harvesting.	Management-related Practice	Lack of incentives/lack of knowledge
PQE	Remove and destroy all dead plants. Do not mix immature pods and damaged gleanings with main produce	Management-related Practice	Lack of incentives/lack of knowledge
	During drying		
PQE	Dry harvested pods to moisture levels of 6-8%	Technology-related Practice	Lack of incentives/lack of knowledge/cash pressure
PQE	Slow drying in a well ventilated environment (Mandela Cock)	Technology-related Practice	Lack of incentives/lack of knowledge/negative collateral effects (theft)
AFLA risk-reduction specific	Clean and dry containers for transporting nuts from either the field to storage or from storage to markets to avoid contamination.	Management-related Practice	Lack of incentives/lack of knowledge or access to proper bags
	In Storage and Transportation		
AFLA risk-reduction specific	In-shell storaged	Management-related Practice	Lack of incentives/poor understanding of benefits and tradeoffs
PQE	Only storage nuts that are properly dried	Management-related Practice	Lack of incentives/lack of knowledge
PQE	Storage in a dry and ventilated environment protected from insects	Technology/Infrastructure-related Practice	Lack of incentives/lack of knowledge/limited acces to technologies-storage infrastructure
PQE	Use clean and dry bags and stack them on pallets or poles.	Input-related Practice	Costs/lack of knowledge
PQE	Make sure stacks of good sizes are made i.e. up to 10 bags hig. Use of propilene bags is not recommended	Management-related Practice	Lack of incentives/lack of knowledge
AFLA risk-reduction specific	Periodically check stored groundnuts for mould growth and insect infestation	Management-related Practice	Lack of incentives/lack of knowledge
AFLA risk-reduction specific	Shift from manual to mechanical shelling	Technology/Infrastructure-related Practice	Limited access to proper technologies; negative perception of proposed technology; poor understanding of tradeoffs/benefits
AFLA risk-reduction specific	Avoid water addition during manual shelling a/or previously to marketing for enhance weight	Management-related Practice	Wrong incentives/lack of knowledge
PQE	Groundnut pods and kernels should be carefully sorted and graded	Management-related Practice	Lack of incentives/lack of knowledge
PQE	Defective (mouldy, discoloured, rancid, decayed, shrivelled) nuts must be removed	Management-related Practice	Lack of incentives/lack of knowledge
AFLA risk-reduction specific	Blanching nuts (large processing)/Physical treatment in combination with sorting	Technology-related Practice	Costs/Knowledge
Dietary & Food Processing Interventions			
	Diversification of consumption (reduce depedency of maize)	Management/system related Practice	Costs/Knowledge/Risk avoidance
	Novasil Clay- for decontamination (animal feed)	Technology related	`
Health Related (Vaccination against Hepatitis C)			Costs/Limited effectiveness

PQE: Productivity and/or Quality Enhancing

Input-related options are expensive, but they are currently also part of broad and planned interventions within the context of irrigation projects and commercialization initiatives in Malawi. Therefore, embedding more specific aflatoxin risk-reduction measures within the context of PQE programs is critical to create incentives for adoption. Furthermore, in formal supply chains, some of the options that have been proposed and are being piloted relate to significant changes in the ways farmer operate. For example, the possibility that some activities traditionally done by farmers, mainly women in the case of manual shelling, can be done by groups of farmers (as an enterprise) or can be assumed by specialized traders/buyers through the use of mechanical shelling. Similarly, new arrangements such as shifting from selling shelled nuts to in-shell nuts are being proposed and some pilot projects initiated. These types of measures would need to be tied to the right incentives for adoption, which would imply a deep assessment of the benefits and drawbacks and distributional effects of doing so, and the application of the best extension methodologies to motivate such "behavioral changes."

Another technological option that is being pursued is variety resistance, with ICRISAT leading the work in Malawi in collaboration with NARS and NASFAM. This is proposed as a solution that would be available in the mid/long-term, significant progress have already been made by ICRISAT on the identification of varieties with different levels of resistance and therefore along the continuum towards fully resistant varieties. From a health perspective, biological control is seen by some experts, as one of the most valuable solutions to address aflatoxin contamination in the field, in both maize and groundnuts, but as it was mentioned above, it has not yet been introduced in Malawi.

In the case of maize, manuals with general recommendations have been elaborated, and training of extension staff has been initiated, but both research efforts and projects in the field have given less relevance to the effective management of aflatoxins in this crop in comparison with groundnuts.

Overall, in Malawi, there is a consensus among stakeholders that there is no "silver bullet" solution to the aflatoxin problem, and that holistic, integrated approaches are required.

4.2.3 Testing Services and Laboratory Accreditation

The Malawian Bureau of Standards (MBS) holds, by law, the responsibility of providing testing of locally manufactured or imported commodities. Domestically, MBS implements the Merchandise Marks Act, providing a seal to manufactured products that achieved compliance with the provisions of the Act. MBS's laboratory has provided testing services to groundnut exporters in the past; however, in recent years, there is a lack of confidence by the private sector in Malawi in the services provided by the MBS laboratory, and, therefore, regaining this trust is a critical step in the process of developing the country's quality and testing capabilities.[22]

The mycotoxin laboratory located at the Chitedze Agricultural Research Station (CARS) has been established as a national reference laboratory for mycotoxin analysis. CARS is associated with research services and carries out testing services of raw materials such as aflatoxins in groundnuts and maize. The lab has so far provided reliable aflatoxin testing of over 500 samples from processors and exporters. It has also carried out over 1500 tests of research samples and it is currently the only operational lab for quantitative analysis of aflatoxins in Malawi[23] There are also other laboratories at ICRISAT, Value and Nutrition and AfriNut, which have acquired rapid, cheaper, user friendly technologies such as ELISA and VICAM.

Neither MBS nor CARS are accredited. An assessment carried out in 2011, by an external consultant, found several deficiencies in all the labs assessed in Malawi, which should be solved before any attempt to achieve accreditation status is pursued. In the case of the MBS, the EU is funding the SQAM (Standardization, Quality Assurance, Accreditation, Metrology) Project, with investments in enhancing

[22] Currently, MBS is not providing testing services to exporters.

[23] For quality control of analytical tests, the laboratory procured maize and groundnut certified reference materials and results have shown that tests are reliable and accurate. Additionally, the laboratory has been performing inter-laboratory comparison with three European accredited laboratories and the results have been comparable with a very small coefficient of variation.

the capacities of MBS estimated at 3.8 million Euro. The support includes significant investments in infrastructure (building construction) and equipment and also support for accreditation of food-quality related labs. However, it is expected that this process will take a few years.

In the case of Chitedze Agricultural Research Station (CARS) efforts have been made to correct deficiencies identified, and the laboratory is currently carrying out tests for several organizations in Malawi. The laboratory has the most sophisticated equipment for aflatoxin testing in Malawi, which was donated under the EU-funded SADC Food Safety Capacity Building on Residue Control (FSCBRC) project. Under the same project, an in-service training course on ISO 17025 at Chitedze was carried out in 2012 and additional equipment required was procured. To date the laboratory has validated an HPLC analytical method for groundnuts, maize and groundnut oil and prepared quality manual. Current, on-going investments by the government in personnel and infrastructure would facilitate the accreditation process in the short-run, which could be achieved with a relatively small sized investment.[24] For Malawi, finding synergies between the investments to be made at MBS and CARs is critical. However, given the progress already made at the aflatoxin laboratory at CARs, providing the technical support needed for the laboratory to consolidate its position as an aflatoxin reference laboratory is critical.

The CARS laboratory has been charged with the responsibility of coordinating regional laboratory proficiency tests for 15 countries, including Ethiopia, Mozambique, Rwanda, Tanzania, Zambia, Ghana, Uganda, South Africa, Malawi, Senegal, Kenya and Nigeria. This initiative is collaboratively being coordinated by the African Agricultural Technology Foundation (AATF), USDA-FAS and IITA. It is envisaged that these countries, over the next two years, will develop and adopt a common sampling protocol and establish common aflatoxin testing methods and protocols.

At the level of national standards, current quality standards for maize and groundnuts include specifications for allowed levels of aflatoxins. In the case of raw groundnuts, the maximum allowed levels for in-shell nuts is 10 ppb and 3 ppb for kernels. In the case of maize, the level is 3 ppb. Levels have also been established for peanut butter.

From the quality perspective, the validity of these standards might need to be analyzed, in consideration to maximum accepted aflatoxin levels. Further information emerging from field assessments about contamination levels and exposure would provide the basis for confirming the validity of the established maximum levels or the need for further adjustments, a process that could be done in coordination with regional initiatives that might emerge. The level of enforcement of current standards is not well understood. MBS carries out testing of processed food, but it is not clear how systematic this process is. Furthermore, with the liberalization of groundnut trade (and partial liberalization of maize), the quality standards for raw products are not really embedded into regulations and therefore are not enforced. For example, in the case of groundnuts, prior to the market liberalization period, quality standards (including strict sorting) was enforced by the government marketing agency—ADMARC: Agricultural Development and Marketing Corporation—, however, during the post-liberalization period, private traders buy groundnuts independently of quality as standards are not enforced.

Conclusively, as illustrated above, the country has been making important progress on the efforts to effectively control aflatoxins; however, the need for further developing capacities at all levels is evident. The MAPAC proposed framework focuses on: i) developing further evidence on impacts; ii) creating awareness about such impacts; iii) mainstreaming adoption of improved practices/technologies; iv) strengthening sampling and testing capacities, and overall strengthening of the standards and policy

[24] As regards to human resource development for the laboratory, the management (Department of Agricultural Research Services) is specifically sponsoring one in-service PhD (chemistry) (completing early 2014), upgrading of one technician from diploma to degree (completing mid 2014) and successfully trained one technician in an intensive laboratory technology course. The management has planned and budgeted for a recruitment of 2 additional chemists with a minimum of a Bachelor's degree in the financial year beginning 1 July 2013. Regarding infrastructure and equipment, the laboratory is carrying out (in progress) renovations involving flow tiling, installing dust proof windows and new air conditioners, and configuring a room into a special mycotoxin handling room. The laboratory has also procured miscellaneous equipment including freezers.

framework to guide and support improvements. Furthermore, the program has been developed under a collaborative and consultative approach to ensure coordinated action.

5. The Proposal: Malawi Programme for Aflatoxin Control (MAPAC)

5.1 Program Vision, Overall Purpose and Objectives

Vision

MAPAC is aligned with the concerted regional vision stated by the Partnership for Aflatoxin Control in Africa (PACA).

> "*MAPAC envisions Malawian farmers, farm households and consumers living healthier and more prosperous lives as a result of reducing aflatoxin exposure to achieve safe levels*."

Overall Purpose

MAPAC aims at improving the health and livelihoods of Malawian farmers, farm households and consumers through effective management and control of aflatoxin-related risks. MAPAC seeks to achieve this through targeted and coordinated interventions to consolidate benefits across three main areas: trade and market access; nutrition & health; and agriculture and food security.

In line with this general purpose, MAPAC's goals are:

- Increase Malawian farmers (with a particular emphasis on small-scale ones) income by enabling sustained market access to domestic and international markets;
- Improve Malawian consumers' health & nutrition by reducing their aflatoxin exposure to safe levels, with associated gains in productivity and long-term healthcare cost reduction; and
- Support food security through improving the quality and safety of groundnuts and maize (and other crops) produced by Malawian farmers.

Strategic Objectives

- Build consensus on the focal areas/intervention points to effectively control aflatoxins in Malawi;
- Improve coordination and collaboration of efforts (including inter-sectoral coordination with aflatoxin-specific and broader initiatives in Malawi, as well as synergies with other aflatoxin-related initiatives at the regional and international level);
- Promote joint research and assessments on prioritized topics and develop/strengthen partnerships in key thematic areas;
- Deepen awareness among stakeholders (including consumers) on options and good practices to control aflatoxin risks;
- Improve the effectiveness of technical assistance and extension efforts by encouraging the sharing of experiences, piloting solutions and translating findings into strategic guidelines;
- Build capacities for aflatoxin control across the diverse set of stakeholders involved in maize and groundnut production, as well among supportive institutions;
- Provide strategic orientation and policy direction in relation to effective control of aflatoxins and advocate for the integration of aflatoxin controls within relevant policies and sectoral approaches; and
- Monitor the progress made by the country in the management and control of aflatoxins.

Main Objective

- Develop Malawi's capacity to effectively control aflatoxins in key value chains, through strengthening research and development efforts; mainstreaming good practices and technologies along production and postharvest stages; developing/strengthening testing capacities, and policy

and regulatory frameworks (including enforcement capacities); and increasing public awareness, consumer education and advocacy.

5.2 Strategic Approach

- **Multidimensional**— the approach recognizes the multi-dimensional nature of the impacts of aflatoxins, and therefore the need for an integrated approach to the problem to address impacts in three dimensions: Trade & Market Access; Nutrition & Health; and Agriculture & Food Security;
- **Promotes "Production System" Approaches**— the approach understands the crop specificity in relation to management practices, but also promotes the view of "production systems" for mainstreaming solutions, as maize and groundnuts are generally rotation crops, and part of farmers' traditional production systems;
- **Aligned with Global, Regional/Sub-Regional objectives and strategic priorities**;
- **Aligned with national and local priorities & investments** (NES, ASWAp, NECS, SUN)
- Promotes solutions that are: **holistic and cost-effective and informed by assessments and R&D** efforts;
- **Integrative**—leverages opportunities for integrating aflatoxin risk-reduction management practices & technologies into current and planned commercialization and productivity efforts;
- Recognizes that differences between **informal versus formal commercial channels;**
- Founded on strong **public-private sector collaboration;**
- **Avoids duplication**— to the extent possible, activities under the program would make use of current structures/platforms/committees for the prioritization and coordination of efforts;
- **Outcome orientation**—defines indicators for monitoring progress and results; and
- **Dynamism and flexibility—**MAPAC is designed as flexible and dynamic program to be shaped by the knowledge that will become available through regional and local efforts, and from experiences that are learned, disseminated and shared.

5.3 Programme Framework for Capacity Development and Proposed Components

The program is aligned with PACA's continental framework for aflatoxin control. It proposes a system approach to aflatoxin management, including interventions to build the internal capacities of supply chain actors to control aflatoxins, as well as strengthen external supportive capacities in relation to testing, training services, etc. The framework is presented in Figure 6.

The entry points for capacity development are grouped into three components:

- **Component 1:** Mainstreaming (integrating) good practice and technologies in maize and groundnuts value chains (and possible expanded to other commodities);
- **Component 2**: Testing, Standards & Policies; and
- **Component 3:** Public Awareness, Advocacy & Consumer Education.

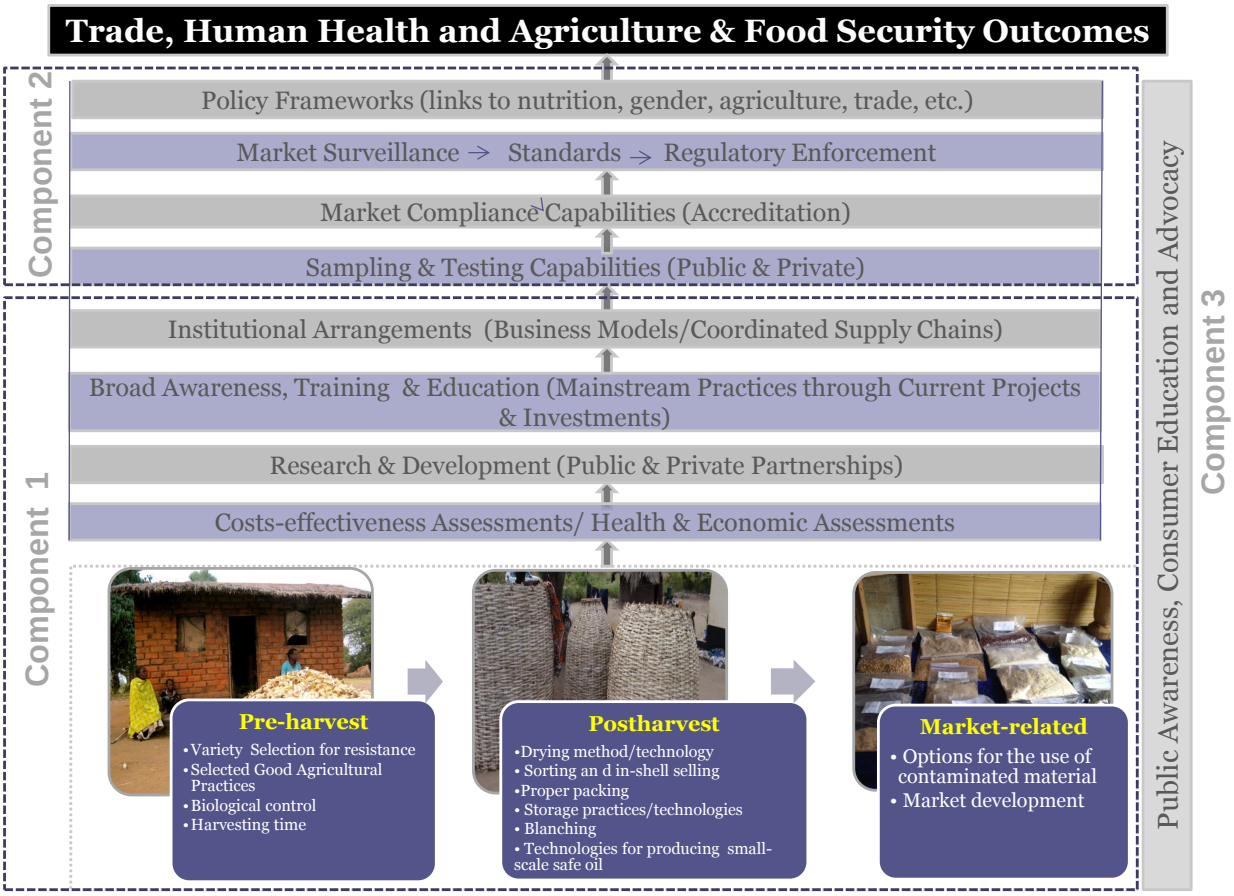
Component 1: Mainstreaming (Integrating) Good Practice and Technologies into key Value Chains:

The objective of this component is to create awareness and understanding of the importance and options for controlling aflatoxins (and mycotoxins, more broadly), and to promote their adoption through training, education and coordinated investments. Activities under this component will be implemented through three sub-components: i) research and assessments; ii) awareness creation, training & technology

transferring; and iii) institutional arrangements/business models for best practice and technology adoption.

The assessment activities contribute to a better understanding of the extent of the aflatoxin problem in Malawi and its economic and health impacts; while the research activities focus on the identification of localized solutions and/or the piloting and validation of technologies and practices that have been proven effective in other countries. Through collaborative partnerships and learning alliances, identified cost-effective practices and technologies would be mainstreamed along key value chains, with an initial focus on maize and groundnuts. The mainstreaming of technologies and practices will consider the high level of informality in these value chains and the high levels of on-farm home consumption (particularly in maize).

Figure 6. MAPAC's entry points for development capacities for aflatoxin control



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***Sub-component 1.1— Assessments and Research*:** The effective control of aflatoxins is the result of multiple and inter-related areas of action. The activities under this subcomponent will contribute to improving the understanding of the prevalence of aflatoxins (and of other mycotoxins) in maize and groundnut value chains in Malawi, and of their associated health and economic impacts; and the identification and piloting of cost-effective technological and management solutions.

Activities prioritized under this sub-component in the short/mid-term include:

Assessments—

- Multi-year assessment of the occurrence and prevalence of aflatoxins (and fumonisins) in maize, their association with dietary intake and assessment of the levels of aflatoxins/fumonisins in blood samples through the use of biomarkers. This assessment will build on the preliminary work done by

ICRISAT in 2008/2009 and the pilot-study on biomarkers, currently under implementation, to assess the level of exposure of the Malawian population to aflatoxins. The assessment can be used to set baselines for aflatoxin exposure in order to monitor the effectiveness of interventions. The study will also build on recent efforts undertaken in other countries to assess the cost-effectiveness of proposed aflatoxin risk-reduction solutions.

- Undertake further research to study the association between aflatoxin contamination and stunting (advocate for Malawi to be part of efforts to be undertaken/supported by PACA in that regards)

- Complement the assessments of the distribution of aflatoxins in groundnuts carried out by ICRISAT in 2008/2009, to include large sample numbers, multi-year assessments, and more quantitative analytical test.

- With further funds and support, the program will expand to cover other relevant crops/food products, and preliminary assessments will be undertaken on the prevalence of aflatoxins on those selected crops/food crops (e.g., cassava).

Research activities—

In this area, research efforts are undertaken by NARS/ICRISAT in relation to variety development of groundnuts for aflatoxin resistance, a process that is complex, representing a potential solution in the long-term. Priority research activities on which the program could focus in the short/mid-term are:

- **Continuity of on-going research on variety development for resistance/tolerance to aflatoxins** — this work has been led by ICRISAT and it is part of the institution's long-term research program on groundnuts. It is important to analyze the possibility of extending it to maize.

- **Bio-control—** it is critical for Malawi to engage proactively on the regional efforts to develop biological control options (e.g., Aflasafe). A priority activity is to develop strong links with the initiatives currently under implementation in Zambia and Mozambique, which also include collective efforts to establish standards/procedures for the registration of biological control agents in these countries—but also including Malawi.

The process of developing biological control products for aflatoxins generally consists of the identification (in cooperation with farmers) of the best local, atoxigenic strains of *Aspergillus* as competitive exclusion agents against toxin-producing strains; the development of field trials; and the evaluation of the cost-effectiveness. Further work could include identification of possible models for the commercialization of these strains and subsequent product and market development.

Considerations to be taken into account in Malawi for the analysis of bio-control as an aflatoxin control option includes:

- learn from implementation experiences in Mozambique and Zambia, and also from other countries, and analyze the possible cost-effectiveness of the technology and of the suitability of public and private existing structures as potential avenues for the distribution of bio-control products to farmers; and

- understand the current distribution of toxigenic and non-toxigenic strains of *Aspergillus spp* on selected maize and groundnut production areas in Malawi—an activity that can be carried out in conjunction with the identification of promising non-toxigenic strains.

These activities should be implemented under the coordination of regional/international research organizations, but in close coordination with national research organizations and seeking the involvement and active participation of key national stakeholders.

- **Conduct detailed research into the most appropriate drying/storage systems to be applied in formal and informal value chains**— in the case of groundnuts, a first activity in this regard is the

need for assessing the level of acceptability (and adoption) of the "Mandela cock technique"[25] by farmers and if theft is found to be a serious issue limiting the adoption, research efforts would need to refocus on developing/disseminating alternative drying practices/technologies. These efforts could be complemented with the assessment of the technical and socioeconomic viability of hermetic bags (and other type of bags) for transportation and storage of groundnuts.

- **Conduct research to better understand the effectiveness of groundnut shelling technology**— There is a lot of shelling technology on the market and a growing willingness by farmers to use mechanical shellers, but there is evidence to suggest that performance has generally been very poor. Most high capacity shellers are imported and do not seem to work well with the Malawian groundnut. There is also a growing number of local artisans making manual shellers, however performance is inconsistent. There seems to be a need for research to inform the design and adaptation of mechanical shellers to complement other strategies propagated by MAPAC such as the proposed shift from buying shelled nuts to buying in-shell nuts at the farm gate.

- **Conduct research on alternative options for product contaminated with aflatoxins**— including its use as biodiesel and cooking oil (in the case of groundnuts) and options for de-contamination. For this activity, collaboration and engagement with regional and sub-regional initiatives is critical.

- **Conduct research to better understand the effects of irrigation and fertilization as an aflatoxin risk-reduction measure in Malawi** — in consideration to the ongoing efforts to expand irrigation and fertilization used in maize and groundnut value chains, efforts that can help to understand the contribution of these measures to control aflatoxins are welcome developments.

Overall, an opportunity that the country could explore is to become a regional center of excellence for groundnut research and innovative practice— an effort that could be pursued through MAPAC, to gain the support of the regional and sub-regional initiatives.

Sub-component 1.2— awareness creation, training and technology dissemination/transferring: This subcomponent aims to create awareness and develop capacities across farmers, traders, processors, extension services and service providers for aflatoxin control in maize and groundnuts.

Activities prioritized under this sub-component include:

- *Develop and implement an extension and skills development plan for the maize and groundnut sectors*, with a view to create awareness and improving farming and postharvest practices that will boost productivity, reduce aflatoxin contamination and contribute to safe consumption, domestic and export market development.

i) Take stock of the learning that is taking place through applied research and through the implementation of the projects and initiatives aimed at mainstreaming good practice/technologies along groundnut and maize value chains—identify what seems to be working and what does not. What is being piloted? What innovations are emerging?

ii) Identify what technologies/practices are ready for broader dissemination and which ones would need further validation and assessments before being mainstreamed / disseminated.

ii) Design a matrix of targeted clients, define their specific needs; the key messages (practices/technologies) to be transferred and the most promising extension methods/communication channels to be used or to be piloted to create awareness, deliver training and education. Develop plans of action to target specific group of stakeholders.

- Agriculture extension providers and service providers

[25] The Mandela cock is a technique developed by scientists in South Africa and has been tested and recommended by ICRISAT/Department of Agriculture Research Services in Malawi. It is a structure that uses the free flowing air to gradually remove moisture from groundnut pods.

- Farmers (women and men) and farmer clubs & community-based organizations
- Local traders & formal traders
- Small & large local processors

iii) Design a strategy for rolling-out the plans through current or new initiatives/projects, and for the coordination of activities, the sharing of experiences, the incorporation of knowledge and technologies as they arise, and the monitoring of progress. Plans can be developed initially for specific target groups and can also be implemented in phases to take advantages of initiatives that are already emerging or planned. For example:

The Plan for enhancing capacities of extension workers and service providers (public-private) could build-upon the work initiated by the DARS and ICRISAT (mentioned earlier), expanding to engage other relevant public and private actors and experiences, with the purpose of establishing a learning alliance through which capacities of extension services are strengthened on the basis of 'learning by doing', and sharing knowledge and experiences. Thus, extension professionals are exposed to knowledge and selected tools/methods (specific videos, manuals, farmers training methodologies), whose usefulness is validated within the context of existing projects/initiatives or current activities, and adaptations proposed as a result of the implementation experiences. This implies a systematic process of learning by doing and assessing effectiveness, rather than a single-training activity or set of workshops about methods/strategies for aflatoxin control.

***Sub-component 1.3. Strengthening supply-chain coordination for mainstreaming practices/ technologies*:** Broad training and education programs will be complemented by more targeted interventions to facilitate the adoption/piloting of specific technologies and new supply chain arrangements. For example, farmer collective shelling and grading as a business enterprise; development of in-shell supply chains; developing storage services and Warehouse Receipt Systems; validating storage technologies; piloting commercial models for bio-control, and overall testing/piloting different type of business models. Furthermore, activities that can be considered under this sub-component could be the establishment of 'thematic hubs' for prioritized interventions areas: e.g. "**Drying and Storage Hub**" for both (maize and groundnuts or per crop) to pilot innovations, bring international expertise, engage with regional efforts (e.g., AflaSTOP),[26] discuss implementation challenges, etc.

Priority activities under this component:

- identify the models that have been tested in the past or are being tested and share lessons from implementation experiences;
- establish "technology/practice hubs" and share experiences of piloting initiatives as they emerge (e.g. Drying & Storage Hub) and engage with regional efforts;
- develop capacities of buyers, traders and small enterprises to articulate proposals to benefit from productive alliances, public-private partnerships, challenge funds and any other public-private partnerships that are supporting investments in maize and groundnut value chains.
- develop a system for assessing the effectiveness of the models emerging.

Component 2: Testing, Standards & Policies

Activities under this component seek to: i) strengthen the capabilities of Malawian organizations and stakeholders for diagnostic, sampling and testing of aflatoxins (and mycotoxins more broadly); ii) update relevant standards iii) provide a supportive regulatory policy framework for the application of

[26] AflaSTOP: Storage and Drying for Aflatoxin Prevention (AflaSTOP), a project implemented in Kenya by ACDI-VOCA, aiming at testing innovative drying and storage technologies, leverage partners to commercialize these technologies, and scale storage technologies that will reduce aflatoxin and post-harvest losses at the smallholder farmer level across the African continent.

aflatoxin control measures; and iv) advocate for the integration of aflatoxins as a critical component of relevant policies. This component would be implemented through two sub-components: 1) diagnostic testing and accreditation and 2) standards, regulations & policy frameworks.

Subcomponent 2.1. Diagnostic testing and accreditation: Prioritized activities to be implemented in the short- term under this component include:

- Support the process of accreditation of the CARS laboratory;
- Follow-up on the progress made in the development of the capacities of the MBS towards the achievement of accreditation status;
- Training buyers and other key stakeholders on sample protocols and the use of simple diagnostic/testing methodologies;
- To provide a regulatory framework to support the development of biocontrol options
- To engage with MBS in order to contribute to the shaping of the program in relation to the adoption of food safety systems by SMEs (GMPs and HACCP)[27]

***Subcomponent 2.2. Standards, regulations and policy frameworks*:** Among several stakeholders in Malawi, the view is that regulatory intervention is a necessary complementary measure to achieving important gains in the fight against aflatoxins. Possible entry points for interventions that have been mentioned include: mandatory sorting and grading by groundnut farmers; the establishment and enforcement of buying seasons to avoid early buying of wet groundnut crops; formalize marketing through licensing of buyers and traders; updating and enforcement of standards in maize and groundnuts, etc.

These issues require further discussion and analysis in order to better understand the benefits and drawbacks of regulatory interventions, and the implications in terms of capacities and investments needed for effective enforcement.

The question that Malawi needs to answer is: what are the most economical and simple range of strategies that will help the country to achieve trade, health and food security objectives. The answer is not simple, but a first preliminary step is the assessment of the cost-effectiveness of different strategies, including the proposed regulatory interventions. However, if awareness is especially weak, any attempts to manage aflatoxin risks through more specific and demanding interventions, such as regulatory enforcement would certainly become overwhelming tasks. Therefore, it is clear that the discussion and analysis on the need for regulatory intervention to achieve effective aflatoxin control needs to start, however, it needs to go hand in hand with broad investments to improve production and compliance capacity.

A possibility that the country could assess under this component is the feasibility of initiating a voluntary certification program for groundnuts targeting specialized markets, and reward producers for their efforts on delivering safe and quality groundnuts. In the case of maize, a systematic program to monitor aflatoxin levels, at least through formalized systems (e.g., routine monitoring of mycotoxins in maize-based weaning foods), would be very valuable to support awareness efforts, and provide the foundations for further regulatory initiatives that might be needed.

Furthermore, the activities under component 1 (assessments), as well as the developments at a regional level, would provide the foundation for the scope of the activities that could be undertaken in relation to updating standards.

Component 3-- Public awareness, advocacy, and consumer education:

Activities under this component seek to create broad awareness about the implications of aflatoxin exposure and how to minimize risks of Malawian consumers (urban and rural). The priority area in this in this component will be to achieve the integration of aflatoxins into Nutrition Education and Awareness

[27] Which is currently a component of the SQAM (Standardization, Quality Assurance, Accreditation, Metrology) Project.

Campaigns, to benefit from the frameworks for broad dissemination that have been established under nutrition-related initiatives.

A critical aspect to consider on the efforts to create broad consumer awareness on aflatoxins is the fact that aflatoxins are "poisonous substances," yet they also happen to affect crops that are vital in providing food security to millions of Malawians. Therefore, a critical challenge relates to refraining from implementing public awareness campaigns intended to scare consumers as a means to create demands for aflatoxin-safe maize and groundnuts. Malawian consumers would certainly benefit more from the dissemination of proactive messages that help them to identify aflatoxin risks, while highlighting the health and potential economic *benefits* of effective control and management.

At the advocacy level, activities to create awareness among policy makers and gain support to make aflatoxin control a crosscutting priority area of action. Advocacy activities need to focus on increasing the visibility of Malawi within the context of regional and sub-regional initiatives related to aflatoxin control, while facilitating their implementation at a national level, including the monitoring of results.

6 Implementation Arrangements

6.1. A Road Map for Action

As it has been mentioned before, the proposal on a programme for aflatoxin control (MAPAC) is a result of concerted action; however, it is also a call for it. Thus, before moving to analyze options for the formalization of the program through the establishment of institutional arrangements, further consultation and engagement of actors across Ministries, relevant national stakeholders and regional organizations/initiatives is needed. In the short term, immediate progress steps can be made in relation to the following areas proposed in the programme (with further interest of the different stakeholders other areas actions under the different component activities can also be undertaken):

i) **Immediate Steps:**

Component 1— Mainstreaming (Integrating) Good Practice and Technologies into Key Value Chains

Subcomponent 1.1 Assessments and Research

Activity 1—Define the scope of the assessment of the occurrence and prevalence of aflatoxins (and fumonisins) in the maize value chain, their association with dietary intake and assessment of the levels of aflatoxins/fumonisins in blood samples through the use of biomarkers. Discussions should also cover the need (or not) for undertaking further assessments in groundnuts and the utility of the proposed assessment as the defined baseline for MAPAC.

Create a working group to discuss the scope of the proposal(s) in maize (and further assessments in groundnuts), which is incorporating several interlinked dimensions:

-crop contamination; dietary intake; assessment of aflatoxins in blood samples through the use of biomarkers, and cost-effectiveness of different control options (analyze the possibilities that the assessment work can be linked to the work on bio-control)

Key actors:

Lead coordinating entity:	Department of Agriculture Research Services with the support of the MoIT.
	ICRISAT: Lead coordinating agency for the work on biomarkers.
Partners:	USDA, NASFAM, the Kamuzu Central Hospital (Consider inviting Abt Associates) and engagement of interested donors and private actors.

Outcome: Written Proposal(s) defining roles and responsibilities and assess opportunities for funding.

Range of the Investment to be made (estimate): US$ 300,000-400,000.

Prospective donors/co-funding: USDA, Bill & Melinda Gates Foundation

Activity 2— Biological Control: Discuss and articulate a proposal for the introduction of biological control in Malawi, as a complementary measure for the integrated management of aflatoxin in groundnuts and maize in Malawi. An important entry point for this work is the initiative undertaken by SATH to promote the registration of Aflasafe at the regional level.

Key actors:

Lead coordinating entity: Department of Agriculture Research Services (providing the link to relevant national authorities and divisions within the Ministry of Agriculture and other relevant national entities) with the support of the MoIT.

Key possible partners: SATH, USDA, and IITA.

Outcome: Written Proposal(s) defining roles and responsibilities and assess opportunities for funding.

Range of the Investment to be made: US$ 500,000- US$600,000—but could be linked to the assessments above (under activity 1), to reduce costs.

Prospective donors/co-funding: Bill & Melinda Gates Foundation, USAID/SATH, USDA, DFID, and others.

Sub-component 1.2—Strengthening supply-chain coordination for mainstreaming practices/ technologies

Activity 1—Awareness/Training of Farmers: the preparation of a proposal on skills development for the different actors (service providers, farmers, traders, processors, etc.) in groundnuts and maize value chains is a priority activity in Malawi (particularly in groundnuts, given the possible expansion of investments via challenging funds/matching grants). In the meantime, progress could be made in relation to assessing the opportunities to validate the awareness creation tools prepared by ICRISAT and the Department of Agriculture at Chitedze, through current groundnuts projects and investments

Key actors:

Lead coordinating entities: ICRISAT and Department of Agriculture, Research Services with the support of the MoIT.

Key possible partners: Twin, Department of Extension Services, NASFAM, agencies/service providers implementing/financing projects on groundnuts, groundnut exporters.

Outcome: Written plan for scaling-up the use of communication tools in current groundnut projects, including strategy for rolling it out.

Range of the Investment to be made: proposal could be prepared within the context of current institutions' activities**.**

Prospective funding/co-funding: the Peanut Mycotoxin Innovation Lab (PMIL) and DFID (funding for implementation of the proposal).

* There is a funding opportunity to support awareness and training activities through the regional proposals being elaborated by ICRISAT to be submitted to the Peanut Mycotoxin Innovation Lab

(PMIL). These proposals will focus on the groundnut/peanut value chain in Malawi, Zambia and Mozambique and will address issues around breeding, agronomy, and value chain approaches to increase productivity, profitability and safety of groundnuts, including aflatoxin management. If the proposals are approved, the projects will start in late September/early October.

For this subcomponent, it is recommended to establish an informal WG to initiate a discussion about harmonization of technical messages in relation to aflatoxins in groundnuts and maize. The group could be led by ICRISAT/The Department of Agriculture Research Services, and the Ministry of Industry and Trade, with the participation of public and private actors that are involved on groundnut and/or maize initiatives, and that have been engaged in the development of MAPAC.

Component 2— Testing, Accreditation and Policies

Subcomponent 2.1 Diagnostic testing and accreditation

Activity 1— Testing/Accreditation: create a task force to get support for the accreditation of the mycotoxin laboratory at CARS.

Key actors:

Lead Coordinating entity:	Department of Agriculture Research Services (Chitedze Agriculture Research Station) with the support of the MoIT.
Key partners:	Ministry of Agriculture and Food Security, Ministry of Industry and Trade, Twin, FERA (UK Food Environment and Research Agency), Donor Committee on Agriculture and Food Security (DCAFS, led by the World Bank) and other interested national and regional stakeholders.
Outcome:	Plan highlighting the road map for the accreditation of the laboratory to be submitted to interested donors/partners.

Range of the Investment to be made (estimate): US$ 10,000/15,000 (proposal preparation).

Prospective funding/co-founding: APPSA, DFID, EU, Peanut Mycotoxin Innovation Lab (PMIL). (for proposal preparation and implementation)

Component 3— Public awareness, advocacy, and consumer education

Activity 1— Integrating Aflatoxin into Nutrition Campaigns: identify key entry points for integrating aflatoxin messages within the context of the current and planned nutrition and educational campaigns, and undertake a pilot effort.

Key actors:

Key Coordinating entities:	MoIT and the Nutrition Department
Key partners:	NECS/SUN, GAIN, NARS, DFID, DCAFS and key project implementers and extension services.
Outcomes:	Writing document identifying entry points and effective messages.

Range of Investments to be made (estimate): US$ 10,000- US$15,000 (in the preparation of the proposal)

Prospective funding/co-funding: DFID

The outcomes for the proposed activities are expected in a period of 3-6 months (proposals prepared and submitted for funding).

6.2 Institutional Arrangements for MAPAC and recommendations for follow-up

6.2.1 Proposed short-term institutional arrangements

In consideration of the need for further discussions on the type of institutional arrangements needed to guide the implementation of MAPAC, a proposal is made to maintain the current informal structure, under the coordination of the MoIT, but make an effort to bring together other key actors, particularly relevant within the context of maize production and commercialization (e.g. WFP, representative of ASWAp/TWG on food security and several other NGOs as detailed in and civil society organizations working on maize and groundnut value chains—see Annex 3). Immediate key roles for the MoIT are illustrated above, in relation to provision of support and/or engagement with key institutions to support the development of the proposals. Furthermore, the MoIT will have the responsibility in leading the discussions related to the formal or informal arrangements for the coordination of MAPAC, at the level of the government agencies concerned and among concerned public and private stakeholders, more broadly.[28]

Furthermore, although several of the members of the Donor Committee on Agriculture and Food Security (DCAFS) participated in the stakeholders' workshops for the development of MAPAC, it is recommended that the MoIT officially presents this MAPAC document to the Committee to get their views and endorsement. Also, the document should be officially shared with PACA.

Outcomes:

- Establishment of an effective coordinating mechanism(s) for the prioritization of activities, coordination of actions and monitoring of progress in relation to aflatoxin control in the country.

- Endorsement of the document by the DCAFS.

6.2.2 Mid-term Institutional Arrangements for MAPAC

Public and private sector stakeholders confirmed their commitment and support for MAPAC during the validation workshop held on Lilongwe, Malawi on July 10, 2013. The main discussions during the workshop centred on the effective coordinating mechanisms for MAPAC. As MAPAC is formulated as a national program rather than a forum/network, it was considered critical to have in place strong coordinating mechanisms to ensure progress towards established objectives/expected outcomes.

Coordinating roles associated with MAPAC implementation include:

- Coordinate the elaboration of Annual Plans & support the implementation of planned activities
- Define and put in place a system to assess performance of the programme (and of working groups that emerge)
- Prepare reports and other administrative functions
- Advocacy nationally, regionally and internationally
- Fund raising for proposals elaborated in coordination with participant institutions
- Articulate activities of participants and maintain cohesion (WGs/relationship and bridge-building)
- Consolidate information about initiatives/projects implemented in Malawi (and results emerging from those activities), publications, etc. (ideally they should be available on a website)

Four possible options for MAPAC's coordinating arrangements were presented during the validation workshop, and are illustrated below. Options 1, 2 and 3, delegate the responsibility of the overall

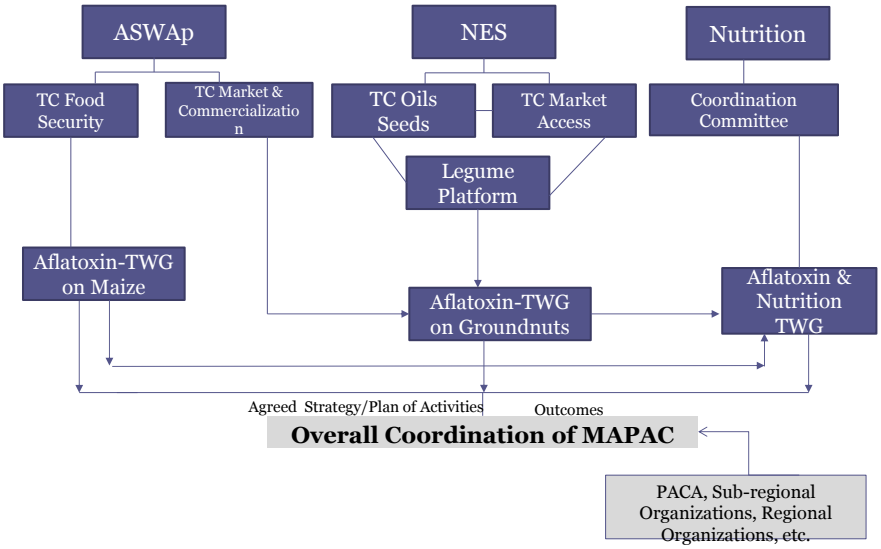
[28] During the validation workshop, several stakeholders highlighted the desire of having an independent entity coordinating MAPAC activities and ensuring that progress is made on the different components proposed. A decision was made that the MoIT will lead the discussions among the government agencies concerned, in relation to the most feasible mechanisms for the coordination of MAPAC, taking into account, among other factors, the stakeholders views, existing structures, and also budgetary considerations. A stakeholder meeting would be organized by the MoIT to communicate the results of those deliberations.

coordination to an organization (whether public or private entity). An Option 4 (informal arrangements) was also discussed at the workshop, consisting of a flexible structure where the responsibilities of the organization of meetings rotate among participant organizations. Under all options, it is recommended that a type of advisory committee or supportive/consultative group can be established with the participation of leading international and regional institutions/programs. It is critical to get regional and international organizations involved and get support for the implementation of the program.

i) Option 1— Taking advantage of existing coordinating structures established for the implementation of national strategies/plans/approaches

A set of coordinating structures have been established around the ASWAp, the NES and the National Nutrition Strategy. As illustrated in Figure 7, in the case of the ASWAp and the NES, Technical Committes (TCs) have been created. ASWAp, under the leadership of the Ministry of Agriculture, operates two Technical Committes, one on food security (focusing on maize) and the other on market and commercialization (including groundnuts). Under the NES, coordinated by MoIT, of relevance within the context of aflatoxins are the TC s on market access and legumes. Under this approach, it is proposed to establish an aflatoxin-Technical Working Group (TWG) on maize led by the Ministry of Agriculture within the context of current arrangements for the implementation of the ASWAp; while under the NES a TWG on groundnuts can be created bringing together membership from the relevant Technical Committes. A third TWG on aflatoxins and nutrition and health issues can be created under the current Scaling-Up Nutrition inititiative. The coordination of these three groups can be under a single public or private institution (to be determined) or done throught an informal arrangement between the public institutions leading the national strategies/programs. Under a formal structure, the entity in charge of the coordination of MAPAC will provide administrative support to the TWGs and will ensure cross fertilization of ideas and initiatives among them.

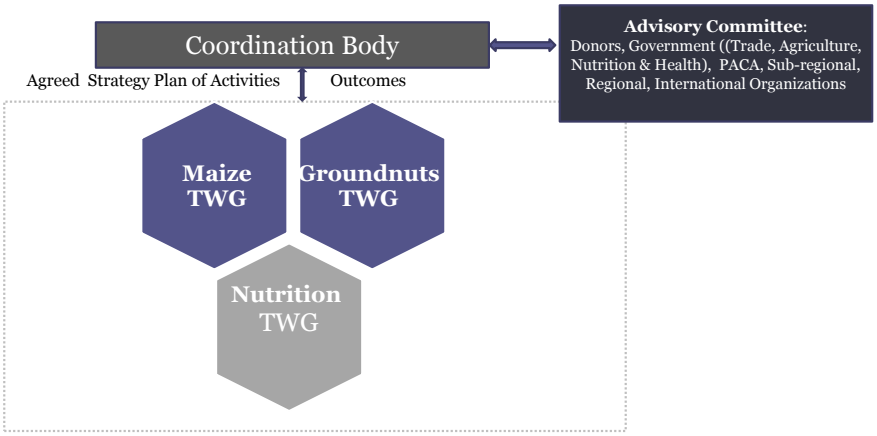
Figure 7. Institutional arrengements for MAPAC: taking advantage of current structures



ii) Option 2— Built Around Crop Specific Priorities

Under this option, MAPAC's coordination would lie with a public or private institution, with three working groups being created around maize, groundnuts and a cross-cutting group on nutritional and health aspects.

Figure 8. Institutional arrengements for MAPAC: creating new working groups



iii) Option 3— Built Around Sub-themes/TWGs

As in the options 1 and 2 above, MAPAC's coordination would lie with a public or private institution, with three working groups created around MAPAC's components: mainstreaming good practice; testing, accredditation and standards; and public awareness, advocacy, and consumer education.

iv) Option 4— Informal Arrangement— the implementation of MAPAC will lie with a type of informal working group, with either a single institution playing the coordination role or sharing responsibilities among the participants, for example, by rotating responsibilities in the organizations of working group meetings and activities.

6.3. Opportunities and challenges to institutionalize MAPAC

In response to the above proposals, several stakeholders highlighted the desire of having an independent entity/organization in charge of coordinating MAPAC activities and ensuring that progress is made on the different components proposed. Creating a new entity to coordinate MAPAC is not seen as a viable option. With the informal option (option 4), the responsibilities and costs will be shared among organizations; however, it is also considered not viable, as stakeholders believe the implementation of MAPAC needs to secure strong coordination and commitments.

Some stakeholders believe taking advantage of existing coordinating structures seems to be the best option for launching MAPAC; however concerns were raised in relation to having separate working groups for maize and groundnuts, as expertise and resources may be limited to have effective representation on both TWGs that are dealing with the same issues, but in different crops. Furthermore, setting the coordination of MAPAC in a government entity was perceived as not very effective, given the wide range of responsibilities already managed by the government. For this option to function properly, strong coordination across concerned Ministries and public institutions would be needed, and this is an area where some stakeholders believe improvements are still to be made. Furthermore, a budget would need to be secured to support the hiring of the needed personnel or arrangements would be needed to ensure that the additional functions would be covered by existing personnel and structures within the organization.

The African Institute of Corporate Citizenship (AICC), currently coordinating the Legume Development Trust (formally known as the legume platform), was mentioned as a possible independent coordinating body, however, there were concerns about the cost implications and who will cover those costs. It is estimated that a simple structure for MAPAC would be required, including a half-time coordinator and a part-time person in charge of developing/updating a website page with information on

MAPAC and providing administrative support to the working groups (US$ 30,000-32,000/year). Additional administrative costs, related to overhead (office/telephone, etc.) and organization of meetings should be considered as well, but they could be shared, if the coordination of MAPAC is located within an existing organization. Currently there are emerging efforts to provide support to ongoing coordinating mechanisms, for example, under the NES, DFID is hiring a technical person to support the activities under the TWG on Oilseeds, a possibility would be that activities in relation to groundnuts can be coordinated under this TWG.

A decision was made during the validation workshop that the MoIT will lead further discussions, in relation to the most feasible mechanisms for the coordination of MAPAC, among the government agencies concerned and also engaging other relevant institutions and allies. The discussions will take into account, among other factors, the views expressed by the stakeholders, existing coordinating structures, and also budgetary considerations. A stakeholder meeting would be organized by the MoIT to communicate the results of those deliberations. It was also agreed that, in the meantime, MoIT would coordinate activities related to MAPAC.

7. Results Framework for the Overall Program (reference)

i) Short-Term Results Framework

Activity	Leading Responsible Agency/Organization	Time-frame
Proposal(s) development on assessment of aflatoxin in maize and introduction of biocontrol as a complementary measure for the integrated control of aflatoxins in maize and groundnuts (activities 1 & 2)	Lead Organizations: DARS in coordination with MoIT (involving several partners)	Proposal formulated and submitted to donors by early October 2014 (A discussion among possible partners in relation to biological control took place in Malawi on August 8, with the participation of COMESA, IITA, USAID/USDA , the Malawian Department of Agriculture and MoIT)
Assessing the opportunities to validate the awareness creation tools prepared by ICRISAT and those prepared by the Department of Agriculture at Chitedze, through current groundnut private and public projects and investments	Lead Organizations: DARS and ICRISAT	Strategy for engagement with ongoing projects developed by October 2014
Task force to get support for the accreditation of the mycotoxin laboratory at CARS.	Lead Organizations: DARS in coordination with MoIT (involving several partners)	Proposal on strengthening laboratory developed by early November (subject to funding for TA in the preparation of the proposal).
Integrating Aflatoxin into Nutrition Campaigns: identify key entry points for integrating aflatoxin messages within the context of the current and planned nutrition and educational campaigns.	Lead Organizations: MoIT and Nutrition Department (support of DFID)	January 2014 (Subject to funding for preparation phase)
Discussions leading to the establishment of an effective coordinating mechanism (s) for MAPAC	Lead Organizations: MoIT	Definition of mechanisms by early October
- Presentation of MAPAC document to DCAFS, and sharing with PACA and other relevant regional and international organizations	Lead Organizations: MoIT	August to early September

ii) Mid-Term Results Framework: Five Years (Reference)

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal: Improving the health and livelihoods of Malawian farmers, farm households and consumers through effective management and control of aflatoxin-related risks **Specific goals:** - Increase Malawian farmers (particularly small-scale ones) income by enabling sustained market access to domestic and international markets; - Improve Malawian consumers' health & nutrition by reducing their aflatoxin exposure to safe levels, with associated gains in productivity and long-term healthcare cost reduction; and - Support food security through improving the quality and safety of groundnuts and maize (and other crops) produced by Malawian farmers.	- Malawi nutrition & health indicators improve from baseline - Increase in the volume of groundnut exports, specially to aflatoxin-sensitive markets - Increase in the share of export price/sale price of groundnuts by smallholders - Reduction in the percentage of sample tested in Malawi reporting unsafe aflatoxin levels (both for maize and groundnuts)-- as per current national standards or Codex standards - Number of farmers that adopt improved technologies/practices for aflatoxin control - Local demands of RUTFs fully satisfied with quality and safe groundnuts from Malawi	- Malawi public health and nutrition indicators - Malawi productivity and trade indicators for maize and groundnut - Laboratory reports - Project reports - Companies/buyers' records	- Macro-economic and political stability - Proactive Government involvement and leadership - Donor interest, engagement/support - Malawi is able to maintain its competitive advantage in the production of groundnuts (and maize) in the region - No major weather events occur
Program main purpose/objective: Develop Malawi's capacity to effectively control aflatoxins in key value chains, through strengthening	- Reduction of aflatoxin contamination in maize and groundnut products (from 2009 and 2013 baselines) -- Increase in the volume of groundnut exports, specially to aflatoxin-	- Malawi productivity and trade indicators for maize and groundnut	- Stakeholders interest - Malawi is able to maintain its competitive advantage in the

research and development efforts; mainstreaming good practices and technologies along production and postharvest stages; improving testing, policy and regulatory frameworks; and increasing public awareness, consumer education and advocacy	sensitive markets - Local demands of RUTFs fully satisfied with quality and safe groundnuts from Malawi - Reduction in the percentage of sample tested in Malawi reporting unsafe aflatoxin levels (both for maize and groundnuts)-- as per current national standards or Codex standards - Increase in the number of analytical test carried out in-country by accredited laboratories	- Laboratory reports - Project reports - Companies/buyers' records - 2014 baseline study; aflatoxin sampling across value chain; ex-post impact assessment	production of groundnuts (and maize) in the region - No major weather events occur - Proactive Government involvement and leadership - Donors' interest/engagement/support
Outputs: **Component 1- Mainstreaming (integrating) good practice and technologies across groundnuts and maize value chains** **Research and Assessments**			
(1) Scale of the aflatoxin (fumonosis) problem quantified through assessing prevalence/occurrence in maize crops, analyzing blood samples and relating it to dietary intakes.	- Aflatoxin contamination in maize value chain mapped, and key intervention sites determined/levels of exposure determined. Results are communicated to stakeholders.	- Progress reports - Geo-spatial maps - Peer-reviewed publications of ex-ante baseline study and ex-post impact assessment. - Workshop documentation	- Good collaboration among partners - Government leadership/interest
(2) Biocontrol of aflatoxins to reduce maize and groundnut crop contamination deployed/Registration by regulatory authorities	- Registration procedure approved by crop protection authorities - Number of farmers that use biocontrol product against aflatoxin	- Project Reports; registry. - Progress reports	- Good cooperation among partners nationally and regionally/Donor interest
(3) Cost-effective drying, storage and shelling methods are identified and validated	- Number of technologies identified and validated (including cost/effectiveness)	- Progress reports	
(4) Options for the use of contaminated product are identified	- Number of technologies identified and validated (including cost/effectiveness)	- Progress reports	
(5) Options for the de-contamination of sub-products (oil and cake) in small-scale enterprises identified and validated	- Number of technologies identified, validated (including cost/effectiveness)	- Progress reports	
(6) Benefits of integrated	- A cost-benefit analysis performed to identify intervention methods		- Good cooperation among partners nationally and

management approaches against pre- and post-harvest aflatoxin contamination determined and promoted	(e.g., biocontrol, drying, storage and low-cost diagnostics) with the best returns in reducing the levels of aflatoxins in the value chains of maize		regionally/Donor interest
Awareness creation, training and technology dissemination/transferring		- Training attendance lists - Number of multiplication events	
(7) Capacities for effective aflatoxin control, of extension services (public and private) strengthened ; (8) Effective awareness, training and communication tools and methods identified, piloted and mainstreamed through groundnuts and maize projects	- Skill development program targeting different stakeholders developed - Number of extension services staff (public & private) trained - Number of training methodologies and materials/tools validated/developed and piloted. - Number of projects that incorporate "aflatoxin training/investments" as part of their activities	- Number of re-inforcing/experience sharing workshops - Videos, training materials, etc. - Project reports	- Good cooperation among partners nationally and regionally/Donor interest/ farmer interest
(9) Capacities for effective aflatoxin control of farmers, and other key actors in the maize and groundnuts value chains strengthened	- Number of farmers and traders trained - Number of farmers/traders that applied integrated approaches/methods for the control of aflatoxins (e.g. # farmers adopting proper drying and storage technics; biological control, GAP);	- Training attendance lists - Number of events - Project reports/Monitoring Systems	- Farmer interest - Incentives for adoption (e.g. Aflatoxin training linked to productivity enhancing projects; better prices, etc.)
Strengthening supply-chain coordination for mainstreaming practices/ technologies			
(10) Learning Alliances and Thematic Hubs consolidated as critical platforms for the exchange of experiences among groundnut and maize stakeholders	- Number of thematic groups emerging/Number of meetings/workshops, etc.	- Meeting notes/agenda	- Good cooperation among partners nationally and regionally/Donor interest/ farmer interest
(11) Maize and groundnut's value-chains strengthened through increasing coordination between farmers and buyers and through partnerships involving different organizations	- Number of partnerships established and number of farmers participating	- Project reports - Number of projects approved (challenging funds, innovation grants, etc.)	
(12) Business models/institutional arrangements for the dissemination and/or	- Number of business models piloted and mainstreamed (e.g. centralized service provision; Warehouse receipt systems, etc.)	- Project reports	- Good cooperation among partners nationally and

commercialization of technologies/practices piloted and mainstreamed	- Number of farmers participating in coordinated supply-chains		regionally/Donor interest/ farmer interest
Component 2- Testing, Standards and Policies			
(13) Reliable and accredited facilities carried out aflatoxin (mycotoxins) analysis in support of monitoring systems, research projects and commercial services to the industry	- A laboratory is accredited and providing research, surveillance/regulatory and commercial services - Sampling protocols established and applied - Revised standards	- Laboratory records - Document on sampling procedures - Number of training events on sampling	- Demand for services increase - Good cooperation among partners nationally and regionally/Donor interest/ Government interest
(14) Quality standards (including maximum aflatoxin levels) for maize and groundnuts standards revised and updated if needed.	- Analysis of the Cost/benefit of regulatory enforcement of standards/other selected measures - Quality program for groundnuts (and possible for maize) operating	- Report/standard document - Report document - Program records	
(15) Quality and Safety Program for Groundnuts for exports implemented	(grades and standards, as well as routine implementation of ELISA along groundnut value chain, to enhance market linkages/ monitoring)		
(16) Aflatoxins are integrated as a core part of agriculture, nutrition & health and trade policies.	- Number of training events, seminaries targeted to government officials, - Plan highlighting the strategy for integrating aflatoxin into on-going nutrition initiatives	- List of attendees, workshop agendas, meetings, etc. - Plan document	- Good cooperation among partners nationally and regionally/Donor interest/ Government interest/Consumer interest
Component 3- Public awareness, advocacy, and consumer education:	- Number of training events; pamphlets and communication materials prepared and distributed	- List of attendees - Number of events	
(17) Aflatoxin awareness/education is incorporated as core element of nutritional campaigns	- Participation in regional events and benefiting from regional projects/investments	- Number of projects funded through regional initiatives	
(18) Malawi participate proactively and benefit from the engagement in regional and sub-regional initiatives related to aflatoxin control	- Number of MAPAC's initiatives funded.	- Number of projects/initiatives funded under MAPAC/Size of the investments made	
(19) Proposed elements of this program are properly supported and funded by government agencies and development partners		- Project reports	

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Annexes

Annex 1—List of stakeholders consulted (participants to consultation workshops and approach individually through phone and personal interviews)

Name	Organization	Email Address
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Annex 2—Recent Aflatoxin Related-Initiatives in Malawi

Activities	Partners	Funding
Groundnut variety improvement for yield and adaptation, human health and nutrition: includes breeding for low aflatoxin and field management practices	ICRISAT/NARS/NASFAM	McKnight Foundation/CCRP
Post-harvest value-chain technology improvements in groundnuts in Malawi and Tanzania, includes local manufacture of tools for groundnut handling & processing	ICRISAT/NASFAM	McKnight Foundation/CCRP (2009-2013)
Mapping of aflatoxin contamination of groundnuts and products in Malawi - national survey completed 2009/10	ICRISAT/NASFAM	McKnight Foundation/CCRP (2009-2010)
Groundnut variety improvement for yield and adaptation, human health and nutrition: includes monitoring blood aflatoxin loads	ICRISAT/Lilongwe Central Hospital	McKnight Foundation/CCRP (2010-2014)
Analysis of groundnut markets in Malawi - includes impact of aflatoxin on trade.	NRI PhD studentship	McKnight Foundation/CCRP (2007-2009)
Groundnut variety improvement for yield and adaptation, human health and nutrition: includes developing education materials and links to policy makers.	ICRISAT/ NASFAM/ NARS	McKnight Foundation/CCRP (2006-2010)
Post-harvest value-chain technology improvements in groundnuts in Malawi and Tanzania, includes aflatoxin testing of ingredients for infant complimentary foods	ICRISAT/NASFAM | Sokoine University of Agriculture	McKnight Foundation/CCRP (2009-2013)
Innovative communication media and methods for more effective aflatoxin mitigation, variety uptake and use interventions in groundnut in Malawi and Tanzania	Danish Management / ICRISAT | ARI Naliendeli	McKnight Foundation/CCRP (2011-2012)
Capacity building for aflatoxin management and control in groundnuts in Malawi	UNIDO, ICRISAT	UNIDO (2008-2011)
Value chain analysis of selected commodities	CYE consults	Europe Aid Beneficiary Framework (2008-2009)
Capacity Building for Aflatoxin Management and Control in Groundnuts	UNIDO	UNIDO (2009-2012)
Assessment of Aflatoxin Testing Facilities in Zambia and Malawi	AECOM International Development	USAID- South Africa; SATH, USDA (2011)
Growing With Groundnuts	Ex Agris	RLEEP (2011-2014)
Increasing incomes of smallholder farmers through enhancing their participation in the groundnut value chain	NASFAM	RLEEP (2011-2013)
Integrating Nutrition in Value Chains	Community-based organizations/Nasfam/Several other partners	USAID (2012-2015)
Developing smallholder Fairtrade nut value chains that meet European retail market standards.	Twin, NASFAM, Ikuru, POTC	DFID Regional trade Facilitation Program (2005-2009)
One year pilot. Installation of pilot peanut processing, aflatoxin laboratories and scoping for antoxigenic fungal trialling.	Twin, NASFAM, Ikuru	DFID Regional Standards Program (2008-2009)
Smallholder Nut Equipment Fund for post harvest equipment to manage crop quality including aflatoxin.	Twin, NASFAM & Ikuru	Comic Relief / Sainsbury's Fair Development Fund (2009-2011)
Quality management systems. Mapping critical control points in a smallholder peanut value chain.	Twin, NASFAM	Comic Relief, Trade Program (2006-2009)
Facilitating the start up of Afri-Nut a peanut processing joint venture in Malawi.	Twin, NASFAM, Ex-Agris Cordaid, Waterloo Foundation	DFID – Business Innovation Facility (2010-2011)
Value Chain Approach- Aflatoxin (Groundnuts)	Twin	Southern African Trade Hub (2011-2012)
Increasing female smallholders' income and health prospects through the promotion of safe groundnuts in Malawi.	Twin, NASFAM	GPAF DFID (2012-2014)
The Borlaug Fellowship Program-- fellow working to develop appropriate SPS testing protocols and methodologies in Malawi.	2012- ongoing	USDA (2012- Ongoing)
Testing Lipid Nutrient Supplements (LNS) with lower energy dose/ high micronutrients to prevent child stunting and support normal motor development.	UC Davis; Univ of Malawi; Nutriset; Institut de Recherche en Sciences de la Sante, Burkina Faso; Project Peanut Butter, Malawi, and others	Bill & Melinda Gates Foundation (On going)
Regional registration of biological control (Zambia, Mozambique, and possible Malawi)		Southern African Trade Hub

Annex 3. List of some of implementing partners of agriculture and nutrition initiatives/grants (Ministry of Agriculture and Food Security). 2011

Initiative For the Development and Equity In African Agriculture (IDEAA)
World Vision Malawi (WVM)
Farmers Union of Malawi (FUM)
AFRICARE
ACDI VOCA
Total Land Care
Catholic Relief Services (CRS)
Emmanuel International
Project Concern International
ICRISAT
National Smallholder Farmers' Association of Malawi (NASFAM)
Canadian Physicians for Aid and Relief (CPAR Malawi)
CADECOM
Evangelical Lutheran Development Service (ELDS)
Adventist Development and Relief Agency (ADRA) Malawi
Feed the Children International
Concern Universal (CU)