**Republic of the Gambia**





**Situational Analysis for Aflatoxin Mitigation within the National Food Safety System of The Gambia**

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**On behalf of:**

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**In Support to**

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# List of Acronyms

|  |  |
| --- | --- |
| AfricaAIMS | Africa Aflatoxin Information Management System  |
| ANR | Agriculture and Natural Resources |
| ASPA | Association of Producer Associations  |
| ATWG | Aflatoxin Technical Working Group  |
| AUC | African Union Commission |
| CAADP | Comprehensive Africa Agriculture Development Programme  |
| CFR | Case Fatality Ration  |
| CPMS | Cooperative Produce Marketing Societies  |
| DALY | Disability-Adjusted Life Years  |
| DoA | Department of Agriculture |
| DLS | Department of Livestock Services |
| DPV | Direction de la Protection des Vegetaux  |
| ECOWAP | Economic Community of West African States Agricultural Policy |
| ECOWAS | Economic Community of West African States  |
| EU | European Union |
| FAO | Food and Agriculture Organization  |
| FBOs | Farmer Based Organizations |
| FCAC | Food Control Advisory Committee  |
| FFS | Farmer Field School |
| FGD | Focus Group Discussions |
| FSQA | Food Safety and Quality Authority  |
| GAP | Good Agricultural Practices |
| GGC | The Gambia Groundnut Corporation  |
| GHP | Good Hygienic Practices |
| GNAIP | Gambia National Agricultural Investment Plan |
| GoTG | Government of The Gambia  |
| HBV | Hepatitis B Virus  |
| HCC | Hepatocellular Carcinoma  |
| HIV | Human Immunodeficiency Virus  |
| HPS | Hand Picked Selected |
| IDSR | Integrated Disease Surveillance and Response |
| IITA | International Institute for Tropical Agriculture  |
| MICS | Multi Indicator Cluster Survey  |
| NARI | National Agricultural Research Institute  |
| NCR | Net Cash Receipt  |
| PACA | Partnership for Aflatoxin Control in Africa |
| ppb | parts per billion  |
| REC | Regional Economic Communities  |
| SAD | Scientific Affairs Directorate  |
| SC | Scientific Committee |
| SCF | Stakeholder Consultative Committee |
| SPS | Sanitary/Phytosanitary |
| WHO | World Health Organization |

# Executive Summary

Aflatoxin is a major cause of pre- and post-harvest loss groundnuts, maize and rice which are widely consumed by the general Gambian population, therefore constitutes a significant food and feed safety risk. Aflatoxin contamination of crops can result in foregone revenues and profit from domestic, regional and international trade. Aflatoxin, a highly toxic metabolite produced by *Aspergillus flavus* and *parasiticus* fungi, is known to cause immune-system suppression, growth retardation, liver disease, and death in both humans and domestic animals.

In a concerted effort to address the aflatoxin problem, Africa-led Partnership for Aflatoxin Control (PACA), through Meridian Institute (USA), commissioned this situational analysis for the mitigation of aflatoxin within the food safety system of The Gambia. The objectives of the situational analysis were to: (a) review the country’s food safety systems and effects of aflatoxin along the main agricultural value chains; (b) develop and use an economic analysis framework to reveal the cost of aflatoxin to health, trade and agriculture; (c) formulate evidence based recommendations that will form part of the input into the country’s investment strategy, as well as specific investment options required for aflatoxin mitigation in the medium term; and (d) inform the GNAIP review and AfricaAIMS data submission and implementation process.

The situational analysis revealed that there is limited knowledge and application of Good Agricultural Practices (GAP) by groundnut, maize and rice farmers aimed at mitigating aflatoxin contamination. Farmers’ access to production inputs such as certified seeds, fertilizer and agrochemicals are limited, posing major challenges to mitigating aflatoxin contamination, in addition to increasing production and productivity. The analysis further revealed that awareness of the occurrence of aflatoxin and its consequences is generally low among the population, including the actors of the three value chains assessed under this study.

The economic impact assessment revealed average losses on international and human health amounting to USD 2,105,020 and USD 94,383,398, respectively.

# 1.0 Introduction

The aflatoxin challenge is a significant threat to food and economic security, and undermines poverty eradication in Africa. It is a major cause of post-harvest loss that further constrains the amount of food reaching our markets and households across the African continent. According to the World Health Organization (WHO, 2011), aflatoxin contamination leads to 64% reduction in food quality. In addition, aflatoxin poses a major public health challenge to consumers all over the continent and can result in foregone revenues and profit from domestic, regional and international trade.

In a concerted effort to address the aflatoxin problem, the African Union Commission established a continental Sanitary/Phytosanitary (SPS) working group to mainstream SPS matters in the Comprehensive Africa Agriculture Development Programme (CAADP) framework and establish an Africa-led Partnership for Aflatoxin Control (PACA). CAADP provides an integrated framework of development priorities aimed at restoring agricultural growth, rural development and food security in the African region. In its very essence, it seeks to implement the key recommendations on food security, poverty reduction and sustainable use of natural resources, made at recent global conferences. The CAADP comprises fourpillarsand severalcross-cuttingissues.

In West Africa, The Economic Community of West African States (ECOWAS) is coordinating the implementation of the CAADP for which it has developed the Regional Agricultural Policy (ECOWAP). In 2009, the Government of The Gambia (GoTG) developed a CAADP Compact and The Gambia National Agricultural Investment Plan (GNAIP). The GNAIP’s development objective is to increase food and nutritional security and household incomes through increased agricultural and natural resources production and productivity.

The goals of PACA are to reduce the incidence of aflatoxin in food, improve public health, increase trade, augment smallholder income, and enhance food security in Africa thereby creating an Africa free from the harmful effects of aflatoxins. The aim is for this process to become a part of the CADDP framework. The Gambia, one of the six PACA pilot countries, undertook a situational analysis in The Gambia for the mitigation of aflatoxin within the national food safety system during the period January to June, 2015.

The analysis will catalyse strategic actions across the agriculture, health and trade sectors in The Gambia by identifying existing programs that can integrate aflatoxin control measures, avoid duplication of effort and providing the necessary input to align aflatoxin control with broader food safety and SPS issues within The Gambia. The analysis will also inform the review of the GNAIP as well as the development of the Africa-led Aflatoxin Information Management System (AfricaAIMS). In addition, the situational analysis will assess the economic impacts of aflatoxin in health, trade and agriculture.

## The aflatoxin problem

*Aspergillus flavus* and *A. parasiticus*, whose natural habitat is the soil, are among the most widespread fungi that produce aflatoxins. These fungi produce several types of aflatoxins; *A. flavus* isolates producing aflatoxins B1 (AFB1) and B2 while *A. parasiticus* isolates produce AFB1, AFB2, AFG1 and AFG2. These fungi can colonize a wide variety of food commodities including maize (corn), sorghum, rice, millet, oilseeds (including groundnuts), spices, tree nuts, and dried fruits (Strosnider et al., 2006).

*Aspergillus* contamination during crop production and other stages along the value chain depends on favourable environmental conditions for the fungi to thrive. During crop development, damage by pests (birds, mammals, and insects) or the stress of hot, dry conditions can result in significant fungal infections. In The Gambia, high moisture contents at the time of harvest and storage is also shown to increase aflatoxin levels.

Specifically, aflatoxin-producing *Aspergillus* grows best at temperatures between 25°C and 33°C, and relative humidity greater than 50%. Drought stress has been found to increase the number of *Aspergillus* spores in the air, increasing the chance of infection in crops (Sanders et al., 1993). Drought, high temperatures, low soil fertility, pest infestation and other stresses that affect plant growth during pollination also increase the level of aflatoxins produced by the *Aspergillus* fungi, exacerbating the problem. Thus, aflatoxins disproportionately affect food and feed in tropical and subtropical regions of the world, which includes The Gambia.

Aflatoxins are known to cause serious health effects in humans and livestock, leading to significant adverse impacts in the form of increased epidemiological disease burden and adverse impacts on the country’s agriculture, food security, and trade, resulting in negative consequences on the economy.

***Aflatoxins are a global food safety and public health threat***

Aflatoxins constitute a significant food and feed safety risk. Exposure to aflatoxin is widespread, primarily through the ingestion of contaminated food and feed. The Food and Agriculture Organization (FAO) estimates that aflatoxins affect 25% of the world’s crops while the Centres for Disease Control estimates that 4.5 billion people are chronically exposed to aflatoxin through contaminated food. The health hazards associated with aflatoxin exposure include aflatoxicosis, liver cancer, nutritional interference and suppression of the immune system, which predisposes the body to human immunodeficiency virus (HIV) infection, and possibly other communicable diseases.

In The Gambia, extensive research efforts have documented high liver cancer incidence resulting from childhood hepatitis B infections, lifetime dietary aflatoxin exposure, and chronic hepatitis C infections (Turner, et al, 2000; Wild, et al., 1993). About 57% of the liver cancer cases are attributable to chronic hepatitis B infection. Hepatitis B prevalence rate in The Gambia is about 15%, with age-specific prevalence as high as 20% in 10- to 20-year olds (Hwang and Cheung, 2011). The Gambia Hepatitis Intervention Study clearly showed that immunization is highly effective in preventing chronic hepatitis B infection and the likely onset of hepatocellular carcinoma, and that hepatitis B vaccination can be implemented in the national immunization programs of developing countries (WHO, 2015).

Some experts have associated chronic aflatoxin exposure to childhood stunting as well as interference with gut health and nutrient metabolism (Turner et al, 2007; Smith et al, 2012). Stunting is widely recognized as a major human and development problem throughout Africa, because it lowers lifetime productivity and GDP. Almost one (20%) in five children under age five in The Gambia are moderately underweight, 4.2% are classified as severely underweight, and (23.4%) of children are moderately stunted or too short for their age while 9.5% are moderately wasted or too thin for their height (MICS, 2010).

Furthermore, aflatoxin contamination of agricultural commodities can reduce the volume and value of agricultural sector output, generally, and impact each of the four pillars of food security - availability of food, access to food, utilization of food and stability in each of these three elements. Contamination in staple crops can directly reduce the local availability of safe and nutritious food. Producers not able to comply with more stringent regulations will earn less, which reduces farm households’ capacity to access purchased food. Greater food insecurity can result from poor utilization if the food consumed is not nutritionally adequate or if it has deteriorated due to mould. The dependence of aflatoxin prevalence on climatic conditions places the stability of food security at risk as well.

The Gambia is not self-sufficient in food; both imported and locally produced and processed foods are consumed by the general population. People consume groundnuts and cereals that are locally processed in their homes mostly with no regard to quality checks and food safety. Groundnuts are usually contaminated with aflatoxins, while maize and rice are highly susceptible to aflatoxin contamination. The majority of Gambians are however not aware of the existence of these toxins in their food and their effects on health. Gambians are therefore at greater risk of exposure to aflatoxins.

***Aflatoxin can impact domestic and international trade of commodities***

The Codex Alimentarius Commission has set international standards for aflatoxin and many countries have established regulations to limit human and animal exposure, typically expressed in parts per billion (ppb). While regulation is clearly warranted to protect the consumer, food and feed safety regulations can result in foregone revenues and profit from domestic commerce and international trade; therefore, producers, traders, and processors incur increased operating costs as they strive to meet the standards. If they fail to comply, additional costs will arise from rejection of shipments; increased rates of sampling at borders; and in the worst case, loss of admissibility into foreign markets. While the regulatory control regime with respect to aflatoxin varies across most African countries, any or all such costs may occur if regulations are tightened or more strictly enforced. Similarly, actual costs of reducing contamination will rise to the extent that consumers become more aware and demanding, or traders apply higher science-based standards, or processors begin to test susceptible raw materials.

Groundnut is The Gambia’s principal export crop constituting approximately 66% of the earnings from agricultural exports. The European Union’s (EU) was the most important market for Gambian groundnuts, but the imposition of strict aflatoxin standards has effectively restricted entry of The Gambia’s groundnut consignments to the EU. There is a need for the country to deal effectively with the export-restricting problems posed by aflatoxin contamination.

In response to the challenge in ensuring food safety, including the mitigation of risks associated with the consumption of aflatoxin contaminated food and feeds, The Gambia enacted the Food Safety and Quality Act 2011. The Act has established the Food Safety and Quality Authority (FSQA) as the National competent authority and given the priority and high profile accorded to food safety, the government decided to place the FSQA in the Office of the President. The Act is a modern science- and risk-based legal food safety management instrument that covers the entire food value chain from production to consumption. The FSQA became operational in 2013 and henceforth has been focussing on its food control mandate (inspection). The food safety science related work, the development of regulations and enforcement regimes are yet to take off in earnest. The institutional framework of the FSQA has all the elements necessary for the assessment of risk related to aflatoxin in The Gambia and for its mitigation if the structures and systems are fully operationalized.

# 2.0 The country assessment

This country assessment covers the three sectors that have priority under PACA’s program, namely agriculture and food security, trade and health. The remaining Chapters of this report are organized as follows: Chapter 3 briefly presents a conceptual framework for conducting country assessments, while the subsequent chapters present the results of this assessment in the following order – (a) identification of priority crops of concern in The Gambia, (b) prevalence (distribution and degree) of aflatoxin contamination in the identified crops, (c) current risks of aflatoxin contamination and exposure existing in The Gambia, (d) awareness levels among stakeholders, (e) economic impact analyses of aflatoxin contamination in the country, (f) identification of gaps and intervention options for aflatoxin mitigation in the country, (g) policy, legal and institutional environment as it pertains to aflatoxins, and (h) conclusions of the situation and economic impact assessments.

# 3.0 Overview of the Conceptual Framework

The core steps followed in conducting this country assessment are:

**Step 1: Identify Key Crops of Concern.** An initial list of potential crops for study was agreed at the PACA Pilot Country Inception Workshop held in Tanzania from 10th to 11th June, 2014. These comprise groundnuts, maize, rice, millet for the West Africa sub-region. The Aflatoxin Technical Working Group (ATWG) subsequently approved groundnut, maize and rice (in order of priority) at the presentation of the Inception Report (22nd January 2015) by IRIS Consultants. The selection criteria were based on crop susceptibility levels to aflatoxin contamination, production, consumption and contribution to food security and GDP.

 **Step 2: Determine the Prevalence of Aflatoxin.** The prevalence, distribution and degree of aflatoxin contamination on the selected crops were determined through review of available secondary data; published reports; key informant interviews and focus group discussions.

**Step 3: Characterize Risks of Aflatoxin Contamination and Exposure.** The core risks of aflatoxin contamination in the selected commodities are low production and productivity in agriculture, losses in trade due to low quality, unsafe food and feed and associated health risks. The core risks and final uses of the selected crops were assessed along the value chains using secondary data; checklists for value chain actors during focus group discussions, key informant interviews and observations during site visits. Fifteen focus group discussions were conducted in all the agro-ecological zones of the country.

**Step 4: Estimate Economic Impact from Aflatoxin Contamination.** In this step we estimate the economic impacts on agriculture and food security, economic impacts resulting from market losses in both domestic and international markets, and economic impact resulting from the consumption of aflatoxin-contaminated food by humans. Depending on the finding from step 3, further analysis focused on the most significant impacts (e.g., health impacts).

Data was obtained from secondary data; checklists for value chain actors during focus group discussions, key informant interviews and observations during site visits. The estimation of economic impact for price loss, export rejects and health economic impact were analysed using formulae presented in section 8.3 and 8.4 of the report.

**Step 5: Identify Opportunities for Aflatoxin Control.** The institutional, legal and regulatory framework was assessed through literature review and an assessment of Food Safety and Quality Authority (FSQA) and the National Agricultural Research Institute (NARI) Aflatoxin testing laboratory. Focus group discussions and key informant interviews were also used to assess opportunities for awareness creation. Assessment of available control approaches and technologies was conducted through literature review, focus group discussions and key informant interviews. Based on the review of the risk of contamination along the value chain key gaps for aflatoxin control were identified.

**Step 6: Conduct Stakeholder Workshop to Validate Findings and Identify Priority Action Steps.** In this final step, a multi-sectoral workshop will be conducted with key stakeholders representing agriculture, trade, and health from the public and private sectors to discuss the draft assessment. Key stakeholders (which include solutions providers, researchers, and legal and regulatory experts) will make presentations that augment the discussion to identify current prevention, control and mitigation opportunities and gaps. Breakout sessions with small groups will work to identify and sketch out priority action steps.

# 4.0 Identification of the Key Crops of Concern

In The Gambia, crop production is widespread and carried out by smallholder farmers for food and cash. Major food crops grown comprise cereals (early and late millet, maize, sorghum and rice) and cash crops constitute groundnut, sesame and cotton. Groundnut, maize and rice (in order of priority) were identified based on their susceptibility levels to aflatoxin contamination, production, consumption and contribution to food security and Gross Domestic Product (GDP). Figure 1 shows production levels of groundnut, maize and rice from 2005/06 to 2014/15 cropping season. Groundnut is the major cash crop of The Gambia. Its production averaged 106,110 MT over the last decade with the highest production registered in 2006/2007 cropping season - 150,140 MT. Maize serves as the first harvested, marketed and consumed crop for most farmers during the cropping season. Its average annual production oscillated around 28,250 MT with the highest production registered in 2013/2014 crop year of 33,060 Mt. Rice is the most important food crop in The Gambia; its production in a decade (2005/2006 – 2014/2015) revolved around an annual average production of 38,390 MT paddy (24,951 MT milled) which is only 11% of the national requirement. The deficit is bridged by commercial imports and to some extent food aid. In 2013, about 130,000 MT of milled rice were imported into the country some of which were also unofficially re-exported to the neighbouring countries.

 Source: Planning Services, Department of Agriculture

# 5.0 Prevalence of aflatoxin and aflatoxin-producing fungus

The prevalence, distribution and degree of aflatoxin contamination on the selected crops were determined through review of available secondary data; published reports; key informant interviews and focus group discussions. Aflatoxin contamination and prevalence in agricultural commodities is mostly determined by the type of aflatoxigenic strains present in the environment, agricultural practices, processing and storage conditions. In The Gambia, very little information exists for the distribution of aflatoxin producing fungi in soils or crops. However, since The Gambia share similar climatic conditions and agricultural practices with Senegal, the strain profiles and distribution of toxigenic species in both countries may be similar.

The fungus *A. flavus* was detected in soil samples collected from the NARI Experimental Station in the Western Region of The Gambia (Darboe, 2010, unpublished report). This was part of a trial/pilot study to identify the most resistant or tolerant variety of groundnut to *Aspergillus* infection and aflatoxin contamination in The Gambia. Diedhiou et al. (2011) reported the presence of *Aspergillus* section *Flavi* (*A. ﬂavus, A. tamarii* and the unnamed taxon SBG) in two agro-ecological zones in Senegal similar to The Gambia, i.e. Guinea Savannah and Sudan Savannah zones. Of the aforementioned aflatoxin producing species, the SBG happens to be the toxigenic member of more importance due to their ability to produce copious amounts of both aflatoxins B and G. This strain, SBG, has been reported to be restricted/limited to countries in West Africa (Benin, Burkina Faso, Nigeria, Senegal, and Sierra-Leone) in a study that considered the diversity of aflatoxin producing fungi and their impact on food safety in sub-Saharan Africa (Probst, 2014). The ongoing exchanges of seeds, produce, products and by-products among farmers and traders of the two countries, and also the weekly markets organised along borders of the two countries which are frequented by farmers and traders provide a conducive environment for strain transfer across the borders.

In another ongoing effort (the aflasafe project) to characterize indigenous fungal populations in soil and mitigate aflatoxins in crops, soil samples were analysed to determine the distribution of *Aspergillus* species and their relationship to aflatoxin contamination in food by geographic location. Strains from the soils have been selected as potential biocontrol (aflasafe SN01®) for further field efficacy trials but the results are yet to be published.

**5.1 Direct evidence of aflatoxin prevalence**

### 5.1.1 Direct evidence of aflatoxin contamination in groundnut and groundnut products

The data on the occurrence of aflatoxin in groundnut in this assessment were obtained from two sources, The Gambia Aflasafe programme (which has not yet been officially published) and the EU Rapid Alert System for Food and Feed. The National Agricultural Research Institute (NARI), the Department of Agriculture (DOA) under the Ministry of Agriculture and The Gambia Groundnut Corporation (GGC), the FSQA in collaboration with the International Institute for Tropical Agriculture (IITA) in Nigeria and Direction de la Protection des Vegetaux (DPV) in Senegal, are involved in the implementation of the Aflasafe programme in The Gambia. Groundnut samples were collected from groundnut buying points (Secco) in 28 villages across the country and analysed for aflatoxin contamination at IITA. The unpublished data (Table 1) show that percent samples with detectable aflatoxin range from 30 in Lower River Region to 75 in Upper River Region –North. West Coast Region has the highest mean aflatoxin B1 level (170.06 ppb) whilst Lower River Region has the lowest (2.19 ppb). The highest mean total aflatoxins were recorded in West Coast Region (267.87 ppb) and the lowest (2.78 ppb) in Lower River Region. All the samples in North Bank Region exceeded the maximum limit for total aflatoxins while only 15% of samples from Lower River Region exceeded the maximum limit.

Table 1: Occurrence of aflatoxins in groundnut in The Gambia.

|  |  |  |  |
| --- | --- | --- | --- |
| **Regions** | **N** | **Samples with detectable aflatoxins (%)** | **Aflatoxin concentrations (ppb)** |
| **Range of AFB1** | **Mean AFB1** | **Samples exceeding maximum limit for AFB1 (%)** | **Mean of total aflatoxins** | **Samples exceeding maximum limit for total aflatoxins (%)** |
| West Coast | 20 | 65 | 1.6–1189 | 170.06 | 60 | 267.87 | 60 |
| Lower River | 20 | 30 | 1.55– 17.53 | 2.19 | 20 | 2.78 | 15 |
| Central River- South | 20 | 65 | 2.92–218.6 | 33.56 | 100 | 39.04 | 60 |
| Central River-North  | 20 | 70 | 6.48–569.7 | 68.17 | 70 | 102.32 | 100 |
| Upper River-South | 20 | 50 | 2.24–200.64 | 15.57 | 100 | 16.5 | 40 |
| Upper River-North | 20 | 75 | 0.79–42.86 | 3.55 | 40 | 4.60 | 10 |
| North Bank | 20 | 55 | 16.35–342.71 | 73.96 | 100 | 102.24 | 100 |

N = Number of samples analysed

Maximum limit for AFB1 = 2 ppb (EC 852/2004)

Maximum limit for total aflatoxins = 4ppb (EC 852/2004)

Source: aflasafe programme in The Gambia

Aflatoxin levels from EU Rapid Alert System for food and feed (RASFF) are indicated in Table 2. These results are based on test carried out on groundnut – for bird feed and food (Hand Picked Selected (HPS) confectionery) - exported to the EU. The levels exceeded the maximum residue limits established by the EU Regulation No.78/200 2 2002/32/EC for bird feed and HPS confectionary from groundnut, and as a result these consignments were rejected and returned to The Gambia.

Table 2: Aflatoxin levels from EU Rapid Alert System for food and feed (RASFF)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Date of case  | AFB1 (ppb) in sample | Maximum permitted level of AFB1 (ppb) in EU | Total aflatoxin (ppb) in sample | Maximum permitted level of Total aflatoxins (ppb) in EU | Product | Consignment weight (Kg) |
| May 8, 2015 | 101 | 20 | 223.8 | NA | Bird feed | 18,000 |
| May 7, 2015 | 142 | 20 | NA | NA | Bird feed | 20,230  |
| May 5, 2015 | 207 | 20 | 306.4 | NA | Bird feed | 108,000 |
| May 5, 2015 | 194 | 20 | NA | NA | Bird feed | 25 |
| May 5, 2015 | 83.7 | 20 | NA | NA | Bird feed | 18,000 |
| March 25, 2015 | 50.5 | 2 | 64.4 | 4 | Food (HPS confectionery) | 18,240 |
| March 25, 2015 | 70.2 | 2 | 90.5 | 4 | Food (HPS confectionery) |
| December 23, 2014 | 185 | 20 | NA | NA | Bird Feed | 18,000 |
| December 22, 2014 | 70 | 2 | NA | 4 | Food (HPS confectionery) | 18,000 |
| November 25, 2014 | 97.7 | 20 | NA | NA | Bird Feed | 18,000 |
| November 19, 2014 | 35.4 | 20 | 40.3 | NA | Bird feed | 18,000 |
| July 5, 2012 | 101 | 2 | 144 | 4 | Food (HPS confectionery) | 18,000 |
| July 5, 2012 | 30 | 2 | 46 | 4 | Food (HPS confectionery) |
| March 17, 2012 | 25.6 | 2 | 53.8 | 4 | Food (HPS confectionery) | NA |

In Senegal, an informal survey of roasted snack peanuts, groundnut oil and groundnut cake in several markets across Dakar and within the groundnut-growing region of the country, revealed aflatoxin levels ranging from 25 to 236 ppb (Imes, unpublished, undated).

### 5.1.2 Direct evidence of aflatoxin contamination in maize

The occurrence of aflatoxin in maize has not been reported in The Gambia. However, in Benin, pre-harvest maize is reported to be contaminated with aflatoxins; stored maize contained AFB1 with levels up to 14 g/kg (14,000,000 ppb) and AFG1 up with levels to 58 g/kg 58,000,000 ppb). Maize samples collected from silos and warehouses in Ghana also contained aflatoxins at levels ranging from 20 to 355 g/kg (20,000,000 to 355,000,000 ppb) (Bankole, 2003). In Senegal, maize samples from the Nioro zone (adjacent to the North Bank Region of The Gambia) located in the groundnut basin, where crops are commonly rotated between groundnuts and maize were also contaminated. This study found samples in Nioro with extremely high levels at 852.5 ppb (Imes, unpublished, undated).

### 5.1.3 Direct evidence of aflatoxin contamination in rice

There is no data in The Gambia on aflatoxin contamination of raw rice; however rice samples analysed in Nigeria contained AFB1 within the range of 37.26–113.2 ppb ((Makun et al., 2014). In Iran, rice bran kept in storage for one year was reported to contain aflatoxins up to 17.53 ppb, while fresh samples (storage time not indicated) contained 3.43 to 18.7 ppb (Fatemeh Zaboli et al., 2010).

### 5.1.4 Aflatoxin contamination in cooked foods

An aflatoxin-specific monoclonal antibody-based immunoaffinity chromatography method was developed and used for the rapid screening of aflatoxins from a variety of cooked foods in The Gambia (Hudson et al., 1992). The aflatoxin levels are presented in Table 4 below. The results showed that groundnut sauces had the highest levels of contamination (19–943 ppb with a mean of 162ppb)

 **Table 4. Aflatoxin levels in cooked foods from various sources in The Gambia**

|  |  |  |
| --- | --- | --- |
| Samples (cooked foods) | Range (ppb) | Mean (ppb) |
| Groundnut sauces | 19 – 943 | 162 |
| Millet | 1 – 27 | 14 |
| Sorghum | 2 – 16 | 9 |
| Rice | 2 – 19 | 10.5 |
| Leaf sauces | 21 – 36 | 28.5 |

 Source: Hudson et al., (1992)

Further works are in progress to provide more evidence on prevalence of aflatoxin in a range of agricultural commodities in The Gambia. These include International Trade Centre funded Audit of the handling, processing and storage of groundnuts for aflatoxin contamination between depots and markets; the aflasafe initiative to test the efficacy of biological control agent - aflasafe SN01® product for toxigenic *A. flavus*; and the Africa Aflatoxin Information Management System - AfricaAIMS.

# 6.0 Risk characterization of aflatoxin contamination

The characterization of risks of aflatoxin contamination in relation to the final uses and value chain process of groundnuts, rice and maize are evaluated and discussed below. The final uses of groundnuts, maize and rice were determined to assess where the largest impact of contamination is likely to be and, correspondingly, the distribution of economic impacts between human and livestock health, agriculture and food security, and domestic and international trade.

## 6.1 Final uses of groundnuts

In The Gambia, it is reported that about 50% of the groundnut produced is marketed locally and internationally (Mbenga, NARI, 2014; unpublished). Farmers reported that about 13% of the total groundnut produce (8,966 Mt) is kept for seed (Table 5). Our calculations show that about 10,000 Mt are exported. Per capita consumption is estimated at 26,000 kg/year or 77 grams per/capita/day.

 Table 5. Final uses of groundnut

|  |  |  |
| --- | --- | --- |
| 1 | Total production (decorticated) (Mt) |  68,971 |
| 2 | % kept by farmers for seed and consumption |  55  |
| 3 | Quantity kept by farmers for seed and consumption (Mt) |  37,933  |
| 4 | % kept by farmers for seed out of total production |  13  |
| 5 | Quantity kept by farmers for seed (Mt) |  8,966  |
| 6 | Quantity consumed by farmers (own consumption) (Mt) |  28,967 |
| 7 | % traded by farmers (from total production) |  45  |
| 8 | Quantity traded by farmers (Mt) |  31,038 |
| 9 | Exported (from quantity traded) (%) |  33  |
| 10 | Quantity exported (Mt) |  10,242  |
| 11 | Quantity consumed from what is traded (Mt) |  20,796 |
| 12 | National consumption (6+11) (Mt) |  49,763 |
| 13 | National population (Million) |  1.90  |
| 14 | Per capita consumption (Kg/year) |  26.191 |
|   15 | Per capita consumption (g/day) | 77 |

Groundnut is an essential component of the diet of Gambians; it is a valuable source of plant protein. Based on the information from the focus group discussions with rural and peri-urban stakeholders, groundnut is consumed at least thrice a day. The groundnuts consumed are likely to be contaminated by moulds and aflatoxins thus compromising safety of the food.

Groundnut derivatives, i.e. crude oil and cake, are exported. The balance of groundnut cake after export is fed to livestock, mainly poultry in the form of compounded feed (containing maize, groundnut cake and rice bran). Most of the aflatoxins are extracted during the oil extraction process. The high aflatoxin contamination in groundnut and its derivatives apart from the oil[[1]](#footnote-1) constitutes a potential food safety hazard posing health risk to both humans and animals. Groundnut hay, estimated at 1.5 Mt per hectare, is collected after the groundnut is harvested is dried and conserved for feeding mainly draft animals and small ruminants. Groundnut farmers also sell some of their hay to supplement their income.

## 6.2 Final uses of maize

Information obtained during the FGDs in March 2015 indicate that, on average, 50% of the maize crop produced by farmers is marketed and the remaining 50% is used for home consumption and seed for the next cropping season. The consultant’s expert view suggests that at least 80% of the marketed crop is used for human consumption and the rest fed to poultry. Maize constitutes an important component of the diet of Gambians, particularly in the rural areas where it is consumed at least once a day mostly blended with millet for couscous or porridge. Per capita consumption of maize is estimated at 152 kcal/day (FAOSTAT, ). Maize grain and stover are important livestock feeds. Maize grain is used in the manufacture of poultry feeds making up about 60-70% of the ingredients. Maize stover is mostly left in the fields and grazed by livestock after the harvest.

## 6.3 Final uses of rice

Ninety percent of the rice produced is consumed by the producing households and the remaining 10% is for sale and seed; this owes to the fact that rice farmers do not produce enough to satisfy their needs for the whole year. It was estimated that local production covers the needs of producers for between 2 to 12 months of the year. Households having all year round rice self-sufficiency from own productions are in the minority. Rice producing households that are not self-sufficient resort to buying imported rice. The Gambia imported 88,214 Mt, 140,672 Mt and 139,871 Mt of rice in 2010, 2012 and 2014, respectively (GBOS, 2015). The average Gambian consumes rice at least once a day. Per capita consumption of rice is estimated at 320 g/day (CILSS Cereal Balance Sheet, 2012).

The by-products of rice processing, the bran, is used as a component of supplementary feeds for livestock and compounded feeds mainly for poultry and pigs; the husk is discarded. Rice straw is left in the fields and grazed by cattle and small ruminants, however, there is an emerging trend in which the straw is commercialized in livestock markets.

## 6.4 Risk of contamination along the groundnut, maize and rice value chains

Aflatoxins can affect the entire groundnut, maize and rice supply chains beginning at the farmer’s field. The analysis of risks of contamination was performed along the value chains of the three commodities beginning with pre-harvest and extending to post-harvest contamination that directly impact agriculture and food security; risks of contamination and exposure in domestic and international trade.

### 6.4.1 Risk of contamination at pre-harvest

Contamination of agricultural commodities by aflatoxins can occur at any stage of the chain from production, harvesting, post-harvest handling, processing, storage and distribution. Good Agricultural Practices (GAP) such as the use of certified seeds, timely planting, maintaining optimal plant densities, timely application of fertilizer at the recommended rate, avoidance of drought stress and controlling other plant pathogens, weeds, and insect pests can reduce infestation in the field.

Our field research revealed that there is limited knowledge and application of GAP by groundnut, maize and rice farmers aimed at mitigating aflatoxin contamination. Farmers’ access to production inputs such as certified seeds, fertilizer and agrochemicals are limited, posing major challenges to mitigating aflatoxin contamination, in addition to increasing production and productivity. Furthermore, there is limited access to implements for land preparation delaying farm operations. Less than 5% of groundnut, maize and rice farmers that attended the FGD use improved seeds, fertilizer and pesticides. According to the 2011/2012 Agricultural Survey, 19% of households use manure while 33% use chemical fertilizers and 48% reported not being able to afford fertilizers due to high costs. Use of herbicides was also reported to be low (11%) because of high cost. Almost all the female farmers indicated that they have limited access to farm implements for land preparation delaying farm operations.

Extension advice on agronomic practices from the extension services are basically geared towards increasing yields; extension messages do not address aflatoxins. Farmers reported limited contact with extension agents; the extension: farmer ratio is about 1: to over 3,500 (ANR Policy, 2009-2015). The extension services are not equipped with essential working tools such as mobility or well-planned extension messages, skills and knowledge to transfer appropriate technologies or provide much needed advice and information to producers in the investment and management of their enterprises (ANR Policy, 2009-2015).

Good Agricultural Practices to reduce *Aspergillus* infestation in the field are being promoted in The Gambia through Farmer Field Schools (FFS) and use of biological control methods. Thirty FFS for groundnuts were established by Agri-business Services and Producers Association (ASPA) with support from the Sector Competitiveness and Export Diversification Project of the Enhanced Integrated Framework to mitigate aflatoxin contamination. A biological control method whereby non-aflatoxigenic strains (Aflasafe SN01®) of *Aspergillus* are sprayed on fields to compete with those strains producing aflatoxins is on trial in The Gambia.

### 6.4.2 Risk of contamination at harvest and post-harvest

Groundnut farmers experience late harvesting as a result of unavailability and affordability of labour or appropriate technology, mainly draught animal and implements. Male and female groundnut farmers reported lifting groundnut from the soil with animal–drawn lifters or the traditional hoe. The lifter cuts off the roots below the crops and loosens the soil. The inappropriate use of groundnut lifting tools could lead to the bruising of the nuts making them more susceptible to fungal infection. The harvested plants are left on the ground with the nuts facing upwards for about 5 to 7 days. The partially dry plants are then piled on the ground into large heaps resulting in poor air circulation in tandem with the increased moisture and high temperature within the heap thus increasing the nuts’ susceptibility to aflatoxin contamination. The partially dry plants are manually threshed 2 to 3 weeks after stacking using sticks which could lead to damaging the nuts, and bagging in polypropylene bags instead of jute bags. The recommended practices are to arrange harvested groundnuts in windrows with the pods facing upwards towards the sun for about 14 days and latter stacked on a raised platform and allowed to dry to less than 12% moisture level before threshing. After threshing, additional drying should be done ideally on a concrete floor if the moisture content is over 10%. The groundnuts should be sorted and all discoloured, shrivelled, and mouldy nuts should be removed before bagging and evacuation to the homestead. Because of on-farm buying by itinerant groundnut traders, there is no incentive for farmers to sort at farm level.

Maize farmers reported incidents of their crops left in the fields being contaminated as a result of unseasonal rain. Maize farmers leave the mature plants to dry in the field for about 14 days before harvesting. Harvesting is done by plucking the cobs from the dry plants. The harvested maize cobs are further dried in the homestead either on a platform (thus preventing contact with the soil) in the open air or inside a room before shelling; drying time could last for up to 30 days. Drying harvested maize in the cob to 15.5% moisture content or lower within 24 to 48 hours will reduce the risk of fungus growth and consequent aflatoxin production (Hamilton, 2000). Shelling of small quantities of maize used for home consumption is done using mortar and pestle while for larger quantities, they are put in bags and beaten with sticks. This practice may result in broken grains that increase the chances of the fungi penetrating the maize grains. No improved shelling methods were reported to be in use. The shelled maize is sorted and mould infested grains are removed by hand picking.

Rice harvesting is done by hand using either a knife or sickle with the knife being more prevalent, especially with the women. The paddy rice harvested by sickle is left to dry in the field for 6 to 7 days and the knife harvested for 3 to 5 days and subsequently taken to the homestead for storage. Some farmers reported incidents of contamination with sickle harvested crops left in the fields as a result of unseasonal rain. Threshing is usually done by beating the bundle of rice stalks on empty barrels placed on bags spread on the ground. Threshed paddy is dried on drying floors, recycled bags, tarpaulin, or on corrugated iron sheets. Farmers are generally aware of the need to thoroughly dry the crop before threshing and storage**.**

### 6.4.3 Risk of contamination in storage

The decorticated groundnuts, shelled maize and milled rice kept for seeds are stored in recycled 200 litre vegetable oil drums or 20 litre plastic containers. According to the farmers, there is no quality deterioration of the seeds stored in this manner. Farmers are aware of the merits of treating the stored seeds with fumigants such as phostoxin but these products are not readily available in the rural areas, as such farmers resort to buying unregistered chemicals at the weekly markets (loumos) in The Gambia and Senegal. Fumigation in storage has been shown to significantly reduce the incidence of fungi. Shelled maize and paddy rice are put in polypropylene flour bags for marketing and household consumption.

The harvested crops are stored inside the producers’ houses or specially built structures. Over 80% groundnut farmers reported storing their crops for seed and consumption inside houses. The seeds for planting are kept in the drums or plastic containers. Maize farmers reported placing the bags on corrugated iron sheets placed on the ground inside their houses, or on platforms erected within their compounds. Threshed paddy is put in bags and stored on corrugated sheets placed on the floor or on platforms in their houses. Knife harvested paddy is stored in the houses in panicles arranged in such a way as to allow aeration. The storage structures generally have limited ventilation. Storage practices at farm level expose the products to potential further aflatoxin contamination. Groundnuts farmers store their crop destined for marketing for 2 to 4 months depending on market conditions. The groundnut, maize and rice for seed and home consumption are stored on average for 2 to 6 months. Farmers reported that despite the availability of communal stores, most of these are not functional. Metal silos also promoted by FAO have not had successful uptake due to unaffordability.

### 6.4.4 Risk of contamination during processing

Processing of groundnuts is done at three levels namely household, local market and industrial levels. At household level, the groundnut in shell are manually decorticated generally by women and children after either sprinkling or dipping them in water for about two minutes; according to them this makes the decortication process easier and results in less breakage of the kernels. Groundnut kernels obtained from dipped in-shell groundnuts are dried for a minimum of 2 hours. These decorticated groundnut kernels, if not properly dried would pose increased risk of higher aflatoxin levels in the product. The groundnut kernels are sorted into various categories: category 1: seeds for planting (selected based on seed size, shape, non-split); category 2: nuts for direct household consumption and processing into groundnut paste and powder (smaller size nuts, discoloured, splits and shrivels); and category 3: black and mouldy nuts (which are evidently highly contaminated).

Processing into groundnut powder at the household level is done manually using mortar and pestle or hand operated grinder. At the household and market levels, processing into paste involves roasting, removal of skin, sorting and grinding using the hand operated grinder or mechanized grinders. The nuts used to produce groundnut powder and paste includes defective ones which may be contaminated with aflatoxin. During our visits to the markets, it was observed that good manufacturing and hygienic practices (GMP/GHP) were not being applied and it was reported that the operations were not being regulated by the Competent Authority.

The Gambia Groundnut Corporation and Royal Enterprise are involved in the processing of groundnuts for export. The companies buy unshelled groundnuts which they decorticate and crush for oil. Most of the aflatoxins are extracted during the oil extraction process; the aflatoxin level in the oil is relatively lower leaving the greater portion of the metabolite in the cake. If this cake is used for food or animal feed, potentially harmful amounts of aflatoxin may be ingested.

Home processing of maize and rice for domestic use is done using mortar and pestle; with the bran as a by-product. At the local market level, processing into maize flour and maize grits is done with no regard to good hygienic and manufacturing practices. There are currently rice mills operated by various Farmer Based Organizations (FBOs) and individuals in villages and local markets. The consumption of the products produced at household level and the markets poses a potential health risk.

### 6.4.5 Risk of contamination during transportation

Maize, rice and groundnuts are transported from the farms mostly by animal drawn carts - horses, donkeys and oxen. According to the Agricultural Census (2011/2012) the major mode of transport by farmers (86%) is horses and donkey carts. Farmers transport their groundnuts from the farm to the homestead and to the formal Cooperative Produce Marketing Societies (CPMS) buying points, commonly known as secco, using animal drawn carts. From the secco, the nuts are evacuated to the depots of the GGC, the major processor and exporter of groundnuts and its by-products. The GGC uses river barges to evacuate their stocks from the regional depots to the processing plant at Denton Bridge. Traders also purchase and evacuate nuts directly from the farmers’ fields and transport the produce to the loumos, regular markets, private operators engaged in processing and export using commercial trucks. The bulk of the decorticated nuts in the loumos are evacuated to the Greater Banjul Area, specifically Serekunda and Brikama wholesale and retail markets (Sandika) using commercial trucks. The risk of aflatoxin contamination is higher in river transportation because the barges are old, and given the length of time it takes to arrive at Denton Bridge and the prevailing storage conditions of the barges. Contamination could occur during transportation if the carts, lorries and barges are not cleaned after each operation. The bags used in these operations are predominantly re-cycled several times without proper cleaning, thus posing more risk of contamination.

### 6.4.6 Risks of contamination in domestic and international trade

Groundnuts and maize are commodities from which a diverse range of products are made and the raw materials used are mainly rejected kernels. Aflatoxin contamination levels are not considered in the selection of the raw materials used in the preparation of these products. The raw materials used in the production of groundnut paste and flour mostly constitute the rejected nuts which are potentially highly contaminated with aflatoxin, thereby posing a health risk. There are no price differentials based on aflatoxin contamination levels for any of the commodities presenting a greater risk of aflatoxin exposure to the consumer; there is no incentive for the farmer and other actors to place uncontaminated products in the markets.

The concern over the health hazards of aflatoxin-contaminated groundnuts has led to the imposition of more stringent regulations by some countries. For instance, the European Union (EU) has set a harmonized aflatoxin regulation for European food and feed. In general, a more stringent standard on AFB1 is applied to food products intended for direct human consumption, compared to the regulations applied to food products that are to undergo further processing (Boakye-Yiadom, 2003). The maximum permissible levels for AFB1 is 2ppb for groundnuts intended for direct human consumption, and 4 ppb for total aflatoxin if intended as an ingredient of foodstuffs. For bird feed, the level for AFB1 is 20 ppb. Currently, the exports of groundnuts are mainly hand-picked selected (HPS) for wild bird feed to EU and smaller quantities to Asia. The crude oil, in which aflatoxin contamination is not a major issue, is exported to France and Italy. The non-detoxified groundnut cake is exported to Senegal and Mauritania. The country is not fetching premium price from exports of these commodities resulting in economic losses.

### 6.4.7 Risk of contamination of livestock feeds

Susceptibility of livestock to aflatoxin varies by species. Susceptible species include chicken, swine, cattle and sheep in order of decreasing sensitivity. Livestock in intensive systems are at higher risk of dietary exposure than animals in extensive systems. In The Gambia, intensive production systems are limited to commercial poultry production, and semi-intensive systems are to pigs, cattle and sheep. Thus, aflatoxins are more likely to be a problem in commercial poultry production systems.

The most common aflatoxin feed sources include groundnut cake, maize and rice bran, the raw materials used as components of supplementary feeds for livestock and compounded feeds for poultry and pigs. In countries where regulation for aflatoxins in animal feeds exists, the permissible aflatoxin levels in animal feeds range from 0 to 50 parts per billion (ppb) with an average of 20 ppb (FAO 2004). Consumption of mycotoxin contaminated diets by farm animals can cause a wide variety of adverse clinical signs depending on the nature and concentration of the mycotoxins present, the duration of exposure, and the animal species and its nutritional and health status prior to exposure.

As indicated above, poultry is the most affected, as over 60% of poultry feed sources are susceptible to aflatoxin contamination. Feeding of aflatoxin contaminated feed to poultry leads to high morbidity and mortality resulting in severe economic losses; reduced feed intake or feed refusal, poor feed conversion efficiency, reduced growth rate, egg production inhibition and egg hatchability, impaired kidney function, altered immune mechanism resulting in vaccine failures and increased susceptibility to infections. Poultry feed contaminated at the level of 3,000 ppb may result in levels of 3 ppb in poultry meat. Aflatoxins may also be carried over from feed to eggs (Zaghini et al. 2005); this implies that aflatoxin contaminated poultry products (meat and egg) can lead to increased human exposure to aflatoxins.

Low levels of aflatoxin (20 to 200 ppb) in the diet of pigs can result in decreased feed intake, slower growth rate and decreased ability to resist disease. In general, younger animals are more susceptible than older market animals or breeding animals. With increasing levels of aflatoxin in the diet, repressed feed intake and growth rate become severe. If aflatoxin levels are high enough, liver damage can occur. Trace levels of aflatoxins and their metabolites may also carry over into the edible tissue of meat-producing animals. When aflatoxin contaminated rations are fed to lactating animals, the toxin may be secreted in milk resulting in a negative impact on suckling young. AFB1 is metabolized to AFM1 in the liver and excreted in the milk of dairy cows.

As indicated above, the composition of the feeds given to poultry is derived from susceptible crops and their by-products - maize, groundnut cake and rice bran. The feeding of aflatoxin-contaminated feeds to poultry can have health impacts on the birds and economic impacts on the producers; in addition, the consumption of poultry products from chickens fed aflatoxin contaminated feeds can have heath impacts on humans.

# 7.0 Awareness Levels

The awareness levels of groundnut, maize and value chain actors vary (Table 6). Compared to the maize and rice value chain actors, the groundnut value chain actors are relatively more aware (50%) of aflatoxin contamination. Among the least aware are the industrial feed millers and commercial poultry farmers (less than 25%) who are not even aware that the raw materials used to manufacture poultry feed could be contaminated with aflatoxin. Furthermore, the commercial poultry farmers are not aware that poultry eggs and meat could be contaminated if their flocks are fed aflatoxin contaminated feed. They are also not aware of the disease conditions associated with the consumption of aflatoxin contaminated feed by their poultry flocks and the attendant health implications in humans by the consumption of contaminated poultry meat and eggs. As also shown in the table, the members of the consumer associations have very low awareness level; they do not know the health implications associated with the consumption of aflatoxin contaminated foods. There are no differences between male and females in terms of awareness of aflatoxin issues.

**Table 6. Level of Awareness among value chain actors for groundnut, maize and rice**

|  |  |
| --- | --- |
|  | **Level of Awareness****( 50% = high; <50% = median; <25% = low** |
|  | **Male** | **Females** |
| **Crop / Actors** | **50%** | **< 50%** | **<25%** | **50%** | **< 50%** | **<25%** |
| **Groundnuts** |
| Producers | X |  |  | X |  |  |
| Processors (Household) | X |  |  | X |  |  |
| Processors (Market) |  |  | X |  |  | X |
| Exporters | X |  |  |  |  |  |
| Formal Traders |  |  | X |  |  | X |
| Informal Traders |  |  | X |  |  | X |
| Consumers |  |  | X |  |  | X |
| **Maize** |
| Producers |  |  | X |  |  | X |
| Processors (Household) |  |  | X |  |  | X |
| Processors (Market) |  |  | X |  |  | X |
| Formal Traders |  |  | X |  |  | X |
| Informal Traders |  |  | X |  |  | X |
| Consumers |  |  | X |  |  | X |
| **Rice** |
| Producers |  |  | X |  |  | X |
| Processors (Household) |  |  | X |  |  | X |
| Processors (Market) |  |  | X |  |  | X |
| Formal Traders |  |  | X |  |  | X |
| Informal Traders |  |  | X |  |  | X |
| Consumers |  |  | X |  |  | X |
|  |  |  |  |  |  |  |
| Transporters |  |  | X |  |  | X |
|  |  |  |  |  |  |  |
| Poultry Feed Millers |  |  | X |  |  | X |
| Poultry Farmers |  |  | X |  |  | X |

The older farmers who are aware of aflatoxin in groundnuts got the information from the then Department of Agriculture (DoA), but the younger ones got it from their parents. Some farmers were exposed to the aflatoxin problem through a study tour to Malawi and South Africa and Farmer Field Schools.

# 8.0 Economic Impacts Resulting from Aflatoxin Contamination

## 8.1 Agriculture and Food Security

The occurrence of aflatoxins is confirmed throughout the value chain of the three commodities. The prevalence of the fungus in the soil has an impact on yields of the infested plants thereby reducing production and productivity. Given the low level of application of good agricultural practices by small-scale farmers, who in addition to having inadequate knowledge of GAP, lack the resources to acquire the necessary agricultural inputs, such as fertilizer, certified seeds, agro-chemicals and appropriate implements needed for the optimization of their farm outputs. The low productivity and production problem identified with the operations of the small-scale farmers is multi-dimensional; however, the aflatoxin problem is an important contributor in this. Our field research and literature review did not reveal any quantifiable data on the effect of aflatoxin contamination at the farm level on yields and productivity in The Gambia. Thus the economic impact of aflatoxins on food security pillar 1 (availability – local production) is unquantifiable.

The national consumption is estimated for groundnuts at 53,108 tons, equivalent to 77% of total production; for maize 14,125 tons, equivalent to 50 % of total production; and for rice 153,501 tons, made up of 24,951 tons from local production and 128,550 tons from imports. Groundnuts, maize and rice together account for 36% of the total calorie intake of Gambians with rice contributing 26% (Figure 2). Without any differentiation in the consumption of these commodities based on aflatoxin contamination levels, and the population being heavily dependent on the end uses of these commodities in their daily diets are therefore exposed to aflatoxin and its health consequences. This impacts particularly on the food security of Gambian population as it concerns the third pillar of food security (utilization – food safety).

Data Source: FAOSTAT 2011

Of the estimated total production of the three commodities, 20,795 tons of groundnuts are marketed locally and 10,242 tons are exported; about 7,000 tons of maize are marketed locally and about 2,500 tons of locally produced rice are kept for seed or marketed locally. The income generated from the sale of these commodities is used by farmers to purchase food to augment their household food security, agricultural inputs and other needs. For all these commodities marketed at the local market there is no price differentiation based on aflatoxin contamination levels. For the groundnuts and groundnut products exported the prices are determined internationally. The Gambia’s current exports of groundnuts and products are limited to nuts for bird feed, crude oil and cake, which do not attract premium prices. Given that the producer price paid to the farmers by exporters is set by a price determination mechanism based on the international prices for the different commodities, it is evident that the farmers do not receive a premium price. The groundnut product which fetches the best price in the international market is HPS confectionery nuts. It should be noted that the only evident impact on the farmers’ income derived from the marketing of their produce relates to the component of the produce that is exported. This situation affects negatively the farmers’ disposable income and thus impacts food security of farmers as far as the second pillar of food security (accessibility – purchasing power parity) is concerned.

## 8.2 Economic impact on domestic Trade

In The Gambia, there is substantial trade of agricultural commodities particularly of groundnuts, rice and maize in the domestic markets comprising regular and weekly (loumos) markets. Currently there exists national standards for groundnuts and rice; the standard for maize is being drafted. The marketing of these commodities are regulated under the Food Safety and Quality Act, however, regulations for enforcement have not yet been developed. In the same vein, maximum limits for aflatoxin contamination in the three commodities have not yet also been established by FSQA.

There exists no price differentiation for the commodities according to the level of aflatoxin contamination. Groundnuts are marketed in two forms: groundnuts in shell and decorticated groundnuts. Decorticated groundnuts are sorted and marketed in two grades: whole kernels and splits mixed with broken kernels. The whole kernels are used for seed and consumed by households and fetch a higher price. The physical separation is however not based on the level of contamination with aflatoxin and no reliable data exists on the quantities of whole and split kernels in the market.

Maize is also marketed in two forms: in cobs and kernels. The kernels are marketed in two grades: whole sound kernels and the damaged kernels, with the damaged kernels fetching a lower price and mainly used for animal feed. However, the separation is not based on level of aflatoxin contamination and no reliable data exists on quantities to undertake economic analysis. Marketing of rice is in the forms of paddy and milled.

The value added products derived from groundnuts (paste, flour, roasted peanuts, boiled, oil) and maize (flour, grits) and the by-products (hay, groundnut cake, rice and maize bran, rice straw) are marketed. Aflatoxin contamination is not taken into consideration in the determination of prices of all the products and by-products of the commodities. Consequently, the economic impact of aflatoxin contamination in the domestic market is negligible.

## 8.3 Economic impact on international Trade

Groundnuts constitute the most important export agricultural commodity and foreign exchange earner for the Gambian economy. Table 6 presents data (volumes and values) on exports of groundnut products comprising shelled (HPS), crude oil and cake from 2000 to 2014. It shows a general decline for shelled (HPS) and cake, while the crude oil exports experienced an increase in terms of both volumes and values (Table 7).

Table 7. Quantities and values of Gambia groundnuts, oil and cake exports

|  |  |
| --- | --- |
|  | **Commodities** |
|  | **Groundnut Shelled**  | **G/nut Oil** | **Cake** |
| **Year** | **Quantity (MT)** | **Value****($'000)** | **Unit Value ($/MT)** | **Quantity (MT)** | **Value ($'000)** | **Unit Value ($/MT)** | **Quantity****(MT)** | **Value****($)** | **Unit Value ($/MT)** |
| 2000 | 26818 | 7634 | 285 | 5700 | 4000 | 702 | NA | NA | NA |
| 2001 | 28000 | 4800 | 171 | 7600 | 5500 | 724 | NA | NA | NA |
| 2002 | 30000 | 5100 | 171 | 15707 | 9116 | 530 | NA | NA | NA |
| 2003 | 12000 | 2500 | 208 | 5000 | 3000 | 600 | NA | NA | NA |
| 2004 | 9000 | 2100 | 233 | 7200 | 4500 | 625 | NA | NA | NA |
| 2005 | 20000 | 5000 | 250 | 800 | 560 | 700 | NA | NA | NA |
| 2006 | 16000 | 4300 | 269 | 4900 | 3600 | 735 | NA | NA | NA |
| 2007 | 17000 | 7500 | 441 | 1800 | 3238 | 1750 | Na | NA | NA |
| 2008 | 18000 | 8200 | 456 | 1800 | 3300 | 1833 | NA | NA | NA |
| 2009 | 18000 | 9200 | 511 | 5927 | 6560 | 1107 | NA | NA | NA |
| 2010 | 7558 | 5852 | 774 | 6165 | 6691 | 1085 | 10518 | NA | 301 |
| 2011 | 5148 | 4643 | 902 | 7460 | 6826 | 915 | 11459 | NA | 363 |
| 2012 | 4536 | 3629 | 800 | 7962 | 9244 | 1161 | 1130 | NA | 361 |
| 2013 | 504 | 383 | 760 | 831 | 1030 | 1240 | 4100 | NA | NA  |
| 2014 | 1494 | 0 |  NA | 5519 | 0 |  NA |  NA | NA | NA  |

Sources: FAO STAT, GBOS, GGC

In the past, the EU was the principal destination of groundnut (HPS 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, as such the only products now exported to the EU are bird feed and crude oil. However recent consignments of bird feed exported to EU have been rejected due to high aflatoxin contamination levels above the EU set maximum levels resulting in 14 rapid alerts between March 2012 and May 2015. In the contrary, exports of crude oil to the EU have increased over the years. There are smaller quantities of HPS exports going to Asia (mainly Vietnam), where the maximum levels for aflatoxin are less stringent. All these products are for further processing. Groundnut cake is exported primarily to Senegal and Mauritania where aflatoxin contamination is not a barrier. 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 where aflatoxin contamination is not a barrier. The economic analysis therefore focuses on the groundnut export trade where aflatoxin contamination is a factor in the pricing and market access.

The economic losses from exports of groundnut products can be categorized into two: i) price losses and ii) rejects due to aflatoxin contamination.

### 8.3.1 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.

The computations were done using the following equations:

**ELSi = ∑in(Xi \*Yi ) (1)**

**Where ELsi** = the Price Economic Loss incurred in the export of shelled or HPS confectionery groundnuts for a particular year (i)

 **Xi** = quantity of total groundnut exported for a particular year in a confectionary form.

 **Yi** = price differential between international premium price (PPi ) and actual price (APi ) of total exported confectionery groundnuts for a particular year i.e (PPi – APi)

Figure 3 presents details for all three categories of economic losses: shelled (HPS), groundnut cake and rejects from the Rapid Alerts for period 2000-2014. Figure 3 also highlights the annual economic loss incurred from the export of HPS reached a peak of US$2,759,400 in 2009 with downward trend thereafter due to declining exports.

 Source: This study

The groundnut cake is mainly exported to Senegal and Mauritania, not meeting the food safety regulations of the EU markets. 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. The determination of the losses was computed using the following equation:

 **ELCi = ∑n (xi \* zi ) (2)**

Where ELCi = Economic Loss from groundnut cake trade in the sub-region and beyond for a particular year

 xi = quantity of groundnut cake exported for a particular year

zi = Price differential between detoxified groundnut cake (Pd ) and non-detoxified (Pn )

n = the number of years of groundnut cake exports

### 8.3.2 Losses resulting from rejected exports

Groundnut exports whose level of aflatoxin exceed 4ppb 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. In this analysis it is assumed that all the rejected consignments associated with the 14 rapid alerts on Gambian HPS from 2012 to 2015 (Table 2) are 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. It should be noted that 12 of the 14 rapid alerts issued were for the Gambia Groundnut Corporation.

Losses from rejected and returned consignments of exported shelled groundnuts were computed using the formula below, which is an estimate of the difference in revenue that would have been earned from selling edible confectionery groundnuts (HPS edible) and the actual net revenue earned from selling crushed oil and cakes from returned consignments of HPS Bird Feed.

L r = P hps + (Pgno \*0.4+ P gnc \*0.6) – (F c + H c + C c)

Where, L r represents losses from rejected and returned consignments of exported HPS Bird Feed,

P hps represents premium price shelled edible (HPS confectionery)

Pgno represents prevailing selling price groundnut oil

P gnc represents prevailing selling price groundnut cake

F c represents the cost of return freight

H c represents the cost of handling cost of return consignment

C c represents the cost of crushing returned consignment

## 8.4 Economic impact on human health

Hepatocellular carcinoma (HCC) is the most common type of cancer in men in West Africa and the third most common type in The World (Parkin et al, 2001). Data from the Gambia Hepatitis Study (2009- 2013) shows that HCC is top among the five most common cancers[[2]](#footnote-2) of men and the second top among the five most common cancer[[3]](#footnote-3) among women (Annual Report, 2012). Major risk factors for HCC are Hepatitis Viruses (B and C) and exposure to aflatoxins. Aflatoxin exposure has a multiplicative effect in conjunction with HBV infection in the risk of developing HCC.

### 8.4.1 Estimation of aflatoxin exposure using bio-marker based exposure data

Aflatoxin exposure was estimated using bio-marker exposure data set from Turner, et al. (2000). The data set consisted of aflatoxin albumin adduct measures from 444 children aged 3–4 (229 male, 215 female), recruited as part of the Gambia Hepatitis Intervention Study (GHIS), who had not received a hepatitis B vaccine. Blood samples were collected and analysed for plasma aflatoxin-albumin adducts (AF-alb) using ELISA ((detection limit was 2 pg AFB1-lysine equivalents (eq.) per mg albumin (pg/mg)). The aflatoxin adduct measures were converted to aflatoxin exposure in ng/kgBW following the formula developed by Wild, et al. (1996). In that formula, the relationship between aflatoxin-albumin adduct levels and exposure was estimated such that the value was 1.56  following acute exposure. We therefore multiplied each aflatoxin-albumin adduct value by  and then divided it by 1.56 to obtain exposures in . The aflatoxin exposure was calculated for children aged 0 to 14, adult males and females aged 15 to 65+. For children, aflatoxin exposure was calculated for the age group brackets 0 – 4, 5 – 9 and 10 – 14 and geometric mean for these age groups was used; and for adults 15-64 age group bracket was used. The population data and body weights (for children) were derived from the 2013 National Population and Housing Census and [www.cdc.gov/growthcharts](http://www.cdc.gov/growthcharts), respectively. For adults (15 – 64), we assume an average weight of 60kg.

8.4.2 Estimation of population at risk for aflatoxin induced liver cancer

The population risks for aflatoxin induced liver cancer was estimated using the data on aflatoxin exposure in The Gambia as presented above. Hepatitis B prevalence rate in The Gambia is about 15%. The JECFA model of 1997 was used for estimating cancer potency.

The total aflatoxin induced HCC was estimated as follows:

1. HBV+ was estimated by multiplying the prevalence (%) of HBV multiplied by the Gambian population model
2. Aflatoxin induced cases per 100,000 was estimated by multiplying the cancer potency by the exposure estimates.



Where,



This aflatoxin situational analysis used biomarker-based exposure in the health risk assessment and economic impact estimation. The biomarker-based exposure assessment provides for a more robust interpretation of individual exposure by accounting for all possible food sources of aflatoxin. Turner et al. (2000) examined the relationship between Hepatitis B Virus (HBV) and biomarker of aflatoxin exposure for children in The Gambia. The data showed high prevalence and level of adduct (2.2–459 pg/mg) in all 400 samples; high levels of adduct (> 75 pg/mg) were measured in more than 30% of the samples. It also showed that the levels of adducts were approximately twice as high in the dry season as in the wet season attributing this to higher consumption of groundnuts. Groundnuts are harvested in October and stored and consumed in the remaining months. As stated earlier, groundnut, a major source of aflatoxin exposure, is consumed at least twice a day in rural households. According to the study, mean adduct levels in uninfected children, chronic carriers and acutely infected children were 31.6 (n=404), 44.9 (n=34) and 96.9 (n=6) pg.mg, respectively.

The study on dietary intake of aflatoxins and levels of albumin-bound aflatoxin in the peripheral blood of 20 residents of Kenaba Kiang West in The Gambia by Wild et al. (1992) reported that all subjects were exposed to aflatoxins from several food types, with an average daily intake of 1.4 ug/day. A significant correlation was observed between dietary intake and level of albumin-bound aflatoxin.

In another study on aflatoxin, liver enzymes and Hepatitis B virus infection in Gambian children, Wild et al. (1993) collected blood samples from 117 children aged 3 to 4 years from Kuntair or Kerr Cherno in North Bank Region. The study using biomarkers indicated that all but two children showed detectable serum AF-ab with levels ranging from 2.2 and 250.4 pg aflatoxin B1-lysine equivalent/mg albumin. It also indicated that HBV carriers showed moderately higher levels of Af-ab and ALT was unchanged when the HBV carriers were excluded from the analysis, suggesting that factors other than HBV infection contributed to the association.

Similarly Wild et al. (2000) examined the effect of environmental (residence and timing of sample collection) and host factors (age, sex, HBV status and inter-individual variations in carcinogen metabolizing enzymes) in determining blood aflatoxin–albumin adduct levels in 357 individuals of whom 181 were chronic HBV carriers. The results of the study showed that adduct levels were significantly higher in subjects resident in rural [geometric mean adduct level of 34.9 pg aflatoxin B1-lysine equivalent (28.5-42.8; 95% Cl)/mg albumin] than in peri-urban areas (22.2 pg (14.9-33.4)/mg] and were approximately twice as high in the dry season [mid-February to March; 82.2 pg (53.3-130.8)/mg) than the wet season [July to August ; 34.9 pg (28.5-42.8)/mg].

In view of the skewed nature of the distribution with most subjects having low exposure and only few having substantial exposure we decided to use median and quartiles as measures of central tendency and spread, respectively, to better determine a parametric distribution and representation of the data.

In the estimation of the economic impact we used the Disability-Adjusted Life Years (DALY). DALY is an epidemiological measure of disease burden expressed in the number of healthy life years lost due to death or disability caused by disease. The gender specific HCC DALY was derived using WHO’s AFRD Region data used in the Nigerian study. In that study, the estimated value for males was 12.3 DALYs per HCC case and for females 13.8 DALYs per HCC case. Given The Gambia’s proximity and location in the same AFR D region, we adopted these figures.

### 8.4.3 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. Table 8 provides medical costs incurred per HCC case. Most of the burden is related to the medical costs within which inpatient cost is higher. The table also shows that for each HCC prevented, US$ 779.01 is saved from costs due to illness.

 Table 8. Unit costs per HCC case

|  |  |
| --- | --- |
| **Type of costs** | **Amount per person (in US$)** |
| **A: Medical Costs** |
| Inpatient for one week1 | 468.45 |
| Outpatient | 208.56 |
| Prescription drugs | 12.50 |
| **Subtotal (medical care costs)** | **689.51** |
| **B: Non-medical Costs**  |
| Caregiver time costs | 56.00 |
| Transportation | 3.00 |
| Complementary and alternative medicine | 30.50 |
| **Subtotal (non-medical costs)** | **89.50** |
| **Total cost** | **779.01** |

 Sources: MRC and Edward Francis Small Teaching Hospital;

 1 Hospital bed admissions are charged per week

### 8.4.4 Gender specific economic impact

The population modelled in this study had a median of 36,513 females. From a median of 5,477 positive chronic Hepatitis B cases, 1,420 will develop HCC and result to death within the year. From this, morbidity and mortality a total of 73,314 DALYs (discounted at 3%) would be lost equivalent to a loss of US$ 36,803,855 worth of GDP. Total medical cost for females amount to a median of US$ 3,776,412 while non-medical is US$ 555,910.

Table 9. Economic and epidemiological values for females

|  |
| --- |
| **Adult Female Population (15-65+)** |
|   | **1st Quartile** | **Median** | **3rd Quartile** |
| **Total Population** |  **24,688**  |  **36,513**  |  **75,061**  |
| Total DALYs\* |  49,570  |  73,314  |  150,715  |
| **Total Monetized DALYs** |  **24,884,156**  |  **36,803,855**  |  **75,658,921**  |
| Total Chronic Hepatitis B (positive) |  3,703  |  5,477  |  11,259  |
| Total Chronic Hepatitis B (negative) |  20,984  |  31,036  |  63,802  |
| Total HCC cases |  960  |  1,420  |  2,919  |
| Total Deaths from HCC Cases |  960  |  1,420  |  2,919  |
| In-patient Costs (in US$) for 7 days |  1,734,729  |  2,565,677  |  5,274,349  |
| Out-patient Costs (in US$) |  772,324  |  1,142,273  |  2,348,208  |
| Prescription Drugs' Costs (in US$) |  46,289  |  68,462  |  140,739  |
| **Total Medical Costs (in US$)** |  **2,553,342**  |  **3,776,412**  |  **7,763,297**  |
| Total Caregiver Costs (in US$) |  207,375  |  306,709  |  630,512  |
| Total Transportation Costs (in US$) |  55,547  |  82,154  |  168,887  |
| **Total Costs of Alternative Medicine-CAM- (in US$)** |  **112,945**  |  **167,047**  |  **343,404**  |
| **Total Non-medical Costs (in US$)** |  **375,867**  |  **555,910**  |  **1,142,804**  |
| **Total Cost-of-Illness Costs (in US$)** |  **2,929,209**  |  **4,332,322**  |  **8,906,100**  |
| **Total Economic Loss (in US$)** |  **24,884,156**  |  **36,803,855**  |  **75,658,921**  |

For the adult males, the population modelled in this study had a median of 36,474 . From a median of 5,471 cases of chronic Hepatitis B (positive), 1,419 will develop HCC and result to death within the year. From this, morbidity and mortality a total of 73,236 DALYs (discounted at 3%) would be lost equivalent to a loss of US$ **36,764,545** worth of GDP. Total medical cost for adult males amounts to a median of US$ 594,326 while non-medical is US$ 64,684. While the incidence of HCC is higher in men, the value of the DALY is higher for females given their longer lifespan[[4]](#footnote-4).

Table 10. Economic and epidemiological values for males

|  |
| --- |
| **Adult Male Population (15-65+)** |
|   | **1st Quartile** | **Median** | **3rd Quartile** |
| **Total Population** |  **25,885**  |  36,474  |  **65,626**  |
| Total DALYs\* |  51,973.49  |  73,236  |  131,770  |
| **Total Monetized DALYs§** |  **26,090,691**  |  **36,764,545**  |  **66,148,764**  |
| Total Chronic Hepatitis B (positive) |  3,883  |  5,471  |  9,844  |
| Total Chronic Hepatitis B (negative) |  22,002  |  31,003  |  55,782  |
| Total HCC cases |  1,007  |  1,419  |  2,552  |
| Total Deaths from HCC |  1,007  |  1,419  |  2,552  |
| In-patient Costs (in US$) |  286,464  |  403,658  |  726,283  |
| Out-patient Costs (in US$) |  127,546  |  179,726  |  323,372  |
| Prescription Drugs' Costs (in US$) |  7,765  |  10,942  |  19,688  |
| **Total Medical Costs (in US$)** |  **421,775**  |  **594,326**  |  **1,069,343**  |
| Total Caregiver Costs (in US$) |  34,245  |  48,255  |  86,823  |
| Total Transportation Costs (in US$) |  11,648  |  16,413  |  29,532  |
| Total Costs of Alternative Medicine-CAM- (in US$) |  3,883  |  15  |  20  |
| **Total Non-medical Costs (in US$)** |  **49,776**  |  **64,684**  |  **116,375**  |
| **Total Cost-of-Illness Costs (in US$)** |  **471,551**  |  **659,009**  |  **1,185,718**  |
| **Total Economic Loss (in US$)** |  **26,090,691**  |  **36,764,545**  |  **66,148,764**  |
| \* Discounted at 3% |  |  |  |

### 8.4.5 Children specific economic impact

The male children population modelled in this study had a median of 141,220 males (Table 11). From a median of 21,183 positive chronic Hepatitis B cases, 1,727 will develop HCC which will result to death within the year. From this, morbidity and mortality a total of 283,556 DALYs (discounted at 3%) would be lost equivalent to US$ 142,344,930 worth of GDP. Total medical cost amount to a median of US$ 2,301,109 while non-medical is US$ 250,398.

Table 11. Economic and epidemiological values for children male population (US$)

|  |
| --- |
| Children Male Population (0-14) |
|   | 1st Quartile | Median | 3rd Quartile |
| Total Population |  110,461  |  141,220  |  147,625  |
| Total DALYs\* |  221,794.64  |  283,556  |  296,416  |
| Total Monetized DALYs§ |  111,340,910  |  142,344,930  |  148,800,951  |
| Total Chronic Hepatitis B (positive) |  16,569  |  21,183  |  22,144  |
| Total Chronic Hepatitis B (negative) |  93,892  |  120,037  |  125,481  |
| Total HCC cases |  814  |  1,727  |  2,880  |
| Total Deaths from HCC |  814  |  1,727  |  2,880  |
| In-patient Costs (in US$) |  1,222,472  |  1,562,882  |  1,633,766  |
| Out-patient Costs (in US$) |  544,297  |  695,862  |  727,422  |
| Prescription Drugs' Costs (in US$) |  33,138  |  42,366  |  44,288  |
| Total Medical Costs (in US$) |  1,799,907  |  2,301,109  |  2,405,476  |
| Total Caregiver Costs (in US$) |  146,140  |  186,834  |  195,308  |
| Total Transportation Costs (in US$) |  49,707  |  63,549  |  66,431  |
| Total Costs of Alternative Medicine-CAM- (in US$) |  16,569  |  15  |  20  |
| Total Non-medical Costs (in US$) |  212,417  |  250,398  |  261,759  |
| Total Cost-of-Illness Costs (in US$) |  2,012,323  |  2,551,508  |  2,667,235  |
| Total Economic Loss (in US$) |  111,340,910  |  142,344,930  |  148,800,951  |
| \* Discounted at 3% |   |   |   |

\* Discounted at 3%

The female children population modelled in this study had a median of 138,585 (Table 12). From a median of 20,788 positive chronic Hepatitis B cases, 1,695 will develop HCC which will result to death within the year. From this, morbidity and mortality a total of 278,265 DALYs (discounted at 3%) would be lost equivalent to US$ 139,688,940 worth of GDP. Total medical cost amount to a median of US$ 2,258,173 while non-medical is US$ 245,726.

Table 12. Economic and epidemiological values for children female population (US$)

|  |
| --- |
| Children Female Population (0-14) |
|   | 1st Quartile | Median | 3rd Quartile |
| Total Population |  109,635  |  138,585  |  143,941  |
| Total DALYs\* |  220,136.12  |  278,265  |  289,019  |
| Total Monetized DALYs§ |  110,508,330  |  139,688,940  |  145,087,605  |
| Total Chronic Hepatitis B (positive) |  16,445  |  20,788  |  21,591  |
| Total Chronic Hepatitis B (negative) |  93,190  |  117,797  |  122,350  |
| Total HCC cases |  808.04  |  1,695  |  2,808.30  |
| Total Deaths from HCC |  808  |  1,695  |  2,808  |
| In-patient Costs (in US$) |  1,213,331  |  1,533,720  |  1,592,995  |
| Out-patient Costs (in US$) |  540,226  |  682,878  |  709,269  |
| Prescription Drugs' Costs (in US$) |  32,891  |  41,576  |  43,182  |
| Total Medical Costs (in US$) |  1,786,448  |  2,258,173  |  2,345,447  |
| Total Caregiver Costs (in US$) |  145,047  |  183,348  |  190,434  |
| Total Transportation Costs (in US$) |  49,336  |  62,363  |  64,773  |
| Total Costs of Alternative Medicine-CAM- (in US$) |  16,445  |  15  |  20  |
| Total Non-medical Costs (in US$) |  210,828  |  245,726  |  255,228  |
| Total Cost-of-Illness Costs (in US$) |  1,997,276  |  2,503,900  |  2,600,674  |
| Total Economic Loss (in US$) |  110,508,330  |  139,688,940  |  145,087,605  |
| \* Discounted at 3% |  |  |  |

### 8.4.6 Total Economic loss (males and females)

The total economic loss is the sum of all economic losses (adult male and female, children male and female) (Table 13). The total population modelled in this analysis is 1,856,417 aged 0 to 65+. From a median of 14,046 positive chronic Hepatitis B cases,2,575 will develop HCC which will result to death within the year. From this, morbidity and mortality a total of 188,015 DALYs (discounted at 3%) would be lost equivalent to US$ 94,383,398 worth of GDP. Total medical cost amount to a median of US$ **1,525,776** while non-medical is US$ **166,035**.

Table 13. Economic and epidemiological values for the whole population (US$)

|  |
| --- |
| **Whole population (0-65+)** |
|   | **1st Quartile** | **Median** | **3rd Quartile** |
| **Total Population** |  **55,580**  |  93,638  |  **327,203**  |
| Total DALYs\* |  111,599  |  188,015  |  656,991  |
| **Total Monetized DALYs§** |  **56,022,739**  | **94,383,398**  |  **329,809,434**  |
| Total Chronic Hepatitis B (positive) |  8,337  |  14,046  |  49,080  |
| Total Chronic Hepatitis B (negative) |  47,243  |  79,592  |  278,123  |
| Total HCC cases |  1,529  |  2,575  |  8,999  |
| Total Deaths from HCC |  1,529  |  2,575  |  8,999  |
| In-patient Costs (in US$) |  615,104  |  1,036,286  |  3,621,156  |
| Out-patient Costs (in US$) |  273,870  |  461,399  |  1,612,293  |
| Prescription Drugs' Costs (in US$) |  16,674  |  28,091  |  98,161  |
| **Total Medical Costs (in US$)** |  **905,648**  |  **1,525,776**  |  **5,331,609**  |
| Total Caregiver Costs (in US$) |  73,532  |  123,882  |  432,890  |
| Total Transportation Costs (in US$) |  25,011  |  42,137  |  147,241  |
| Total Costs of Alternative Medicine-CAM- (in US$) |  8,337  |  15  |  20  |
| **Total Non-medical Costs (in US$)** |  **106,880**  |  **166,035**  |  **580,151**  |
| **Total Cost-of-Illness Costs (in US$)** |  **1,012,529**  |  **1,691,811**  |  **5,911,761**  |
| **Total Economic Loss (in US$)** |  **56,022,739**  |  **94,383,398**  |  **329,809,434**  |

### 8.4.7 Case fatality ratio

Case Fatality Ratio (CFR) is typically defined as percentage of individual who are diagnosed with a certain disease and subsequently die because of that particular disease within a specified period. CFR ratio is computed as:

CFR= MR (death per 100,000 of population)

 IR (no of new cases per 100,000 of population)

Where MR= Mortality Rate; IR = Incidence Rate

The formula gives the total number of new cases due to aflatoxin intoxication or the incidence rate (IR) per 100,000 of the relevant population. Due to poor prognosis of HCC the ratio of mortality rate is 1.0 which is the CFR used in this analysis as presented in Tables 9, 10 and 11. The tables show that CFR of HCC is extremely high thus according to the assessment all HCC die within a period of 12 months.

### 8.4.6 Overall impact of aflatoxins on agriculture and food security, trade and health

The economic analysis reveals that the impact on international trade is secondary to that of human health. Figure 4 shows that the economic losses to health comprise 98% of the losses computed compared to 2% for international trade.

Figure 4: Economic losses from international trade and human health

# 9.0 Identification of gaps and intervention options for the mitigation of aflatoxin contamination along the groundnut, maize and rice value chains

The country assessment revealed that awareness of aflatoxin in terms of its occurrence and effects among the producers, processors, informal traders, transporters, feed millers, poultry producers and consumers is low. Awareness among the public institutions whose work have a bearing on aflatoxin in maize and rice is low. Stakeholders have a low level of awareness of the Codex and national food safety and quality standards related to the three commodities. The EIF has organised workshops, developed posters, messages and a video to raise awareness on aflatoxin.

**Intervention options:**

* Organise a national conference to build consensus on actions to be taken to address the aflatoxin situation in The Gambia.
* Develop and implement a national communication strategy to create awareness on the aflatoxin situation, effects and mitigation measures targeted at the various value chain actors, service providers, policy makers, legislators, public institutions, consumers and consumer groups.

## 9.1 Identifications of gaps along the value chains

The gaps along the value chains of the three commodities were assessed against the Codex standards and codes of practice. These are: General Principles of Food Hygiene; General Standard for Contaminants and Toxins in Food and Feed; Code of Practice for Peanuts; Code of Practice for the Prevention and Reduction of Aflatoxin Contamination in Peanuts; Code of Practice for the Prevention and Reduction of Mycotoxins Contamination in Cereals; Code of Hygienic Practice in Groundnuts (peanuts), Standard for Groundnut, Standard for Maize and Standard for Rice.

**At farm level**

Application of GAP for the production of safe and quality produce with a focus on aflatoxin mitigation is limited by low access to inputs, knowledge and information.

Identified gaps:

* Unavailability of certified seeds
* Unavailability and unaffordability of inputs – approved agrochemicals, fertilizers, appropriate measuring devices, tools, implements and technologies, proper packaging
* Inadequate drying of groundnuts
* Inappropriate storage infrastructure
* Lack of rapid test kits for aflatoxin and moisture determination on farm site

Intervention options:

* Consolidate and expand the FFS interventions targeting the production of quality and safe groundnuts to maize and rice value chains.
* Include aflatoxin mitigation in the work plans of the public extension services (DOA, DLS).
* Facilitate access to inputs and certified seeds
* Facilitate access to credit

**Transportation facilities**

Identified gap:

* Carts, lorries and barges to carry produce are not properly cleaned and disinfected after each operation.

Intervention options:

* FSQA to develop guidelines and ensure that good transportation practices are applied by lorry and barge operators.

**Processing**

Identified gaps:

* Soaking before decorticating groundnuts for further processing
* The use of defective nuts for processing
* Inappropriate processing equipment, processes and packaging at the level of the local market
* The use of raw materials whose aflatoxin contamination levels are not determined
* Poor environmental and personal hygiene, lack of sanitary facilities in the local market
* At the seccos, the in-shell groundnuts are stored on the ground in the open
* At the industrial level, poor storage facilities, in-shell groundnuts are directly heaped on the floor (un-bagged)
* Lack of rapid test kits for aflatoxin and moisture determination in storage
* Inappropriate storage facilities and practices at the local market level

Intervention options:

* Provide training on GMP and GHP to the processors at the household and market levels.
* FSQA to inspect and ensure that GMPs and GHPs are followed at all levels of processing.
* FSQA to ensure that all exporters implement HACCP.

**Marketing**

Identified gaps:

* Aflatoxin contamination levels are not considered in the marketing transactions of the three commodities.
* The non-separation of extraneous materials from the groundnut produce sold to informal traders purchasing at farm level.
* Screens not properly calibrated and maintained at the level of the seccos.
* Non screening for aflatoxin contamination levels at all reception points of the marketing chain.
* Use of non-accredited laboratories to test for aflatoxin by all exporters.
* Inability to export HPS confectionery groundnuts to obtain premium price due to inability to meet aflatoxin levels set by importing countries
* There is no consumer demand for products based on levels of aflatoxin contamination

Intervention options:

* FSQA to regulate the local markets in particular, sandikas, loumos and municipal markets.
* FSQA to regulate groundnut exports and groundnut, rice and maize imports.
* FSQA to approve laboratories to be used for testing for official controls, including aflatoxins.

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# 10.0 Policy, legal and institutional environment as it pertains to aflatoxins

## 10.1 Agriculture and Natural Resources Policy – ANR (2009-2015)

# The key strategic objectives for the ANR Policy are improved and sustainable measurable levels of food and nutrition security in the country in general and vulnerable populations in particular; a commercialized sector ensuring measurable competitive, efficient, and sustainable food and agricultural value chains, and linkages to markets; institutions (public and private) in the sector are strengthened, and providing needed services, strong and enabling environment, and reducing vulnerability in food and nutrition security; and sustainable effective management of the natural resource base of the sector.

The policy focuses on, among other things, increasing rice production in order for the country to be self-sufficient and implementing special programmes to increase maize production. The policy recognises the role of groundnuts as both food and cash crop and the primary source of livelihood and foreign exchange earnings of the country.

The policy has addressed food safety and quality in its strategies. However, aflatoxin contamination is not identified as one of the critical constraints affecting groundnuts, maize and rice and there is no strategy for the promotion of GAP to mitigate aflatoxin. The policy also recommends for a review of the legal and regulatory framework for food safety. This recommendation has been overtaken by events as this review was carried out in 2010-2011 leading to the enactment of the Food Safety and Quality Act 2011 which established the FSQA that became operational in 2013. The strategies proposed by the policy are now been addressed in draft Food Safety Policy and the ongoing programmes of the FSQA.

## 10.2 National Health Policy (2012-2020)

The goal of the National Health Policy Framework is to reduce morbidity and mortality to contribute significantly to quality of life in the population. Strategies/programmes based on Integrated Disease Surveillance and Response (IDSR) have been put in place to control diseases. The policy acknowledges that cancers continue to pose major public health challenges and adequate measures are being taken to alert those responsible for the prevention, diagnosis, treatment including the management of cancers. However, there are no epidemiological surveillance programmes for cancer and hepatitis B. Intervention options include the integration of cancer and hepatitis B in the IDSR programme. It is recommended that a national screening, vaccination and treatment programme for hepatitis B be developed and implemented. In addition, it is recommended that the National Cancer Registry (NRC) be improved to include age, gender and occupation.

## 10.3 The Gambia Trade Policy 2011

The objective of the policy is to maintain an open and liberal trading environment and to better integrate The Gambia into the global economy. It also aims at providing direction for trade activities as well as to ensure trade mainstreaming in the productive sectors to make its contribution to the attainment of national goals of growth, development, and poverty reduction. It also aims at providing direction for trade activities as well as to ensure trade mainstreaming in the productive sectors to make its contribution to the attainment of national goals of growth, development, and poverty reduction. The policy focuses on measures to: improve the competitiveness of The Gambia trading environment; support production activities for the domestic and international markets; establish and strengthen quality infrastructure for enhanced market access; ensure a fair trading environment for producers and consumers; establish an efficient trade information system; and strengthen bilateral, regional and multilateral trade corporation. With regard to trade in food and feed, the policy makes no mention of The Gambia’s obligations under WTO SPS agreement, in particular as they relate to trade in food. The policy should make mention The Gambia’s obligation under the WTO SPS agreement relating to trade in food.

## 10.4 Draft Food Safety Policy

There is an existing draft food safety policy document which is coherent with the Food Safety and Quality Act. The general objective of the draft policy is that the food which is produced, bought and eaten by consumers do not prejudice their health or economic wellbeing. The scope of the policy extends to animal feeds. It also covers contaminants, including aflatoxin, and the residues of veterinary medicines and plant protection products. It is recommended that the policy be finalised.

## 10.5 The Gambia National Agricultural Investment Plan (GNAIP) 2011-2015

The overall goal of GNAIP is enhanced economic growth and poverty reduction by an increased contribution of the ANR sector to the national economy. To meet this goal, the development objective of GNAIP is increased food and nutritional security and household incomes, particularly for vulnerable households. This will be achieved through increased production and productivity in the ANR sector, based on sustainable management of natural resources, commercialization and active private/sector participation. The GNAIP has six pillars which provided the basis for the six programmes of the Investment Plan: (i) Development of agricultural chains and market promotion; (ii) Improvement of water management; (iii) Prevention and management of food crises and other natural disasters; (iv) Improved management of the other shared resources (common properties); (v) Sustainable farm development; and (vi) Institutional capacity building for the implementation of the GNAIP.

Food safety issues were mentioned in Programme 3 which is expected to boost value-chain stakeholders’ access to markets by improving market analysis and responses so that products meet national, regional and international demand and safety norms. However, there was no mention of aflatoxin.

Programme 5 is aimed at achieving increased and sustained agricultural production and productivity growth by introducing agricultural practices through people-centred learning processes that enhance and conserve local natural resources and the environment, and help smallholder farmers to adapt to climate change. The establishment of Farmer Field Schools (FFS) (Sub-component 1 of Component 1 of Programme 5), is expected toenhance smallholder farm productivity on a sustainable basis through the use of productivity enhancing technologies such as fertilizer, improved seeds and IPPM through the private sector. The field research conducted by the consultants showed that the farmer learning processes (including the FFS) employed by the public extension services was not used to address food safety and quality issues, including aflatoxin.

The aflatoxin problem of groundnuts was a topical issue at the time GNAIP was being formulated coinciding with the validation of the Groundnut Quality Assurance Framework Document and this presented an opportunity for aflatoxin to have been mainstreamed in the GNAIP. It is recommended that during the review of GNAIP, broader food safety and quality issues, including aflatoxin in groundnut, maize and rice, be mainstreamed.

## 10.6 Act and regulations

The Food Safety and Quality Act 2011 establishes the food safety and quality regime along the food and feed chain by instituting structures and control mechanisms to ensure the safety and quality of food and feed. It embraces the food safety risk analysis approach which ensures that all food safety risks are taken into account, including aflatoxin.

Identified gap: There are no regulations to-date for aflatoxin limits for the three commodities

Intervention options:

* Develop regulations to facilitate the implementation of the Act.

## 10.7 Institution – Food Safety and Quality Authority (FSQA)

The organs of the Authority are:

1. The Board of Directors responsible for the overall policy and strategy of the Authority with particular regard to financial, operational, organisational, and administrative programmes and to ensure the implementation of the policy. The Board should ensure that work programmes of the Authority are consistent with government’s legislative and policy priorities in the area of food safety. It commissions and approves food safety risk assessments, including aflatoxin.

**Identified gaps:**

To date no food safety risk assessment study/project focusing on aflatoxins has been commissioned.

**Intervention options:**

1. The Food Safety and Quality Authority responsible for surveillance of food and feed safety hazards, including aflatoxin; preliminary risk assessment (risk profiling); monitoring and control of food safety risks, including aflatoxin contamination along the food and feed chain; developing and maintaining a

food safety information system, including aflatoxin and scientific evidence based risk communication; the development of a general plan for food safety crisis and emergency management; and resource mobilization.

**Identified gaps:**

* Generally, there is insufficient numbers of qualified and experienced staff to implement its mandate.
* Non-existence of programmes and systems for food safety hazards (including aflatoxin) surveillance, monitoring, food recall, emergency planning, disaster management, and risk profiling framework.
* Lack of prevalence data along the value chain.
* No regulations in place to facilitate the implementation of the Act.
* Lack of approved protocols and procedures for the organization, operations and activities of the Authority.
* Non collection of fees from licences and the issue of certificates.
* Lack of a strategic and business plan.
* Lack of food safety information network.

**Intervention options:**

* Recruit qualified and experienced staff; provide continuous training as needed.
* Develop systems, procedures, protocol and programmes to address the gaps identified above in relation to food safety hazards.
* Establish baseline aflatoxin prevalence levels along the groundnut, maize and rice value chains.
* Develop regulations for food safety and quality, including maximum limits for aflatoxins.
* Mobilize resources from licence fees and the issue of certificates.
* Develop and implement a strategic and business plan.
* Establish a national food safety information network and incorporate the AfricaAIMS within it.
1. The Scientific Committee (SC) responsible for developing and proposing scientific opinion of the Authority, including the assessment of food safety risks, and requesting information and research directed at providing information for the assessment of food safety risk, including aflatoxin.

**Identified gaps:**

Since its establishment, it has not had an agenda originating from the Scientific Affairs Directorate (SAD) of FSQA responsible for preliminary risk assessment.

* It has also not issued any scientific opinions or commissioned any research for obtaining scientific data relevant to food safety and quality.
* The members of the SC have not received any structured theoretical and hands-on training in food safety risk assessment, in particular aflatoxin risk assessment and hence the knowledge and experience required for carrying out risk assessments is limited within the SC.

**Intervention options:**

* Develop the capacity of the SC and its Working Groups to carry out their mandate in general and specifically, to address the gaps identified. .
1. The Stakeholder Consultative Forum (SCF) consists of members appointed by the Board. They represent stakeholders along the food and feed chain who have a vested interest in food safety and quality. The Forum ensures that stakeholders’ views and concerns are taken into account; ensures close cooperation between the Authority and stakeholders in the areas of food safety and quality; and ensures risk communications where the Authority identifies or otherwise obtains information of an emerging risk.

**Identified gaps:**

* The SCF have not proactively engaged the Board and management of the Authority to ensure that their food safety concerns are taken into consideration in the programmes and activities of the Authority.
* The stakeholder representatives on the Forum do not provide feedback to the members of their respective constituencies and vice versa do not bring to the agenda of the Forum the concerns and issues emanating from the membership.
* Their capacity in terms of knowledge and understanding of food safety hazards and the national food safety legislation, including aflatoxin, is low.

**Intervention options:**

* Strengthen the capacity of SCF to carry out its mandate and responsibilities in general, and to address the gaps identified.

1. The Food Control Advisory Committee (FCAC), an independent body outside the institutional framework of the Authority, responsible for providing advice on the preparation of primary and secondary legislation related to food and feed; monitoring implementation of food and feed laws and legislations to ensure they meet national objectives and comply with international commitments to government on the performance of the Authority and its structures, including the delegation of responsibility to other bodies; to government on policy with regard to food safety and quality matters.

**Identified gaps:**

* The procedures and processes are not in place for the FCAC to carry out its mandate and functions.

**Intervention options:**

* Put in place procedures and processes for it to carry out its mandate and functions.

## 10.8 Food standard systems, laboratory support services and human capacity to provide aflatoxin safe food to the public

The Gambia Standards Bureau Act 2010 established The Gambia Standards Bureau with responsibility for among others, standardization, became operational in 2012. It has established standards development technical committees made up of stakeholders. National standards for groundnuts and rice, based on Codex standards for which maximum aflatoxin levels have been specified, have been developed; the standards for maize are in a draft form.

There is a National Codex Committee which also comprises a multi stakeholder membership and its primary activity is the review and commenting on Codex draft standards, codes and recommendations with a view to coming up with national positions. The committee builds capacities of stakeholders on the procedures for the development of Codex standards and creates awareness. Its work also covers coming up with national positions on standards for commodities susceptible to aflatoxin and other horizontal standards, e.g., Codex standards for contaminants in food. In addition the National Codex Committee has been designated as the national technical committee for food standards. The Food Act of 2011 recognises the committee as the food control advisory committee mentioned earlier. Given the importance of aflatoxin to The Gambia the committee should set up a technical committee for contaminants in food and feed.

A national programme for laboratory analysis of aflatoxin exists within the Mycotoxin laboratory of the National Agricultural Research Institute (NARI), which has received technical assistance, training and equipment support from West Africa Quality Programme and EIF with a view to acquiring international accreditation (ISO 17025) but so far this has not been attained. The laboratory has also recently received equipment, reagents and training in the context of AfricaAIMS initiative. This will enable the laboratory to carryout tests to establish the prevalence of aflatoxin in groundnut, maize and rice, including imported rice.

Recent assessments by both EDES and FSQA concluded that the laboratory has deficiencies in terms of staff competencies, design and structure. In addition some of the equipment are not functional and there are no good laboratory practices, quality and technical manuals. Aflatoxin tests for exports are carried out by the laboratory; however their groundnut test results were at variance with tests carried out by testing laboratories in the EU as evidenced in the rapid alerts issued by the DG SANCO.

# 11.0 Conclusion

The situational analysis for the mitigation of aflatoxin within the national food safety system of The Gambia has established aflatoxin as a major food safety hazard posing significant risks to humans, animals, and susceptible crops including groundnuts, maize and rice. It also revealed that all the three commodities constitute a very high proportion of the food that is consumed by the general Gambian population, of which own consumption by farmers is the highest. Furthermore, it revealed that awareness of the occurrence of aflatoxin and its consequences is generally low among the population, including the actors of the three value chains assessed under this study. Application of GAP for the production of safe and quality produce with a focus on aflatoxin mitigation should be promoted. It is also crucial to raise awareness among value chain actors and government officials.

The economic impact assessment revealed potential losses in agricultural production and productivity, food security, and obvious losses in international trade. 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. Price losses from rejected groundnuts due to aflatoxin contamination amount to USD 251,418.

The economic impact assessment however show that the most significant impact is on human health. The estimate of economic and epidemiologic (illness) impact show that from a median of 79,592 positive chronic Hepatitis B cases, 2,575 will develop HCC with a total monetized DALY worth USD 94,383,398 of GDP. The estimated economic loss obtained from this analysis is the amount of money that would be saved if efforts are made to reduce aflatoxin exposures.

Given these huge economic losses revealed by the analysis serious attention needs to be accorded to the mitigation of the aflatoxin contamination to reduce the risks it poses to agriculture and food security, trade, human and animal health and the consequential impact on the country’s economy. The urgency, therefore to mainstream aflatoxin mitigation in national policies and programmes, including the GNAIP cannot be over-emphasized.

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1. The filtration process removes the carbohydrate particles on which the aflatoxin adheres itself. It does not adhere to lipids (personal communications GGC) [↑](#footnote-ref-1)
2. Liver, Lung, other GIs, prostate, lymphoma [↑](#footnote-ref-2)
3. Cervical, Liver, Breast, Other Gis, Ovary [↑](#footnote-ref-3)
4. The life expectancy for men in The Gambia is 62 years and 66.7 years for females. [↑](#footnote-ref-4)