STRENGTHENING AFLATOXIN CONTROL IN NIGERIA: POLICY RECOMMENDATIONS

BASED ON FINDINGS OF THE COUNTRY-LED SITUATION ANALYSIS AND ACTION PLANNING (C-SAAP) CONDUCTED FROM 2016 TO 2018 BY THE PARTNERSHIP FOR AFLATOXIN CONTROL IN AFRICA (PACA)*

*The 2017 version has been updated in March 2018 based on the revised C-SAAP report

PACA

Partnership for Aflatoxin Control in Africa

Partenariat pour lutter contre l'aflatoxine en Afrique

Parceria para o Controle da Aflatoxina em África

الشراكة من أجل مكافحة الافلاتوكسين في أفريقيا

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 Nigeria. 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 B1, B2, G1, and G2. 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 IN FOODS?

The Food and Agriculture Organization 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 4ppb 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 have lost more than US$ 670 million per year in export earnings due to the presence of aflatoxins in farm produce. 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 and groundnut, which are staple foods in Nigeria.

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

Fungal growth and the formation of aflatoxins in food are influenced by climatic conditions. Regions and countries, such as Nigeria, located between 40ºN and 40ºS, have a 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. Droughts, high temperatures, 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 NIGERIAN FOODS CONTAMINATED WITH AFLATOXINS?

Samples of maize (taken in 2016) contained detectable aflatoxin levels ranging from 1 – 260 ppb, with a mean concentration of 26.9 ppb. Aflatoxin levels in about 31% of the samples exceeded the European limit of 4 ppb and exceeded the US limit of 20 ppb in 16% of the samples.

Aflatoxin contamination of maize varied across states (Figure 1). Relatively higher aflatoxin contents were detected in maize from Niger, Jigawa and Benue States, which are located in the Southern Guinea Savannah, Sudan Savanah/Sahel Savannah and Derived Savannah agro-ecological zones, respectively. Aflatoxin levels in 44.4% and 33% maize samples from Southern Guinea Savannah, and 55.0% and 20.0% from Derived Savannah were above the EU and US limits, respectively. In Sahel Savannah, 20% of samples were above both the EU and US limits.

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

FIGURE 1: VARIATION OF AFLATOXIN CONTENTS IN MAIZE ACROSS STATES OF NIGERIA

Samples of groundnut collected in 2016 contained aflatoxin levels ranging from 1 – 260 ppb, with mean of 16.4 ppb. Mean aflatoxin contents in the groundnut varied across States (Figure 2). Contamination generally exceeded the national mean of 16.4 ppb in groundnut from Plateau (in Mid-Altitude zone), Katsina (in Southern Sudan Savannah) and Sokoto (in Sahel Savannah zone). Aflatoxin levels in 51% of all the groundnut samples were above the EU limit of 4 ppb and exceeded the US limit of 20 ppb in 14% of the samples. Relatively higher proportions of samples exceeding these limits originated from Mid-Altitude (81.3% above the EU limit and 43.8% above the US Limit), Sudan Savannah (50% above both the EU and US limits) and Southern Guinea Savannah (60% above the EU limit and 6.7% above the US limit).

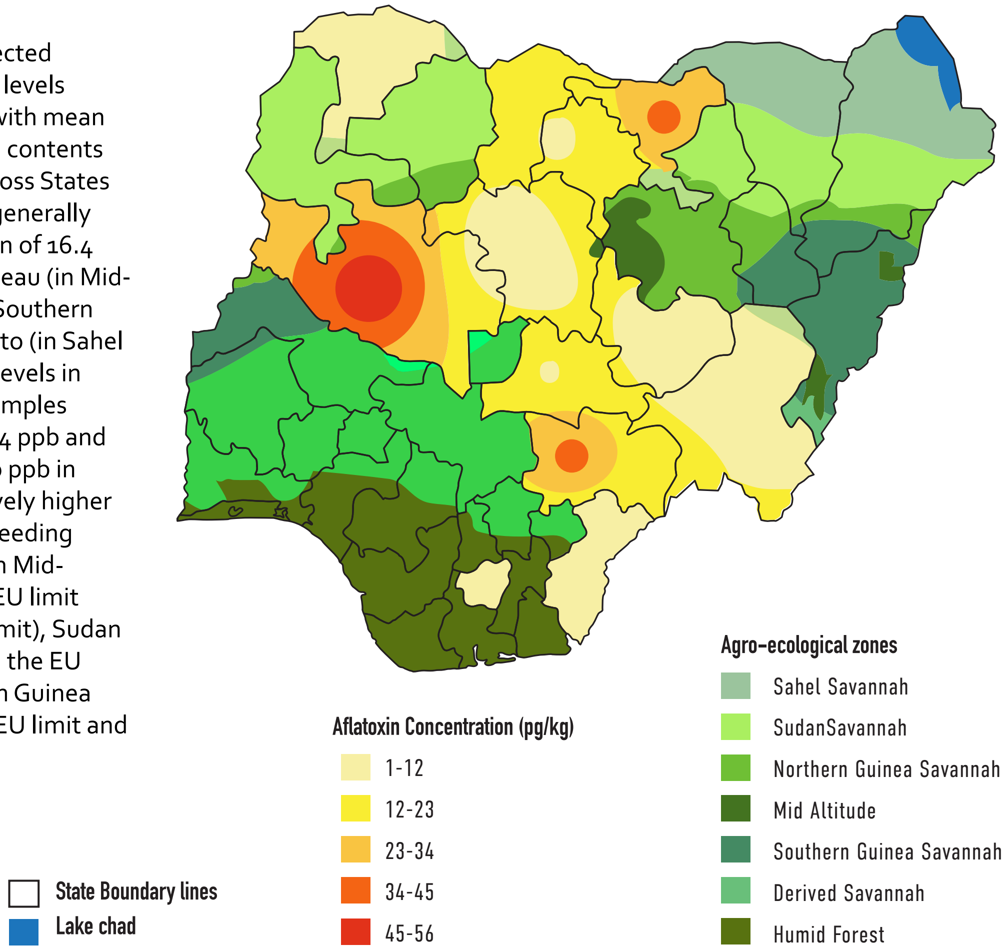


FIGURE 2: VARIATION OF AFLATOXIN CONTAMINATION IN GROUNDNUT ACROSS STATES OF NIGERIA

For sesame, all the samples (also taken in 2016) contained detectable aflatoxin levels ranging from 1 – 150 ppb (mean, 16.8 ppb). Mean aflatoxin contents in the sesame varied across States (Figure 3). Levels in 31% of the sesame samples exceeded the European limit of 4 ppb and 9% of the samples had aflatoxin above the US limit of 20 ppb. Proportions of samples exceeding the EU limit were higher than 31% in the Southern Guinea Savanah (53.8%), Sudan Savannah (42.9%) and Humid Forest (40%). The highest proportion (30.8%) of sesame samples exceeding the USA limit of 20ppb was found in samples from the Southern Guinea Savanah.

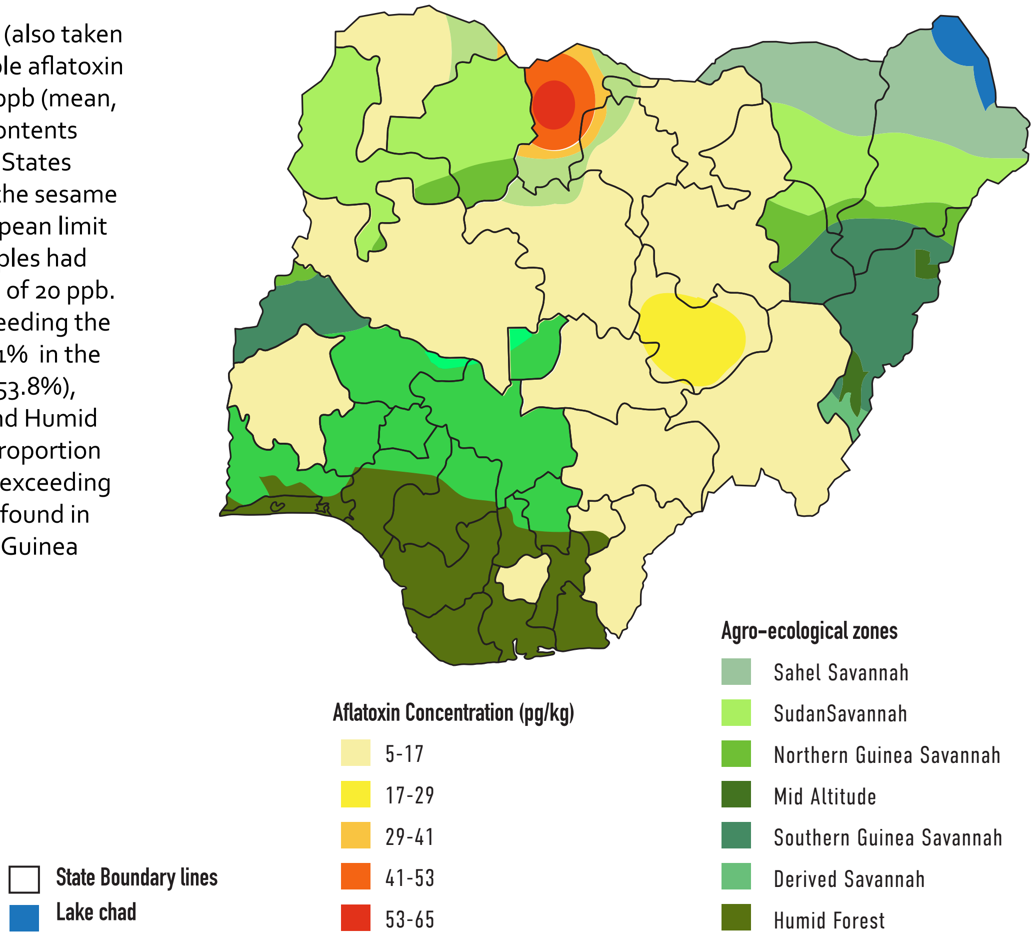
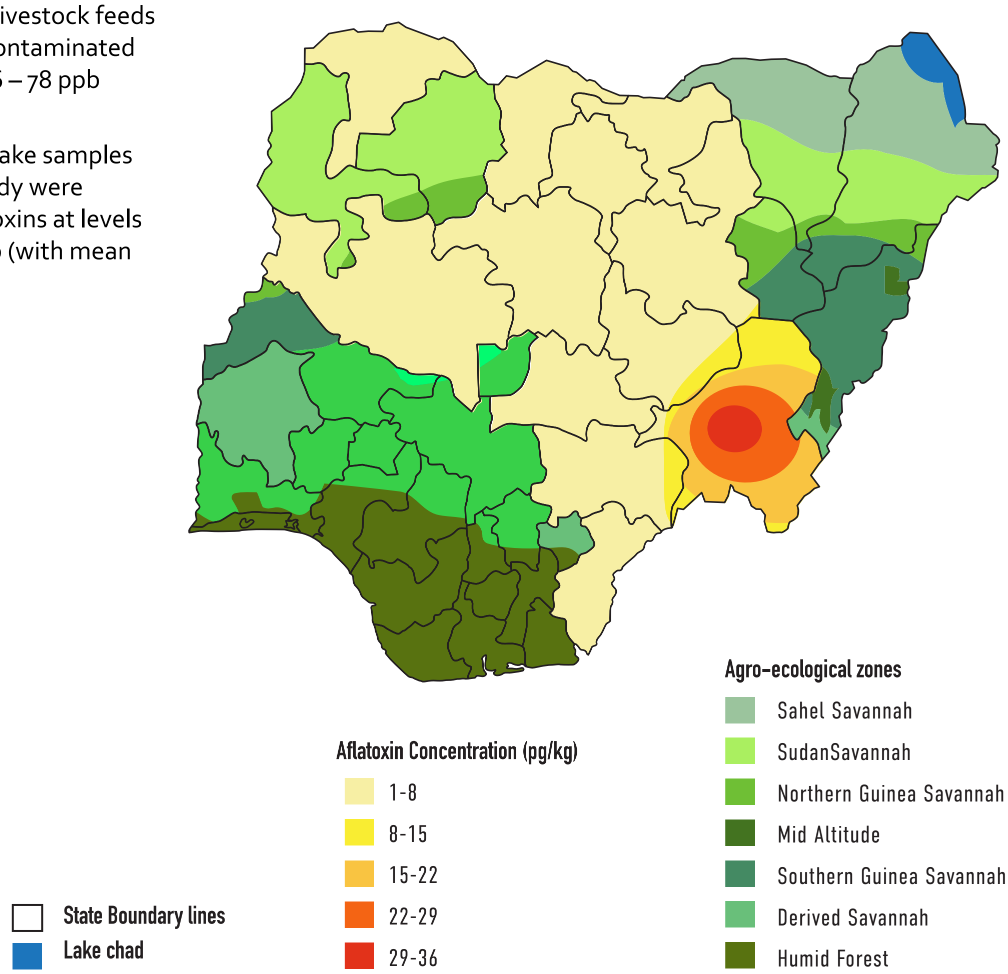


FIGURE 3: THE VARIATION OF AFLATOXIN CONTAMINATION IN SESAME ACROSS STATES OF NIGERIA

Animal feed derived from aflatoxin prone crops are also susceptible to aflatoxin contamination. In Nigeria, all samples of maize based livestock feeds analyzed in 2016, were contaminated at levels ranging from 3.6 – 78 ppb (mean, 27.7 ppb).

Likewise, all groundnut cake samples analyzed in the same study were contaminated with aflatoxins at levels ranging from 4 – 268 ppb (with mean of 68.5 ppb).



8. TO WHAT EXTENT ARE MAIZE, GROUNDNUT AND SESAME IMPORTANT FOR FOOD SECURITY IN NIGERIA?

Maize and groundnut are major staple crops in Nigeria with sesame being an emerging export crop. Maize is a staple food for about 50% of Nigerians. Groundnut, a major crop grown in the arid and semi-arid zones of Nigeria, is either grown for its nut, oil or its vegetative residue (haulms). Groundnut is by far the most nutritive oil-seed used in Nigeria and is widely used as ingredient in weaning foods.

Sesame, also known as beniseed, is an oilseed cultivated for its seeds which contain approximately 50% oil of very high quality and 25% protein. This is an important commercial crop for Nigeria.

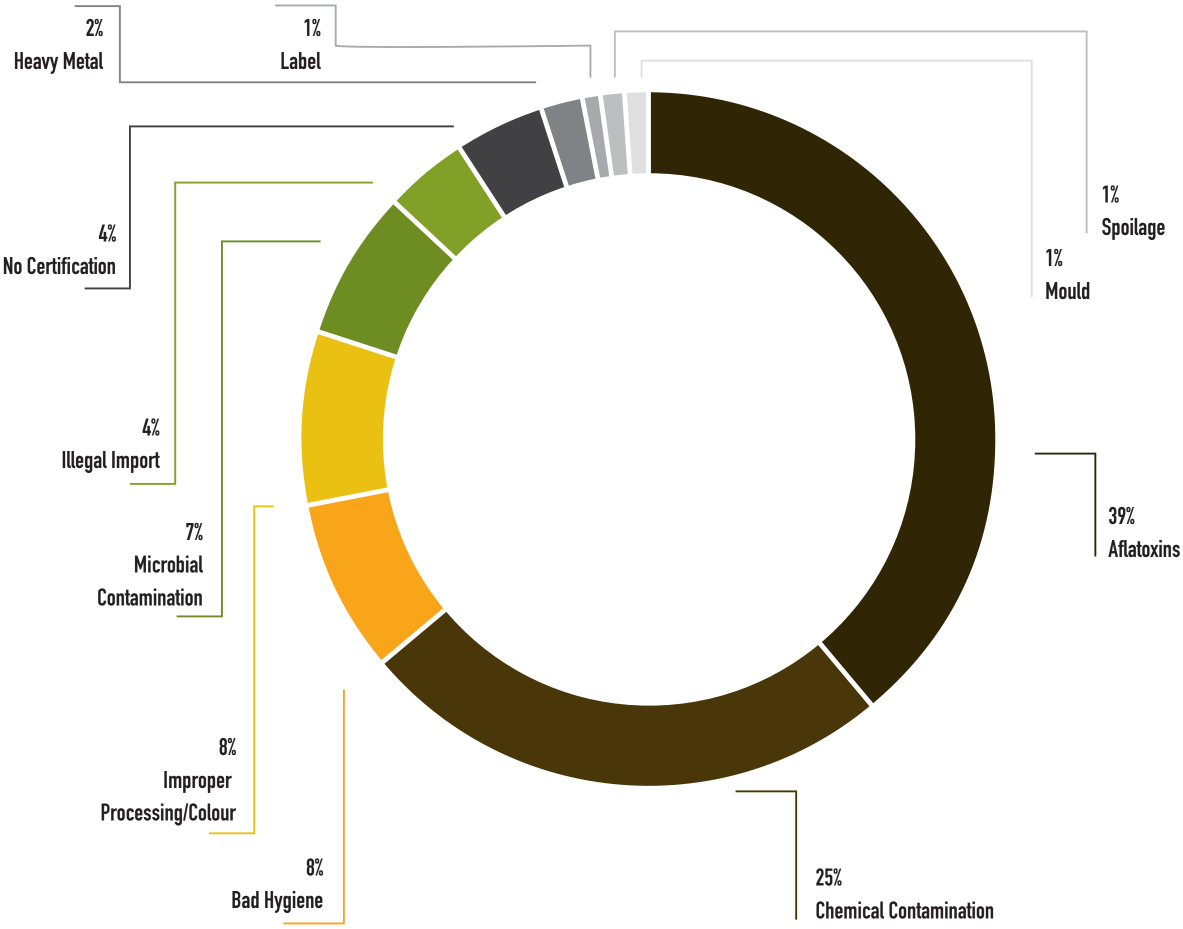
9. WHAT IS THE EXTENT OF AFLATOXIN EXPOSURE AMONG THE PEOPLE OF NIGERIA?

Dietary aflatoxin exposure in Nigeria ranges from 27.36 - 77.38 ng/kg body weight (bw)/day, with a mean national exposure of 34.81 ng/kg bw/day. The national aflatoxin exposure exceeded the health concern level of 0.017 ng/kg bw/day[3] by more than 2,000 fold. Agro-ecological zones with mean exposures above the average (34.81ng/kg bw/day) are Mid Altitude (35.35ng/kg bw/day), Southern Guinea Savannah (37.46ng/kg bw/day), Sudan Sahel (42.18ng/kg bw/day) and Sahel Savannah (46.21ng/kg bw/day).

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

Population risk (cancer cases per year per 100,000 people) for aflatoxin-induced liver cancer ranged from 1.28 in Humid Forest to 2.28 in Sahel Savannah. The trend of liver cancer population risk followed the aflatoxin exposure pattern described in section 9. The national estimate of liver cancer population risk was estimated to be 1.72 cancer cases per year per 100,000 people. With this population risk, it was estimated that Nigeria has 3,262 new cases of aflatoxin-induced liver cancer, annually. The total cases were estimated based on the population figure of 189.56 Million as estimated by the Nigeria National Population Commission in 2016[4] and HBsAg-positive prevalence rate in Nigeria (13.6%)[5].

FIG. 4: PROPORTION OF CAUSES FOR REJECTION OF NIGERIAN AGRICULTURAL PRODUCE BY THE EUROPEAN UNION (COMPILED FROM EU RASFF)



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

With assumption that each liver cancer case results to death within a year, it was estimated that the 3,262 aflatoxin-induced liver cancer cases, would lead to **a loss of 42,574 healthy life years, annually**. The healthy life years lost were estimated using the disability adjusted life years (DALYs) approach whereby DALYs per liver cancer case of 13.05 was used. The DALYs per liver cancer case was based on the sex specific DALYs per case of 12.3 for males and 13.8 for females estimated by Abt Associates Inc. for Nigeria in 2013[6].

12.WHAT IS THE ECONOMIC IMPACT OF AFLATOXIN-INDUCED LIVER CANCER IN NIGERIA?

It was estimated that the liver cancer cases (3,262), as determined in section 10, would lead **to annual financial loss of up to US$ 1,599 million**. This health economic impact of aflatoxin-induced liver cancer was estimated by multiplying the liver cancer cases (3,262) by $490,205, which is the Value of Statistical Life (VSL) estimated by Narayan et al[7] (using income elasticity of 1) per liver cancer death. This loss represents the amount of money that could be saved annually by adopting measures to curb aflatoxin contamination in Nigeria

3 EFSA. 2007. Opinion of the Scientific Panel on Contaminants in the Food Chain on a request from the Commission related to the potential increase of consumer health risk by a possible increase of the existing maximum levels for aflatoxins in almonds, hazelnuts and pistachios and derived products. *European Food Safety Authority Journal* 446: 1-127

4 National Population Commission. 2017. http://population.gov.ng/nigerias-population-now-182-million-npc/ Retrieved on 10th November 2017

5 Musa, B., Bussell, S., Borodo ,M.M., Samaila, A.A. and Femi, O.L. 2015. Prevalence of hepatitis B virus infection in Nigeria, 2000-2013. A systematic review and meta-analysis. *Nigerian Journal of Clinical Practice* 18: 163-172.

6 Abt Associates Inc. 2013. *Country and Economic Assessment for Aflatoxin Contamination and Control in Nigeria*. Prepared for the Meridian Institute in support of Partnership for Aflatoxin Control in Africa (PACA).

7 Narayan, T., Stene, A., Belova, A. and Brown, L. 2013. *A Conceptual Framework for Conducting Country and Economic Assessment of Aflatoxin Contamination*. Prepared for Meridian Institute in support of Partnership for Aflatoxin Control in Africa, Washington, D.C., Abt Associates Inc., 69 p

13. WHAT IS THE CONTRIBUTION OF AFLATOXIN CONTAMINATION TO PRODUCE REJECTION BY THE EUROPEAN UNION?

Data extracted from EU RASFF portal revealed that aflatoxin contaminated produce contribute the largest percentage of agricultural commodities rejected by the EU. Between 1980 and 2016, a total of 389 Nigerian agricultural export shipments were rejected or seized by the EU, with 39% of these being due to aflatoxin contamination (Figure 4).

14. WHAT ARE THE CURRENT INITIATIVES TO CONTROL AFLATOXINS IN NIGERIA?

PACA supported a country-led situation analysis and action planning (C-SAAP) for aflatoxin control along the maize, groundnut and sesame value chains in Nigeria. The policy recommendations in this document are based on the outcomes of the C-SAAP. Additionally, in partnership with key institutions in Nigeria, 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 maize, groundnut, sesame and animal feeds 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 Nigerian 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 who is hosted by the Federal Ministry of Agriculture and Rural Development. 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 NIGERIA?

Aflatoxin control is one of the functions of food safety control systems. In Nigeria, food safety control services are spread over different institutions namely, the Standards Organization of Nigeria (SON), National Agency for Food and Drug Administration and Control (NAFDAC), The Nigeria Agricultural Quarantine Services (NAQS) and The Nigerian Institute of Animal Science (NIAS). The roles of each institution are highlighted below.

A. **The Standards Organization of Nigeria**
   SON is responsible for, among other things, elaboration of food standards. It has set maximum limits for aflatoxins in maize and sorghum (10ppb), groundnut (20ppb), and groundnut cake and sesame seed (4ppb).

B. **The National Agency for Food and Drug Administration and Control**
   The agency enforces food standards, as set by SON, for all types of packaged foods and for any food for export. NAFDAC has a laboratory with capacity to analyze aflatoxins in foods.

C. **The Nigeria Agricultural Quarantine Services**
   This institution is responsible for plant health services including enforcement of safety standards for unprocessed food such as maize grain, groundnut kernels and sesame seeds.

D. **The Nigerian Institute of Animal Science**
   The institute is charged with the responsibility of regulating animal husbandry practices in Nigeria. It is also empowered to regulate the practice of animal scientists in order to contribute to improved animal husbandry practices in the country.

16. WHAT IS THE LEVEL OF AWARENESS AND KNOWLEDGE OF AFLATOXINS AMONG NIGERIANS?

The country situational analysis[8] showed that 64% of agricultural extension officers in Nigeria are aware of the aflatoxin problem and 61% of them consider aflatoxin control issues to be part of their duties. The level of awareness was, however, found to be lower (range of 10.5-30.3% and mean of 20%) among other stakeholders. The highest level (30.3%) of awareness was observed among feedstuff sellers. The awareness level among livestock farmers (27.3%) was also higher than the national average of 20%.

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

The C-SAAP[10] helped identify strategic interventions for aflatoxin control in Nigeria for agriculture, trade and health sectors. The interventions are presented in Table 1.

A preliminary 4 year implementation plan for the strategic interventions was recently developed for consideration by the Government of Nigeria and other stakeholders. The budget of implementing the plan is Naira 16,271 million and will be shared among the ministries responsible for agriculture, trade and health as well as partners that might be interested in investing in aflatoxin control in Nigeria.

8 PACA. 2018. *Country-led Aflatoxin and Food Safety Situation Analysis and Action Planning for Nigeria: Final Report*, Partnership for Aflatoxin Control in Africa, African Union Commission

TABLE 1: STRATEGIC INTERVENTIONS FOR MITIGATION OF THE AFLATOXIN PROBLEM IN NIGERIA[8]

Strategic interventions for Agriculture Sector
1. Gather, share, and scale lessons learned from successful efforts such as the biocontrol program being spearhead by the International Institute of Tropical Agriculture.
2. Develop or update National codes of practice and guidelines on good agricultural practices (GAP) and good animal husbandry practices (GHP) for the prevention and reduction of aflatoxin contamination in priority crops
3. Educate value chain actors (e.g., framers and traders) on aflatoxin prevention programs, including biocontrol
4. Train value chain actors at community levels on the use of codes of practices, GAP and GAHP for aflatoxin mitigation and control
5. Train Agricultural Extension Officers on codes of practice, GAPs and GAHPs
6. Promote good drying, storage and transportation practices for crops
Strategic interventions for trade sector
7. Build the capacity of operators to improve post-harvest practices and enforce aflatoxin control in foods and feed destined for the local market
8. Develop or update guidelines on Good Manufacturing Practices (GMP) and Hazard Analysis Critical Control Point (HACCP) for susceptible products
9. Train commodity control officers on the importance of commodity grading as one of the measures for aflatoxin control
10. Facilitate routine inspection of foods and feeds for control of aflatoxin contamination
11. Encourage the strict enforcement of standards on export products through advocacy, education, training and enforcement
12. Promote use of contaminated foods for non-food purposes, including use as animal feed
Strategic interventions for health sector
13. Establish reference laboratories, including laboratories for biomarkers testing, for mycotoxin testing in six geopolitical zones.
14. Train laboratory technicians and food inspectors on aflatoxin sampling and analysis techniques.
15. Develop programs to monitor aflatoxin level in humans (using biomarkers)
Strategic interventions for creation of enabling policy environment
16. Establish a mechanism for coordination of food and feed regulatory services
17. Revise standards for maximum limits of aflatoxins in groundnut
18. Develop regulations to control aflatoxins in animal feeds
19. Develop regulations to govern alternative uses for aflatoxin contaminated products
Strategic interventions for cross-cutting issues: Research and Knowledge
20. Develop cost effective alternative uses of aflatoxin contaminated produce
21. Develop or validate model facilities for threshing, dying and storage of crops to control aflatoxin contamination
22. Validate and promote the use of hermetic storage solutions to eliminate insect infestation of crops thereby reducing the incidence of aflatoxin contamination of crops
23. Adopt aflatoxin resistant/tolerant groundnut varieties and further research on other aflatoxin crop varieties
24. Generate and use evidence on the impact of aflatoxins through the PACA-led AfricaAIMS initiative
25. Produce evidence about the relationship between aflatoxin prevalence, biomarkers, and incidence of primary liver cancer and stunting.
26. Develop curricula that include aflatoxin education in Primary, Secondary and Tertiary Education
27. Train Primary, Secondary and Tertiary school teachers on aflatoxin risk communication
Strategic interventions for cross-cutting issues: Advocacy, awareness raising
28. Sensitize political leaders on aflatoxins and the need for control measures at all levels, including passage of the Food Safety bill
29. Conduct awareness campaigns and training on aflatoxins for farmers, processors, traders and housewives
30. Create broad-based awareness among consumers
31. Sensitize educational institutions on aflatoxin mitigation
32. Conduct awareness campaign on health impacts of aflatoxins on the vulnerable population in hospitals
33. Sensitize and facilitate the media on aflatoxin mitigation and risk communication
34. Sensitize organized private sector, law enforcement, community and religious leaders on aflatoxins

Partnership for Aflatoxin Control in Africa

More information about PACA:
Visit www.aflatoxinpartnership.org
or contact paca@africa-union.org