STRENGTHENING AFLATOXIN CONTROL IN UGANDA: POLICY RECOMMENDATIONS

BASED ON FINDINGS OF THE COUNTRY-LED SITUATION ANALYSIS AND ACTION PLANNING (C-SAAP) CONDUCTED FROM 2014 TO 2017 BY THE PARTNERSHIP FOR AFLATOXIN CONTROL IN AFRICA (PACA)

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1. WHAT ARE AFLATOXINS?

Aflatoxins are highly toxic metabolites that affect the safety of food and feed in tropical and subtropical regions of the world, including Uganda. They are mainly produced by *Aspergillus flavus* and *Aspergillus parasiticus* fungi that reside in soil. There are four types of aflatoxins that are important in health and agriculture: aflatoxin B_1, B_2, G_1 and G_2. Aflatoxin B1 is the most common of the four types.

2. WHAT ARE THE HEALTH EFFECTS OF AFLATOXINS?

The health effects of aflatoxins can be categorized into two general forms: acute and chronic aflatoxicosis. Acute aflatoxicosis results from ingestion of food containing moderate to high levels of aflatoxins and is characterized by a rapid and obvious onset of toxic responses, including hemorrhaging, acute liver damage, edema (swelling), digestive difficulties, and possibly death, usually within a week of exposure. Chronic aflatoxicosis is experienced when individuals ingest low levels of aflatoxins in food over a long period. This is associated with immune suppression, low birth weight, impaired child growth and liver cancer. The biggest and best known health effect of aflatoxin is liver cancer. It is estimated that globally about 782,200 new cases of liver cancer occur yearly, and that 83% (648,200) of them occur in less developed countries, including Africa[1]. According to Liu and Wu[2], as high as 28.2% of the annual global liver cancer cases may be attributable to aflatoxin exposure and 40% of these cases occur in Africa, making liver cancer the top cause of cancer mortality in the continent. Aflatoxin B1 is recognized by the International Agency for Research on Cancer of the World Health Organization (WHO) as one of the most toxic and carcinogenic substances found in nature.

3. WHAT ARE THE TRADE IMPACTS OF AFLATOXIN CONTAMINATION?

The Food and Agriculture Organization (FAO) of the United Nations estimates that 25% of the food produced worldwide is contaminated with aflatoxins. Due to the increasing recognition of the impact of aflatoxins on human health, food regulatory authorities have set and enforced limits for aflatoxins in traded food. Stringent limits of 2 ppb for aflatoxin B1 and 4 ppb for total aflatoxins in foods are enforced in the European Union (EU). In countries that fail to meet aflatoxin standards, foreign income from aflatoxin prone foods falls as exporters cannot access strategically important international markets. Africa is reported to lose more than US$ 670 million in export earnings due to the presence of aflatoxins in farm produce per year. If a country does not have or enforce aflatoxin regulations, contaminated foods which do not meet export standards will be sold in the domestic market or used for household consumption, increasing the health risks associated with aflatoxin exposure in local communities.

4. WHAT TYPES OF FOOD ARE PRONE TO AFLATOXIN CONTAMINATION?

Aspergillus spp. can colonize and contaminate a wide variety of food commodities with aflatoxins, including maize, sorghum and groundnuts, which are staple foods in Uganda.

5. WHAT ARE THE GLOBAL REGIONS MOST AFFECTED BY THE AFLATOXIN CONTAMINATION PROBLEM?

Fungal growth and the formation of aflatoxins in food is influenced by climatic conditions. Regions and countries such as Uganda, located between 40°N and 40°S, have a tropical climate that favors growth of the aflatoxin producing *Aspergillus* spp. and are thus chronically affected by aflatoxin contamination of food and feed.

6. AT WHAT STAGES ALONG THE FOOD CHAIN DOES AFLATOXIN CONTAMINATION OCCUR?

The risk of aflatoxin contamination begins during pre-harvest and can be worsened by inappropriate harvesting, handling, storage, processing, and transport practices. Drought, high temperature, low soil fertility, pest infestation and other stresses that affect plant growth and vigor increase the likelihood of fungal infection as well as the levels of aflatoxins produced by the *Aspergillus* fungi. Aflatoxin contamination can thus be prevented by application of good agricultural practices in crop cultivation and good management practices in post-harvest food handling.

7. TO WHAT EXTENT ARE UGANDAN FOODS CONTAMINATED WITH AFLATOXINS?

Aflatoxin contamination in the key food crops of maize, groundnut and sorghum is high and widespread in Uganda. Up to 65% of maize in Mubende district and 45% in Kamwenge district contained aflatoxin levels exceeding the Ugandan maximum limit (ML) of 10 ppb for total aflatoxins (Table 1). Mubende and Kamwenge are among the major maize producing districts in Uganda.

1 Ferlay, J., Soerjomataram, I., Dikshit, R., Eser, S., Mathers, C., Rebelo, M., Parkin, D., Forman, D. and Bray, F. 2015. Cancer incidence and mortality worldwide: sources, methods and major patterns in GLOBOCAN 2012. *International Journal of Cancer* 136(5): E359-E386. Doi:10.1002/ijc.29210.

2 Liu, Y. and Wu, F. 2010. Global burden of aflatoxin-induced hepatocellular carcinoma: a risk assessment. *Environmental Health Perspectives* 118(6): 818-824

TABLE 1: OCCURRENCE OF AFLATOXINS IN MAIZE, SORGHUM AND GROUNDNUTS FROM DIFFERENT AGRO-ECOLOGICAL ZONES OF UGANDA[3]

Agro-ecological zone/Crop sampled	District	Positive samples (%)	Range of contamination (ppb)	Positive samples with levels above the ML of 10 ppb (%)
Maize				
Western Savannah Grasslands	Mubende	95	3.50 - 247.50	65
	Kamwenge	100	3.25 - 104.50	45
	Masindi	95	3.05 - 510.00	30
Kioga plains	Iganga	80	4.50 - 77.00	35
	Soroti	50	4.50 - 179.50	40
	Tororo	30	7.00 - 86.00	20
Sorghum				
Kioga plains	Soroti	100	98.25 - 265.50	100
	Tororo	90	4.00 - 215.00	70
North Eastern Savannah Grasslands	Gulu	90	5.50 - 119.50	90
	Amuria	100	28.50 - 472.00	100
	Lira	100	27.50 - 227.00	100
Groundnuts				
Western Savannah Grasslands	Mubende	25	3.0 - 13	10
	Kamwenge	30	5.5 - 12	10
	Masindi	20	2.5 - 175	10
Kioga plains	Iganga	40	2.5 - 450	20
	Soroti	60	3.0 - 31	20
	Tororo	20	3.5 - 11	10
North Eastern Savannah Grasslands	Gulu	20	4.0 - 6	0
	Amuria	60	2.1 - 17	10
	Lira	40	2.5 - 21	10

3 PACA. 2017. *Country-led Aflatoxin and Food Safety Situation Analysis and Action Planning for Uganda: Final Report*, Partnership for Aflatoxin Control in Africa, African Union Commission

Soroti, Amuria and Lira were the districts with the highest risk for aflatoxin contamination in Sorghum (Table 1), where the proportion of sorghum containing aflatoxin levels that exceed the national ML of 10 ppb was as high as 100%. Soroti district is the leading producer of sorghum and groundnuts in Uganda.

Up to 20% groundnuts from Soroti and Iganga contained unacceptable levels of aflatoxins, making these districts the highest risk for aflatoxin contamination in groundnut (Table 1). Iganga is the second largest producer of groundnuts in Uganda after Soroti.

8. TO WHAT EXTENT ARE MAIZE, SORGHUM AND GROUNDNUT IMPORTANT FOR FOOD SECURITY AND TRADE IN UGANDA?

In Uganda, maize ranks third in annual production, after plantains and cassava. It is also the most consumed cereal in Uganda and a major foreign exchange earner, with an estimated value of US$ 27,277,000 and 17,096,000 in 2010 and 2011, respectively. Groundnut is the second most important legume after beans, with a total production of 295,601 Mt and supplying 69 kcal/person/day. Most of the groundnut produced in Uganda is consumed locally as a snack or sauce, but some is used for the production of groundnut butter. In 2011, Uganda exported approximately 150 Mt of groundnuts, which is equivalent to US$ 136,000 in value. Sorghum production is well established in Uganda and has been practiced for centuries. According to the Uganda Bureau of Statistics (UBOS)[4], the Northern region is the leading sorghum producing region in the country with a total annual production of 177,000 Mt.

9. WHAT IS THE EXTENT OF AFLATOXIN EXPOSURE AMONG THE PEOPLE OF UGANDA?

According to the Living Standards Measurement Study (LSMS) data from 2012[5], in Uganda, per capita consumption rates can be as high as 179.6 g/day for maize, 160.4 g/day for sorghum and 91.0 g/day for groundnuts. Based on the data for aflatoxin contamination (Table 1), sorghum could lead to 176.83 ng/kg body weight (bw) per day of aflatoxin exposure, maize to 86.50 ng/kg bw/day and groundnut to 3.33 ng/kg bw/day aflatoxin exposure. There is a high possibility that households will prepare groundnut sauce to accompany a main meal made from either a maize or sorghum base, or both. Based on the daily per capita consumption of maize, sorghum and groundnuts, the aflatoxin exposure can be as high as as 266.21 ng/kg bw/day.

4 UBOS. 2013. *2013 Statistical Abstract*. The Republic of Uganda. Available at: www.ubos.org

5 http://go.worldbank.org/VX1NA9WGC0

10. WHAT IS THE RISK OF DEVELOPING AFLATOXIN-INDUCED LIVER CANCER IN UGANDA?

The risk of developing liver cancer (when individuals are exposed to aflatoxins) is 30 times higher in people exposed to the hepatitis B Virus (HBV) compared to those who are not. In Uganda about 10.3% of the population is HBV positive[6].

In view of the estimated aflatoxin exposure of 266.21 ng/kg bw/day, assuming the average Ugandan consumes maize, sorghum and groundnut on a daily basis, and based on the prevalence of HBV in 10.3% of the population, it was estimated that Uganda experiences a total of 3,700 new cases of aflatoxin-induced liver cancer per year. This estimation is based on the size of Ugandan population in 2014, which was 34,856,831.

11. WHAT IS THE NUMBER OF HEALTHY LIFE YEARS LOST DUE TO AFLATOXIN-INDUCED LIVER CANCER IN UGANDA?

With assumption that each liver cancer case results to death within a year, it was estimated that the 3,700 aflatoxin-induced liver cancer cases, **would lead to a loss of 269,198 healthy life years, annually.** The healthy life years lost were estimated using the disability adjusted life years (DALYs) approach.

12. WHAT IS THE ECONOMIC IMPACT OF AFLATOXIN RELATED DISEASE IN UGANDA?

Monetization of the risk for the 3,700 aflatoxin-induced liver cancer cases, using the transferred value per statistical life (VSL) method, **resulted in an estimated loss of up to US$ 577 million, annually.**

Also, aflatoxin related diseases raise demand for medical supplies and technical personnel at government funded health centers, thus generating a fiscal impact. In Uganda, aflatoxin related illnesses are estimated to cost the government an additional US$ 910,000 expenditure on health services, annually.

As labor efficiency falls due to aflatoxin related illnesses, the time sufferers spend seeking medical attention and the time spent by family members attending to the sick, more labor is required to maintain the same level of economic output in the productive sectors. This results in higher demand for labor which increases real wages, thus yielding higher employment, which translates to an increase of about US$ 13 million in expenditure on labor in the following year.

6 Bwogi, J., Braka, F., Makumbi, I., Mishra, V., Bakamutumaho, B., Nanyunja, M., Opio, A., Downing, R., Biryahwaho, B. and Lewis, R. F. 2009. Hepatitis B infection is highly endemic in Uganda: findings from a national serosurvey. *African Health Sciences 9(2):* 98-108

13. WHAT IS THE IMPACT OF AFLATOXINS ON UGANDA'S INTERNATIONAL EXPORTS?

When aflatoxin contaminated foods are rejected from the international market, Uganda's export sector deteriorates. The country-led situation analysis and action planning (C-SAAP) findings showed that the **total annual export loss due to aflatoxins is close to an estimated US$ 38 million.**

14. WHAT ARE THE PACA SUPPORTED INITIATIVES TO CONTROL AFLATOXINS IN UGANDA?

PACA supported the C-SAAP for control of aflatoxins along the groundnut, maize and sorghum value chains in Uganda. The policy recommendations in this document are based on the outcomes of the C-SAAP. Additionally, in partnership with key institutions in Uganda, PACA is generating and sharing data under the framework of the Africa Aflatoxin Information Management System (AfricaAIMS) initiative. AfricaAIMS generates data on aflatoxin contamination in groundnut, maize and sorghum, as well as on other aflatoxin related issues in the health and trade sectors. The initiative's key objective is to provide locally relevant, home grown and reliable evidence to facilitate informed decisions on policies, food safety regulations and standards, mitigation interventions (e.g. educational and technological), resource allocation, and advocacy and awareness raising activities by the Ugandan government and other stakeholders. Local capacity building, through the provision of equipment and training of personnel, is central to AfricaAIMS.

PACA also provided catalytic support to develop a resource mobilization strategy and convene business meetings to enhance ownership and financing of the national aflatoxin control plan. PACA's catalytic support extends to convening aflatoxin working groups to spearhead planning and implementation of aflatoxin mitigation actions at the country level. In order to ensure that these efforts are well coordinated, PACA has hired a country officer. PACA shall provide ongoing support to track progress in the implementation of the national aflatoxin control plan.

15. WHAT ARE THE ROLES OF KEY INSTITUTIONS INVOLVED IN THE DELIVERY OF FOOD SAFETY CONTROL SERVICES IN UGANDA?

In Uganda, there are multiple (scattered) national food safety agencies, which fall under the ministries responsible for health, agriculture and trade. The responsibilities of each ministry are as follows:

a. **Ministry of Health**
The Ministry of Health carries out food safety control in accordance with the Food Act (1993). However, the Act does not address new developments such as food additives and contaminants. Information from the Ministry of Health indicated that development of a modern and unified National Food Safety Law is underway.

b. **Ministry of Agriculture, Animal Industry and Fisheries**
The food safety roles in the Ministry of Agriculture Animal Industry and Fisheries are distributed amongst three departments, namely the Department of Crop Protection, which is responsible for formulating and enforcing regulations related to seeds, agro-chemicals and the use of pesticide; the Department of Livestock Health and Entomology, which is responsible for ensuring sustainable animal disease and vector control, as well as monitoring animal food quality and safety; and the Department of Fisheries Control, Regulation and Quality Assurance, which is responsible for regulating fish and fish products.

c. **Ministry of Trade, Industry and Cooperatives**
The Ministry of Trade, Industry and Cooperativeshosts the Uganda National Bureau of Standards (UNBS), as mandated by the UNBS Act of 1983. UNBS sets food standards. The Bureau has developed aflatoxin standards and ML for total aflatoxins of 10 ppb for several foods including maize, sorghum and groundnuts. However, there is limited enforcement of these standards. The UNBS laboratory provides analytical and certification services, but only to companies that are exporting to countries where there are aflatoxin regulations.

16. WHAT IS THE LEVEL OF AWARENESS AND KNOWLEDGE OF AFLATOXINS IN UGANDA?

The majority of agricultural value chain actors in Uganda, including extension workers, policy makers, traders and consumers are not aware of aflatoxins and their negative effects on agriculture, health and trade. Most of the value chain actors interviewed during the course of the C-SAAP work admitted that fungal infection is a common occurrence in Uganda's staple foods, but they did not associate it with health risks.

17. EVIDENCE-BASED POLICY RECOMMENDATIONS FOR THE MITIGATION OF THE AFLATOXIN PROBLEM IN UGANDA

Based on the identified gaps in aflatoxin control in Uganda, a set of recommendations were developed by the C-SAAP and validated by stakeholders. The recommendations are categorized under five major areas where Uganda should focus interventions for the control and management of aflatoxins (Table 2).

TABLE 2: STRATEGIC RECOMMENDATIONS FOR MITIGATION OF THE AFLATOXIN CHALLENGE IN UGANDA[7]

Advocacy and awareness raising
1. Carry out far-reaching awareness campaigns to sensitize stakeholders about the aflatoxin challenge
2. Develop and implement a comprehensive national communication strategy that will facilitate delivery of uniform and harmonized messages
3. Advocate for the prioritization of aflatoxin activities in the key government ministries of health, trade and agriculture, and district local governments
Farm level operations
4. Train farmers in good (pre-harvest) agricultural practices and improved post-harvest handling practices
5. Promote the use of bio-control and other effective technologies
Transportation and processor interventions
6. Train processors and produce dealers in quality control and quality assurance with respect to aflatoxins
7. Promote the formation of cooperative societies that enhance the financial capacity of processors and grain traders to acquire improved post-harvest handling technologies
8. Devise efficient alternative uses of aflatoxin contaminated produce
Public Health Management
9. Strengthen the capacity of research institutions in aflatoxin exposure and risk assessment
10. Identify aflatoxin hotspots and the major risk factors to enable public health managers to design practical strategies for the affected communities
11. Carry out HBV vaccinations to reduce the risk of developing liver cancer
12. Promote dietary diversification to reduce over reliance on aflatoxin prone foods
Policy improvement
13. Mainstream aflatoxin control in the National Development Plan and other relevant strategies
14. Enhance the monitoring and enforcement of aflatoxin standards through district authorities
15. Strengthen food safety control systems by fast tracking the relevant policies, including the Food Safety Policy
16. Integrate aflatoxin education into the national curriculum at all levels of the education system.

7 Based on the findings of the C-SAAP: PACA. 2017. *Country-led Aflatoxin and Food Safety Situation Analysis and Action Planning for Uganda: Final Report*, Partnership for Aflatoxin Control in Africa, African Union Commission

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