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## Results Updates on AfricaAIMS and C-SAAP

*February 2016*

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### 1 Overview

Country-focused activities that target the engagement and increased efficiency of African governments to tackle the aflatoxin menace on the continent are priority for the PACA Secretariat. The Africa Aflatoxin Information Management System (AfricaAIMS) and Country-led Aflatoxin and Food Safety Situation Analysis are two examples of such activities. On a general note, both activities aim at providing accurate, comprehensive and reliable evidence-based information required to facilitate informed decisions on policies, regulations, standards, interventions (e.g. educational and technological), resource allocation, advocacy and awareness creation by the country governments and stakeholders. PACA initiated the evidence generation mechanisms/activities by providing countries with support for capacity building in the areas of aflatoxin research in order to provide: (a) baseline information and (b) year-to-year surveillance and monitoring data for aflatoxin contamination of key staple crops in the countries, (c) aflatoxin-relation information from the health and trade sectors. In addition, the health and economic impacts of aflatoxins on the countries are being x-rayed and quantified and priority actions involving existing technologies or newly developed scalable technologies for combating the aflatoxin problem are drafted. The AfricaAIMS activities and preliminary results from the Country-led Aflatoxin and Food Safety Situation Analysis are highlighted in this report:

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### 2 Highlight of Progress/Results

The highlights of progress/results from implementing AfricaAIMS and C-SAAP in the six PACA pilot countries, The Gambia, Senegal and Nigeria in West Africa, and Malawi, Tanzania and Uganda in East and South Africa are presented in this report.

#### 2.1 Africa Aflatoxin Information Management System (AfricaAIMS)

The PACA secretariat has been working with partner institutions in her pilot countries and in Kenya to establish the AfricaAIMS platform, a “one stop shop” database for aflatoxin related information in the health, trade and agriculture sectors. AfricaAIMS project involves the following: (a) building infrastructure and human capacities in-country to gather reliable research-based evidence to inform policy decisions, facilitate interventions and contribute to addressing gaps in technology and regulations; (b) harmonizing data collection and analysis systems on aflatoxins across countries. The AfricaAIMS are “home-grown” owned by AU Member States and respective Regional Economic Communities (RECs) and aim to serve policy makers, regulatory bodies, technical agencies (health, trade and agriculture), researchers, farmers, civil society organizations (CSOs), non-governmental organizations (NGOs), private

sector partners along the key crop value chains and other interested parties through the ARIS 2 portal/database of AU-IBAR.

*Progresses:*

- (1) PACA Secretariat has provided additional consumables, start-up operational grant to match the previously provided aflatoxin testing VICAM equipment and consumables for evidence generation in her first five pilot countries (Malawi, Senegal, Tanzania, The Gambia and Uganda).
- (2) The Kenya Agricultural Research Institute (KALRO) at Katumani is yet to receive VICAM equipment due to delays from the Kenyan Government to approve the duty exemption papers provided by the AUC.
- (3) The aflatoxin testing platform (VICAM) and additional consumables are yet to be delivered to the National Agricultural Quarantine Services (NAQS) laboratory in Ibadan, Nigeria (host lab for AfricaAIMS) due to delay in signing the agreement by the Federal Ministry of Agriculture and Rural Development. Quotations for the VICAM equipment for Nigeria were long received and revised, awaiting procurement.
- (4) The agriculture, health and trade modules for data collection and submission on ARIS 2 interphase of AU-IBAR created.
  - a) The agriculture module has two submodules which showcase information relating to collection of food and feed samples for aflatoxin analysis and data analysis of food and feed samples.
  - b) The health module has four submodules which harbour information relating to diseases associated with aflatoxin exposure, aflatoxin levels in humans/biomarker data, extent of consumption of aflatoxin prone staples and rate of childhood stunting.
  - c) The trade module has two submodules which provide information relating to aflatoxin standards in countries and volume of exports and imports of aflatoxin prone agricultural commodities.
- (5) Data for agriculture are now available for Senegal, Tanzania, The Gambia and Uganda. Secondary data for trade and health sectors are also available for Tanzania and The Gambia, and keyed into the ARIS 2 portal of AU-IBAR. These will be displayed online to the Steering Committee (SC) members during the 8<sup>th</sup> SC meeting. Malawi is currently collecting samples from the field.

## **2.2 Country-led Aflatoxin and Food Safety Situation Analysis**

The PACA Secretariat has been supporting and monitoring the implementation of the C-SAAP activity in its first five pilot countries in order to provide empirical evidence on existing aflatoxin prevalence, legislation, policy and regulation, management practices and other existing control mechanisms that can effectively inform policy and interventions. The C-SAAP

findings form the background for developing country plans towards aflatoxin mitigation in countries and by extension, on the continent.

The situational analysis reports are mainly built around providing empirical evidence on existing aflatoxin prevalence and quantifying the impacts of aflatoxin contamination on the economy including assessing the awareness levels of stakeholders associated with key crop value chains.

The under-listed key crops of concern as related to aflatoxin issues were identified by the Aflatoxin Technical Working Groups in The Gambia, Malawi, Nigeria Senegal, Tanzania and Uganda.

- Groundnuts, maize and rice in Gambia
- Groundnuts and maize in Malawi
- Groundnuts, maize and sesame in Nigeria
- Groundnuts, maize and rice in Senegal
- Groundnuts, maize and rice in Tanzania
- Groundnuts, maize and sorghum in Uganda

To facilitate the C-SAAP process and ensure production of the highest quality report from the study, PACA Secretariat is following a three-step review process for validating the C-SAAP reports from the countries:

- a) Technical review by PACA secretariat for technical details. Reports from Senegal, Tanzania, The Gambia and Uganda were reviewed.
- b) Validation of reports by stakeholders in countries. Reports from Senegal, Tanzania, The Gambia and Uganda have been validated by countries.
- c) Technical review by engaged consultants from Abt Associates for consistency across countries on the economic models adopted. Reports from Senegal, Tanzania, The Gambia and Uganda are being reviewed and finalized by the consultants and Abt team. Therefore, all values reported here are not final for the countries and are subject to change upon submission of report by consultants.

PACA Secretariat is in the process of identifying consultants in Malawi and Nigeria who will lead and conduct the C-SAAP in their countries. The C-SAAP for Nigeria will be supplementary to the 2012 situational analysis conducted by the Abt Associate team and local consultants. Below are result summaries from the C-SAAP reports for Senegal, The Gambia, Tanzania and Uganda.

### ***Aflatoxin Prevalence in Key Crops in the Countries***

A summary of the trend of aflatoxin prevalence in key staples identified by the countries is given in Table 1 below. Maize and groundnuts contain high levels of aflatoxins across the

countries and most cases, more than a quarter of the contaminated crops contained toxin levels above the acceptable thresholds adopted by the countries.



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

**Table 1: Summary Estimates of Aflatoxin Prevalence in Key Crops from Country-led Situational Analysis Studies.**

Country	Groundnut			Maize			Sorghum or Rice		
	N <sup>a</sup>	R <sup>b</sup> (ppb)	% <sup>c</sup>	N <sup>a</sup>	R <sup>b</sup> (ppb)	% <sup>c</sup>	N <sup>a</sup>	R <sup>b</sup> (ppb)	% <sup>c</sup>
The Gambia	140	17.5–1,189.0	10–100	- <sup>d</sup>	- <sup>d</sup>	- <sup>d</sup>	- <sup>e</sup>	- <sup>e</sup>	- <sup>e</sup>
Senegal		29.8–733.3			1.06–852.2			2.1 <sup>e</sup>	
Tanzania	342	31.0–123.0	18–20	622	8.0–1,081.0	2–85	111 <sup>e</sup>	0.01–3.83 <sup>e</sup>	0
Uganda	100	4.0–850.0	10–30	100	86.0–3,300.0	20–65	100	25.0–514.0	65–100

Notes: <sup>a</sup>Number of samples analyzed.

<sup>b</sup>Range of highest contamination levels.

<sup>c</sup>Range of samples above maximum acceptable limits (MAL). MAL are based on standards adopted for each crop per country.

<sup>d</sup>No information available.

<sup>e</sup>Information on rice. No information available for rice in The Gambia.

## SENEGAL

The situational analysis for Senegal was conducted by BIOSCOPE (a team of national consultants) and validated by country stakeholders in July 2015. Groundnut, maize and rice were selected by the country as priority staples for PACA's activities. Since aflatoxins are not regulated in Senegal, the losses in agriculture and those related to food safety, as well as in trade, could be underestimated and will not be easy to quantify. The economic impact analysis therefore focuses on: (a) the health impacts resulting from the consumption of contaminated food products, and (b) impacts from international trade.

- **Impact on Human Health**

To determine aflatoxin's impact on human health in the Senegalese population, a three-step approach was adopted: (a) the biomarker-based approach which indicates real time exposure based on level of aflatoxins in bodily fluids (e.g. blood); (b) the disability-adjusted life years (DALY) which is a measurement of the burden of illness that quantifies not only premature mortality related to the various causes of death, but also the discrepancy between the actual functional state of health of a population and a hypothetical ideal that one hopes to reach; and (c) the Value of Statistical life (VSL) which is a factor for deducing the willingness to pay.

- ✓ **Aflatoxin exposure using biomarker data**

In Senegal, the only data available on aflatoxin content in human bodies are those from Watson et al. (2015). The study covers areas of groundnut and maize consumption as well as other aflatoxin prone foodstuffs. There is indication of a clear correlation between the frequencies of groundnut- and/or maize-based foodstuffs ingested and blood aflatoxin levels.

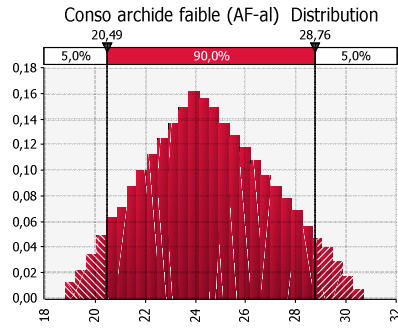
According to the study, aflatoxin levels in human blood are in accordance with the groundnut and maize intake frequency (Table 2). Higher maize or groundnut intake contributed to higher exposure to aflatoxins and vice versa.

**Table 2: Blood aflatoxin levels according to groundnut and maize intake**

Consumption	Number of participants	Geometric average (pg/mg)	Interval (pg/mg)	AF-alb distribution (pg/mg)
<b>Groundnut</b>				
Low (< 4 days/week)	45	24.0	18.7-30.8	24.5
High (≥ 4 days/week)	107	62.8	56.0-74.3	64.4
<b>Maize</b>				
Low (< 4 days/week)	96	41.1	33.5-50.3	41.6
High (≥ 4 days/week)	54	61.4	48.5-77.9	62.6

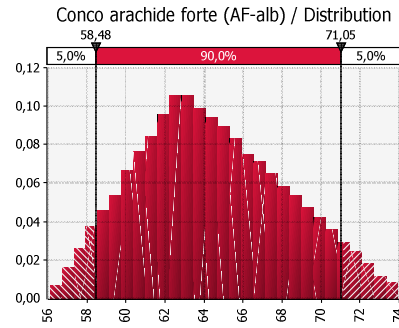
The estimates of exposure variations in the Senegalese population as simulated by the consultants using measures of central tendency (Fig. 1) agreed well with the original

report/study (Table 2). The analysis for low groundnut intake groups showed that in a 90% confidence interval, aflatoxin content varied between 20.4 pg/mg albumin and 28.76 pg/mg albumin adduct (Fig. 1a) while in high groundnut intake group the levels varied between 58.48 pg/mg albumin and 71.05 pg/mg albumin-adduct (Fig. 1b). The values found are greater for individuals who eat maize-based food products more than four times per day (Fig. 1d).



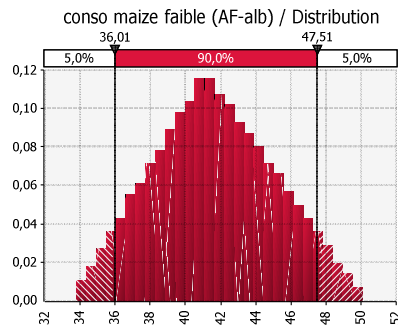
**Figure 1a: Variation of the level of aflatoxin-albumin adducts in blood low peanut consuming Senegalese people (RiskTriang, Min, ML, Max)**

Source: BIOSCOPE



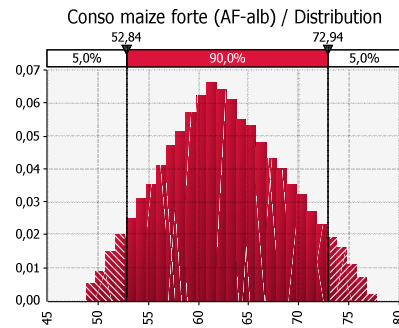
**Figure 1b: Variation of the level of aflatoxin-albumin adducts in blood of people with a high groundnut intake (RiskTriang, Min, ML, Max)**

Source: BIOSCOPE



**Figure 1c: Variation of the level of aflatoxin-albumin adducts in blood of people who consume maize less than four times a week. (RiskTriang, Min, ML, Max)**

Source: BIOSCOPE



**Figure 1d: variation of the level of aflatoxin-albumin adducts in blood of people who consume maize at least four times a week. (RiskTriang, Min, ML, Max)**

Source: BIOSCOPE

### ✓ Disability-Adjusted Life Years (DALY)

In order to accurately estimate the DALY, the incidence of hepatocellular carcinoma (HCC) cases related to aflatoxin was calculated. According to the Senegalese hepatitis control program, 17% of the general population in Senegal are chronic Hepatitis B carriers.

**Table 3: Number of liver cancer cases (maximum, most likely and minimum) versus crop intake by region in Senegal as related to aflatoxin exposure**

Regions	Population	Number of liver cancer cases per year			Crop intake	
		Minimum	Most likely value (distribution average)	Maximum	Groundnut	Maize
Dakar	2,956,023	99 (3)*	133	171 (6)	Low	Low
Ziguinchor	523,840	51 (10)	60	80 (15)	High	Low
Diourbel	1,420,082	137 (10)	164	218 (15)	High	Low
Saint-Louis	870,629	29 (3)	39	50 (6)	Low	Low
Tambacounda	649,854	64 (10)	85	107 (17)	High	High
Kaolack	918,355	91 (10)	120	152 (17)	High	High
Thiès	1,709,112	165 (10)	197	262 (15)	High	Low
Louga	835,325	81 (10)	96	128 (15)	High	Low
Fatick	684,652	66 (10)	79	105 (15)	High	Low
Kolda	633,675	61 (10)	73	97 (15)	High	Low
Matam	541,032	18 (3)	24	31 (6)	Low	Low
Kaffrine	544,011	54 (10)	71	90 (17)	High	High
Kédougou	152,134	15 (10)	20	25 (17)	High	High
Sédhiou	434,877	42 (10)	50	67 (10)	High	Low
<b>Senegal</b>	<b>12,873,601</b>	<b>972</b>	<b>1,213</b>	<b>1,584</b>		
*( ) : Number of liver cancer cases per 100,000 inhabitants					Source: our estimates	
					Source: focus group	

According to Table 3 above, the estimated incidence of liver cancer is lowest in Dakar, Saint Louis and Matam (3-6 cancer cases per 100,000 inhabitants). High groundnut and/or maize production and intake areas (Kaolack, Kaffrine, Tambacounda, Kédougou) are normally expected to have the highest incidence of liver cancer cases per 100,000 inhabitants (10-17 cases of cancer per 100,000 inhabitants). More in-depth analysis with the probability density functions using a simulation model showed that between 1057 and 1477 people would suffer from liver cancer each year in Senegal. The expected number of liver cancer cases per year varies between a minimum of 20 in the Kédougou region and a maximum of 197 in the Thiès region.

**Table 4: Incidence of liver cancer according to age and sex of the population**

Age	Liver cancer per 1,000 males			Liver cancer per 1,000 females		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
0-4 years	0.812	1.013	1.323	0.797	0.995	1.299
5-14 years	1.294	1.614	2.108	1.231	1.537	2.007
15-44 years	2.066	2.579	3.368	2.205	2.752	3.594



45-59 years	0.384	0.479	0.626	0.416	0.519	0.677
60+	0.237	0.296	0.386	0.297	0.370	0.484

For the DALY calculation, the incidences of liver cancer per age and sex was calculated (Table 4). The incidence in males (2.6 cases per 1,000) and females (2.8 cases per 1,000) was highest for age group 15-44 years.

**Table 5: DALY Calculator: Health impact of aflatoxin contamination in Senegal: (DALYs from HCC)**

	Mean	Median	2.5%	97.5%
<b>DALY</b>	98,304	99,777	70,496	123,788
<b>YLD (years lost due to disability)</b>	84,805	85,278	56,997	110,289
<b>YLL (years of life lost)</b>	13,499	13,499	13,499	13,499
<b>Cases</b>	23,429	23,417	21,608	25,328
<b>Deaths</b>	427			

The estimated effects on mortality and morbidity (DALY) shown in Table 5 indicate that, on average, more than 98,300 healthy years are lost each year in Senegal due to aflatoxins. The monetary value of this loss would be equivalent to more than \$128 million in US dollars, or nearly 64 billion CFA francs each year.

#### ✓ Value of Statistical Life (VSL)

The willingness to pay was calculated by determining the VSL in order to quantify the total economic impact of aflatoxin exposure on health. Thus, the economic impact on the health of Senegalese population (12,873,601) is estimated at a minimum of US\$ (2013) 91,930,917 and maximum of US\$ (2013) 161,426,809. The low cut-off and higher cap figures correspond to 0.6% and 1.1% of the GDP respectively. Furthermore, the calculated cost of inaction represents at least 46 billion CFA francs (34% of the health ministry's budget in 2015) and a maximum of 81 billion CFA francs (60% of the health ministry's budget in 2015).

#### • Economic Impact from International Trade

Since aflatoxins are not regulated in Senegal, accumulated direct losses in agriculture, food safety and trade could be minimized. An impact on commerce will be related to international trade *via* the costs associated to groundnut cakes detoxification through ammoniation. Groundnut cake is used mainly as animal feed. Threshold limits for aflatoxins are set for the importing countries. The contamination level in Senegalese groundnut cakes varies between 9.34 ppb and 713.99 ppb. However, contamination data lay often between 80 ppb and 590 ppb, with a mean value of 303.45 ppb. Thus, higher aflatoxin values in groundnut cake above the

maximum permissible limit of 20ppb for young animal feed and 300ppm for finishing animals can often incite the Senegalese industry to use ammoniation to reduce the level and enable their products to comply with the regulations of the export markets. This leads to additional production charges, reaching 33,000 francs/ton for this treatment. Detoxifying the annual exportation of 60,000 tons of groundnut cake from Senegal through ammoniation is estimated to cost 1.98 billion CFA francs. The human cost linked to the workers' safety and accidents recorded for this activity are also other parameters to add onto the calculations.

Furthermore, the cost of complying with the regulations given the two sets of thresholds values on the added value of groundnut and maize value chains was estimated. A loss of almost 41.8 billion and 25.8 billion CFA francs is estimated for groundnut and maize respectively when the 4ppb threshold was applied. Increasing the threshold to 20ppb limit, a loss of almost 16 billion and 4.7 billion CFA francs is estimated for groundnut and maize respectively. However, these possible losses could be considerably reduced, if actors of the value chain applied additional measures to control aflatoxin.

## **THE GAMBIA**

The Gambia situational analysis as presented by the national consultants, IRIS, was validated by country stakeholders in September 2015. Groundnut, maize and rice were identified by the country as priority staples for PACA's activities. The economic impacts resulting from aflatoxin contamination of these crops were determined as: (a) impact on agriculture and food security; (b) impact on domestic and international trade; and (c) impact on human health.

- **Impact on Agriculture and Food Security**

Aflatoxin contamination was confirmed throughout the value chain of the three commodities, affecting the quality of food produced. Small-scale farmers experienced low output during production of crops, which owed to an array of factors including low awareness of the aflatoxin problem and other intrinsic agricultural issues, low level of application of GAP, lack of inputs (fertilizer, certified seeds, and agro-chemicals) and technologies. The economic impact of aflatoxins on the food security pillar 1 (availability – local production) is unquantifiable.

The national consumption is estimated at 53,108 tons (77% of total production) for groundnuts, 14,125 tons (50% of total production) for maize, and 153,501 tons (24,951 tons from local production and 128,550 tons from imports) for rice. Aflatoxin contamination of the crops impacts particularly the third pillar of food security (utilization – food safety) of Gambian population due to heavy dependence on the end uses of the crops in their daily diets and the inability to physically differentiate aflatoxin infested crops from non-contaminated crops. This increases aflatoxin exposure and its health consequences.

There is no price differentiation for the commodities marketed at the local market based on aflatoxin contamination levels. The only evident impact on farmers' income due to marketing of their produce relates to the component of the produce that is exported. For example,

groundnuts and its products are exported and the prices are determined internationally. This negatively affects the farmers' disposable income and thus impacts the second pillar of food security (accessibility – purchasing power parity).

- **Economic Impact on Trade**
  - ✓ **Impact on domestic trade**

There is substantial trade of agricultural commodities particularly of groundnuts, rice and maize in the domestic markets comprising regular and weekly markets (loumos). However, there exists no price differentiation for the commodities according to the level of aflatoxin contamination. Consequently, there is no economic impact of aflatoxin contamination in the domestic trade.

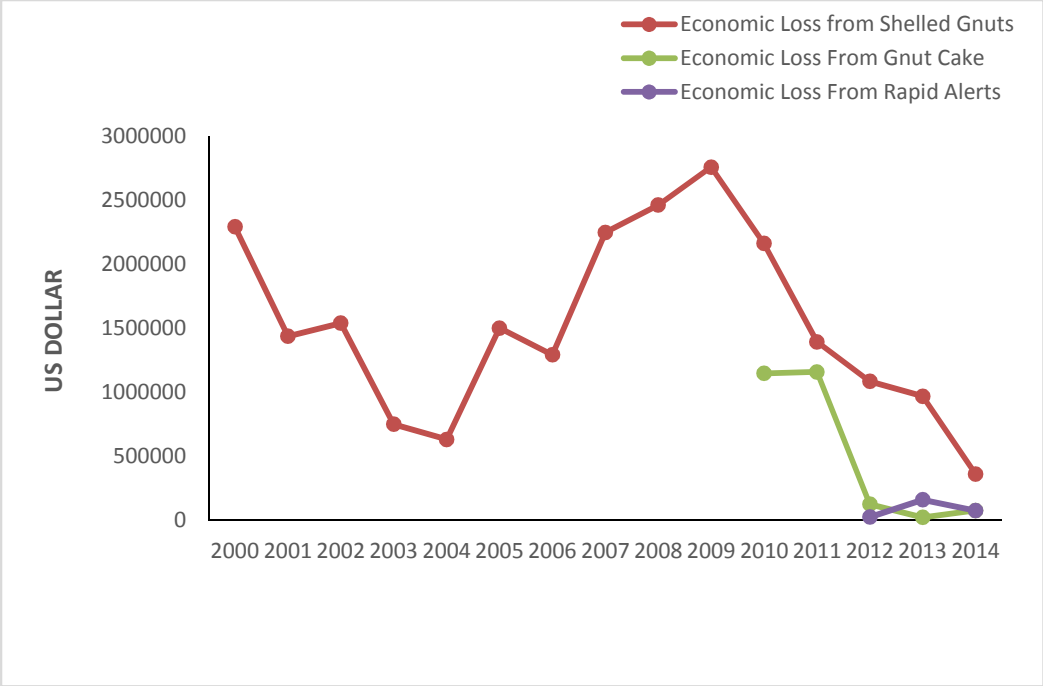
- ✓ **Impact on international trade**

The impact of aflatoxins on international trade in The Gambia is categorized into two: i) price losses from export trade and ii) rejects due to aflatoxin contamination. Groundnuts constitute the most important export agricultural commodity and foreign exchange earner for the Gambian economy. In the past, the EU was the principal destination of groundnut (HPS confectionery and crude oil) exports, but recently the aflatoxin contamination of Gambian groundnuts destined for exports have been higher than the maximum limits set by the EU regulations. The Gambia does not export maize and the locally produced rice, but some of the imported rice is re-exported to countries in the sub-region. The economic analysis therefore focuses on the groundnut export trade where aflatoxin contamination is a factor in the pricing and market access.

#### Price Losses

Price losses are incurred for HPS confectionery with the HPS destined for the “wild bird feed” markets in the EU countries, where it fetches only 70% of premium price. Computations using international premium and actual prices for HPS 60/70 Bird Feed from 2000 to 2014 indicate cumulative economic losses of USD 22,874,517. This translates to an annual average price loss of USD 1,524,968 over the period. These figures should be treated with caution as costs of controls, which would result in having HPS confectionery have not been factored in the computation due to lack of data. If cost of controls were included, the price losses would be less.

Figure 2 below also highlights the annual economic loss incurred from the export of HPS which reached a peak of US\$2,759,400 in 2009, with a downward trend thereafter due to declining exports.



**Fig. 2: Economic losses from groundnut trade since 2000.**

Computations using international price of groundnut cake meeting the maximum aflatoxin level set by the EU and actual prices of cake exported to Senegal and Mauritania from 2010 to 2014 indicate a cumulative economic loss of US\$2,520,991. The average annual loss to cake amounts to US\$504,198. The cumulative economic losses from both HPS and cake amount to US\$25,395,508.

Losses from rejected exports

Groundnut exports whose level of aflatoxin exceed the EU limits (4ppb for confectionery and 10ppb for bird feed) and therefore do not meet the maximum limit are rejected and returned with rapid alerts issued by the EU; the freight and handling charges incurred to transport the consignment to the imported country are lost. Once rejected, the consignment is returned with the exporter bearing the freight and handling charges representing additional losses. The analysis assumed that all the rejected consignments associated with the 14 rapid alerts on Gambian HPS from 2012 to 2015 were crushed into oil and cake. The computations of the total economic losses from 416 Mt of rejects indicate USD 251,418 for the four-year period.

- **Economic Impact on Human Health**

The economic impact of aflatoxin exposure on the health of Gambian populations was estimated *via* four approaches: estimation using biomarker data; estimation using contamination level in food; estimation of medical and non-medical cases for new hepatocellular carcinoma (HCC) cases; and aggregated human health damages due to HCC.

✓ **Possible aflatoxin exposure using biomarker data**

Aflatoxin exposure was estimated using biomarker exposure data set from Turner et al. (2000). Admittedly, this data is over 15 years of age but given that aflatoxin exposure levels have probably not changed over the years as the typical diets of Gambian and agronomic practices have also not changed, the data set is being used to provide a scenario of possible aflatoxin exposure. The data set consisted of aflatoxin albumin adduct measures from 444 children aged 3–4 (229 male, 215 female), who were recruited as part of the Gambia Hepatitis Intervention Study (GHIS), who had not received a hepatitis B vaccine. The mean AF-Alb adduct was 51.94 pg/mg while the estimated exposure was 5.194 ng-AFB/kg-body-wt.

✓ **Aflatoxin exposure using contamination levels in foods**

Dietary exposure to aflatoxin is dependent on the levels of contamination present and on the quantities of contaminated food consumed by individuals. The population risk for aflatoxin induced liver cancer was estimated using the data on aflatoxin exposure in The Gambia. Hepatitis B prevalence rate in The Gambia is about 15%.

**Table 6: Exposure assessment and risk characterisation for aflatoxin in groundnuts, maize and rice**

Commodity	Contamination (ng/g)	Consumption (g food/day)	Exposure (ng kg <sup>-1</sup> Body-wt day <sup>-1</sup> )	<sup>1</sup> Population risk for HCC (cancers/year/100,000)
<sup>a</sup> Groundnut	<sup>a</sup> 122	<sup>b</sup> 65	<sup>a</sup> 132.2	<sup>a</sup> 7.1
<sup>b</sup> Maize	<sup>b</sup> 9.7	<sup>b</sup> 22	<sup>b</sup> 3.6	<sup>a</sup> 0.2
<sup>b</sup> Rice	<sup>b</sup> 7.9	<sup>b</sup> 103	<sup>b</sup> 14	<sup>a</sup> 0.7

Source: <sup>a</sup> This study; <sup>b</sup> Shephard (2008).

<sup>1</sup>Population risk is calculated on the basis of HB prevalence rate of about 15% (Hwang and Cheung, 2011).

As indicated in table 6 above, the aflatoxin level for groundnut is extremely high and above the Codex maximum limit of 20. The relatively high level of consumption of groundnut as a single food and in combination with the basic staples (particularly rice), which are also contaminated, lead to extremely high exposures. Maize and rice are within the limits set by Codex. Rice is the most consumed commodity. Even though rice and maize have similar contamination levels, the higher level of rice consumption results in a higher population risk for HCC. This clearly indicates that the mitigation of aflatoxin in all these aflatoxin sensitive commodities should be a priority.

✓ **Estimation of medical and non-medical costs for new HCC cases**

The computation of disease costs comprises three components: direct, morbidity and mortality costs. Direct costs include medical costs, medical costs uncovered, transportation, caregiver and costs for alternative treatment. Medical cost incurred per HCC case was estimated at US\$689.5

within which inpatient cost had a share of 68%. Non-medical costs were quite lower at US\$159. For each HCC prevented, it is estimated that US\$849 is saved from costs due to illness.

✓ **Aggregated aflatoxin human health damages due to HCC**

In The Gambia, it is assumed that all estimated aflatoxin related cases result in death within twelve months. The Value per Statistical Life (VSL) approach which measures the value of avoiding one premature death was used to estimate the Gambian population’s willingness to pay (WTP) to avoid premature death from aflatoxin-related HCC. The annual loss in productivity related to HCC induced morbidity among the working population (15 to 59 age group) is estimated at USD 2.2 million. This was derived from the Years Lived with Disability (YLD) estimate of 1,279 multiplied by the GDP per worker of US\$1,729. The YLD represents the years of productive life lost due to disability caused by HCC in the working population.

The VSL of elasticity factor 2 due to the low income status of the Gambia, is estimated at US\$9,011, which is the amount needed to avoid one premature death due to HCC. The converted WTP of US\$0.90 represents the amount to be contributed by 10,000 individuals to save this one premature death. With an estimated number of 154 HCC cases, the total economic loss using the Cost of Illness and WTP metrics is estimated at USD 2.3 million, representing less than one percent (0.26%) of GDP.

- **Overall impact of aflatoxins on agriculture and food security, trade and health**

An overview of the economic analysis reveals that the most impact is on human health as shown below.



**Fig. 3: Economic losses from international trade and human health**

## **TANZANIA**

The Tanzania supplementary situational analysis as presented by the team of national consultants was validated by country stakeholders in May 2015. Groundnut, maize and rice were identified by the country as priority staples for PACA's activities. The supplementary report aims to update the 2012 economic impact assessment report of Abt Associates.

- **Economic Impact on Health**

The health and economic impacts resulting from aflatoxin contamination of these crops are anchored on: (a) biomarker exposure estimates; (b) estimates of the number of HCC cases; (c) calculation of the DALYs; (d) calculation of exposure bins; and (e) calculation of the VSL. The impact was calculated taking gender into consideration. These calculations/estimates are being refined for accuracies. Below are draft values.

- ✓ **Estimated Impact on Females**

The population of females modeled in this study had a median of 211,800 persons with an inter-quartile range of 248,800. From a median of 14,830 of chronic hepatitis B cases, 92 cases would develop hepatocellular carcinoma and result into 87 deaths. From this morbidity and mortality, a total of 289,900 DALYs would be lost which is equivalent to a loss of US\$ 176,500,000 worth of a GDP. Therefore, the total economic loss resulting from females has a median of US\$ 176,500,000; ranging between US\$50,650,000 and 418,400,000. Most of the total economic loss is contributed by the loss due to disability and mortality as summarized by the DALYs.

- ✓ **Estimated Impact on Males**

In the population modeled in this analysis, the number of males for most ages was lower than that of females. The median male population was 221,800 persons. Since the calculation of total costs and economic losses depends on the number of cases, most statistics for males will be lower than those for females. However, the difference is not much. For example; the total economic loss contributed by males has the median of US\$ 168,500,000 while that for females is US\$176,500,000. It has been suggested that males are more prone to aflatoxin exposure than females. And probably in reality the economic loss could be more or less the same or even reversed, with that for males being higher than that for females.

- ✓ **Estimated Total Economic Loss (Males and Females)**

The estimated total economic loss is the summation of economic losses caused by ill men and women. The total population modeled in this analysis consisted of men and women aged 15 to 62 with the total of 22,956,186 persons. Out of all those persons, the actual number that would have an economically important effect from aflatoxin exposure has the median of 422,500. From this number, a total of 546,000 DALYs would be lost because of morbidity and mortality from HCC resulting from the synergistic effects of chronic hepatitis B and aflatoxin exposure. Monetization of these DALYs put an economic loss due to mortality and morbidity at a median

of US\$ 332,500,000 worth of a GDP. The total economic loss due to aflatoxin exposure in this analysis has a median of US\$ 332,500,000; ranging between US\$ 92,890,000 and 757,900,000.

## **UGANDA**

The situational analysis for Uganda as presented by the FONUS was validated by country stakeholders in June 2015. Groundnut, maize and sorghum were identified by the country as priority staples for PACA's activities. The economic impact is being determined as: (a) impact on health; and (b) impact on trade.

- **Impact on Health**

Aflatoxin contamination in food grains results into ailments; it is therefore suggested by the CGE model that these ailments will lead to a 0.25 percent and 2.83 percent increase in household demand for domestic and imported health services respectively. Consequently, it is modeled that aflatoxin contamination in foods raise demand for the medical supplies and technical personnel at the government funded health centers thus generating a fiscal impact. In the simulation period, government savings turns out to be US\$ 0.3 million less than it would have been without aflatoxin contamination whereas government expenditure on health services increase by 0.87 percent (US\$ 0.91 million). However, considering that increased medical spending and supplies is no substantial problem, especially for HCC, due to its asymptomatic nature during the early disease stages, the impact of aflatoxins on the health of Ugandans is currently being modeled to fit the public health burden assessment approach which uses the DALY and VSL.

- **Impact on the Export Market**

The impact on the export sector is currently being patterned according to the CGE model which indicates that nominal exports deteriorate by -0.62 percent (US\$ 37.56 million) more than real exports (-0.47 percent) indicating a deterioration in the price of exports (-0.15 percent). It is suggested that export loss of US\$ 37.56 million may be observed despite the depreciation of the exchange rate. Thus aflatoxin makes the local produce less competitive in the export market. The CGE model may not be the best for estimating this impact due to the nature of available data. Consultants are attempting a remodeling of the impact.

## **CONCLUSION**

Aflatoxins tend to have more measurable impact on health than on trade and food security in Africa. Major barriers to quantification of the impacts of aflatoxins on the other two sectors weigh heavily on the insufficiency or lack of standards for aflatoxin prone commodities, lack of aflatoxin regulations especially as regards local market, inability to distinguish aflatoxin contaminated and non-contaminated food at household level, and food scarcity.



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