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# Prioritizing Ghana's Aflatoxin Policy Implementation Plan using P-IMA

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# 1.0 Introduction

In the current global context, Food safety has become important for public health and and international trade. A major food safety concern in Ghana and many African countries is aflatoxin contamination in food and feed. Aflatoxins are harmful toxins produced by certain species of fungi that grow naturally in foods. These fungi infect food products either on the farm or during storage under favourable conditions such as high temperature, high moisture, and presence of pests. Aflatoxin contamination is highly prevalent in Ghana and mostly affect staple crops such as maize, groundnuts, sorghum, millet as well as animal products including meat, fish, eggs and many processed foods. In terms of domestic and international trade, maize and groundnuts and their processed products are most important. Humans and animals are exposed to aflatoxin through consumption and handling of contaminated food and feed.

Exposure to high levels of aflatoxin results in acute health effects such as aflatoxicosis, which can cause death in severe cases. Aflatoxin is a class 1 carcinogen that is known to cause about 30% of all liver cancers in humans. People with hepatitis B and HIV infections are 30 times more likely to develop liver cancer when exposed to aflatoxins. In Africa, aflatoxins can cause roughly one death per 100,000 people annually. In Ghana, though there is no data causally linking aflatoxin to liver cancer, in 2020 about 3,453 people suffered from liver cancer, which is one of the commonest cancers among men representing 21.1% of all cancers. Chronic exposure to aflatoxin is also associated with malnutrition, decreased protein synthesis, delayed recovery from kwashiorkor, immune suppression, impaired liver function, increased susceptibility to infections, growth retardation and stunting in children. A recent total diet study conducted in Benin, Cameroun, Mali and Nigeria showed that morbidity factors caused by co-exposure to aflatoxin B1 and hepatitis B virus suggest several thousands of additional liver cancer cases per year, and a substantial contribution to the burden of chronic malnutrition in childhood (Ingenbleek et al., 2020). Another study conducted in Ghana showed that the chances of liver cancer development would increase to 0.6 per year if infants were fed on maize-groundnut complementary food prepared with minimum AF level of 7.9 µg/kg (Omari and Anyebuno 2020).

The relationship between aflatoxin, malnutrition and stunting is critical because Ghana has made significant efforts by reducing prevalence of stunting from 30% in 2003 to 19% in 2014. However, greater efforts are still required to further reduce stunting prevalence to the Africa Union's Malabo target of 10% by 2025. The Cost of Hunger (COHA) study report of 2012 also shows that Ghana loses about GHS 4.6 billion (US$783 million) annually because of child undernutrition. This amount represents 6.4% of Ghana's Gross Domestic Product (GDP). In livestock, poultry and cultured fish, aflatoxin can cause low productivity, weight loss, various diseases and death. For example, egg production can be reduced by as much as 70% when chickens are fed with aflatoxin contaminated feed.

Aflatoxins also pose a barrier to trade and market development due to the rejection of contaminated products by buyers including the food industry and importing countries. Ghana loses about 319,000 tonnes (18%) of maize annually due to aflatoxin contamination. In 2004, Ghana's peanut butter export had increased to 2.2 million kg at a value of US$2.0 million while raw groundnuts increased to 13.4 million kg valued at US$6.5 million. In the same year (2004), the European Commission's Rapid Alert System for Food and Feed (RASFF) ranked Ghana among the top ten countries with the highest number of alert notifications about high level of aflatoxins. Although the EC investigated the causes of the high number of alerts and recommended some measures for the management of aflatoxin in food, not much has been achieved over the years and the problem persists. In 2019, for example, about 35% of groundnut paste intended for export had total aflatoxins level above the EU limit of 4ppb. Over the years, the number of RASFF's alert notifications on aflatoxin contamination has reduced and at the same time, exports to the EU have also declined. Thus, in 2019, 61,397kg of peanut butter was exported from Ghana of which only 10.3% (6,310 kg) went to the EU markets.

In practice, products that are non-compliant with the EU requirements for aflatoxins are usually diverted to other markets including the domestic and ECOWAS markets where restrictions and enforcements are weaker. With the coming into force of the African Continental Free Trade Agreement (AfCFTA), which prioritises SPS issues, it is likely that compliance with SPS requirements will be strictly enforced and hence may affect trading in products with high levels of aflatoxins within the African continent.

At the domestic level, about 25% of total maize production is processed into various products for export and local markets. However, food industries and organisations such as the World Food Programme that buy maize and groundnuts in bulk sometimes have difficulties accessing aflatoxin-safe products from farmers, produce aggregators and traders. For example, Premium Foods, a major maize trading and processing company in Ghana buys approximately 30,000 tonnes of maize per year but could buy more if safer and quality grains were available.

As a result of the detrimental effects of aflatoxin contamination on health, food and nutrition security and trade, efforts are being made at the continental, sub-regional and national levels to address the problem. The African Union Commission established the Partnership for Aflatoxin Control in Africa (PACA) in 2011 to help develop efficient systems for addressing the problems of aflatoxins in the continent. PACA developed a 10-year Strategy (2013-2022)

to guide its actions and supported the ECOWAS to develop the ECOWAS Aflatoxin Control Action Plan (ECOACAP) that was adopted in 2015 by the ECOWAS Agricultural Ministers.

In line with the PACA strategy and ECOACAP, Ghana, through an AGRA-funded project coordinated by CSIR-STEPRI, has developed a national policy with an implementation plan for aflatoxin control in food and feed. The policy was endorsed by four ministries namely, Ministry of Food and Agriculture (MOFA), Ministry of Environment, Science, Technology and Innovation (MESTI), Ministry of Trade and Industry (MOTI) and Ministry of Health (MOH). Ghana's Cabinet approved the policy for implementation in December 2021.

To facilitate and ensure the effective implementation of the policy, CSIR-STEPRI applied for a project preparation grant from the Standards and Trade Development Facility (STDF) to:

1. Prioritise the strategies, actions and investments in the implementation plan using STDF's Prioritizing SPS Investments for Market Access (P-IMA) Framework[1] and
2. Develop project proposals based on prioritised actions and investments for potential funding by STDF and other providers of SPS assistance/donors.

This report presents the outcome of the prioritization exercise carried out by national stakeholders with the support of P-IMA experts in AGRA. The report is structured into six sections. Section one introduces the report while section two gives an overview of aflatoxin situation in Ghana and the Aflatoxin Policy. Section three provides an overview of the P-IMA Framework, section four gives a brief description of the investment options identified by stakeholders, section five presents the results of the prioritization exercise and finally the conclusion is presented in section six.

# 2.0 Overview of Aflatoxin in Ghana and the Aflatoxin Policy

## 2.1 The Prevalence of Aflatoxin in Ghana

Aflatoxins are naturally occurring toxic metabolites produced mainly by the fungi *Aspergillus flavu*s and *Aspergillus parasiticus* mostly in tropical and subtropical regions of the world, including Ghana. There are four types of aflatoxins that are important in health and agriculture: aflatoxin B1, B2, G1, and G2. Aflatoxin B1 is the most common and the most potent among the four types. Ghana has a tropical climate with an average temperature ranging from 24-30˚C which is optimum for the growth of *Aspergillus flavus* and *Aspergillus parasiticus* and subsequent production of aflatoxins in food and feed (Adu-Gyamfi, 2013). Aflatoxins are likely to be produced when crops are exposed to extreme conditions such as high temperatures, drought, high moisture, high oxygen concentration, and insect infestation.

Aflatoxin production can occur during the pre-harvest and post-harvest periods. During the storage of crops, high levels of moisture and temperature conditions create a suitable environment for the rapid growth of moulds, which in turn metabolize and produce aflatoxins. Furthermore, physical damage to crops during weeding, harvesting, drying, transportation, storage, and marketing can cause decay that enhances the production of aflatoxins.

In most cases, the Aspergillus moulds that produce aflatoxins are visible hence, the presence of the moulds could indicate the presence of aflatoxins. However, in some situations, aflatoxins can be present in foods that are not visibly mouldy. Because the toxins are invisible, their presence can only be quantitatively detected through laboratory analysis. Techniques such as rapid test kits and UV lights can be used to qualitatively detect the presence of aflatoxins in food and feed.

Chronic exposure to aflatoxin can cause liver cancer, which poses a significant health concern with cases increasing from 2,753 in 2018 to 3,452 in 2020 according to the GLOBOCAN statistics (which is the Global Cancer Incidence, Mortality and Prevalence statistics). Other health effects linked to chronic exposure to aflatoxins include decreased protein synthesis, delayed recovery from kwashiorkor, immune suppression, increased susceptibility to infections, growth retardation, and stunting in children. Aflatoxins can cause weight loss, various health conditions, and death in livestock and cultured fish fed with contaminated feed. Chickens fed with contaminated feed often lay 70% fewer eggs than those fed on safe feed. Aflatoxins also pose a barrier to trade due to the rejection of contaminated products by the food industry and importing countries, especially the European Union Member States.

Maximum regulatory limits have been set for aflatoxins in several food products and animal feed and it has been

[1] For detailed information on the P-IMA framework, see: https://www.standardsfacility.org/prioritizing-sps-investments-market-access-p-ima

established that foods containing aflatoxin levels below these limits will pose negligible health risks to humans and animals. In Ghana, regulatory limits have been set for aflatoxins in some foods as presented in table 1.

*Table 1: Ghana's maximum levels for aflatoxins in food*

| Commodity | Maximum level (ppb) | | Ghana Standard |
|---|---|---|---|
| | Total Aflatoxins | AflatoxinB1 | |
| **Maize** | 15 | - | GS 211 |
| **Groundnut** | 10 | 5 | GS 313 |
| **Sorghum** | 10 | 5 | GS 96 |
| **Rice** | 10 | 5 | GS 765 |
| **Soybean** | 15 | - | GS 1039 |
| **Cowpea** | 4 | - | GS 1004 |
| **Groundnut paste** | 4 | | GS 49 |

*Source: Ghana Standards Authority*

*Table 2: Codex, EU, and USA maximum levels for Aflatoxin in food*

| Product | Total Aflatoxins | | |
|---|---|---|---|
| | Codex (ppb) | EU (ppb) | USA (ppb) |
| Groundnut | 15 | 4 | 10 |
| All processed foods for human consumption and diary feed | 15 | 4 | 20 |
| Milk (AFM1) for human consumption | 0.5 | 0.05 | 0.5 |
| Maize | - | 4 | 20 |
| Rice | - | 4 | 20 |

*Source: Omari et al. (2020)*

In Ghana, aflatoxins have been detected in several food products such as groundnuts, maize, white melon seed (known in Hausa as agushie, Yoruba as egusi and in English as Mann's cucumeropsis), chili powder, corn flour and dough, rice, sorghum, millet, and groundnut paste. The European Commission's Rapid Alert System for Food and Feed has reported the presence of high levels of aflatoxins in Ghana's exports such as maize, groundnuts, banku mix, groundnut paste, khebab powder, agushi, and powdered pepper and spices, for which reason the products were rejected. Animal and fish products can also be contaminated with aflatoxins if livestock, poultry and cultured fish are fed with contaminated feed. Several laboratory analyses of food samples in Ghana have shown the presence of high levels of aflatoxins as shown in table 3.

*Table 3: Examples of products with unacceptable levels of aflatoxins*

| Food products | Total Aflatoxin levels (ppb) | Source of information |
|---|---|---|
| **Maize** | 2 – 662 ppb | Kpodo, et al., 2000 |
| **Groundnuts** | 30 of 91 samples exceeded 15ppb | Kpodo et al. (2005) |
| **Groundnut products (groundnut oil, kulikuli and** | 0.05-522.1 ppb | Baah-Tuahene et al. (2015) |

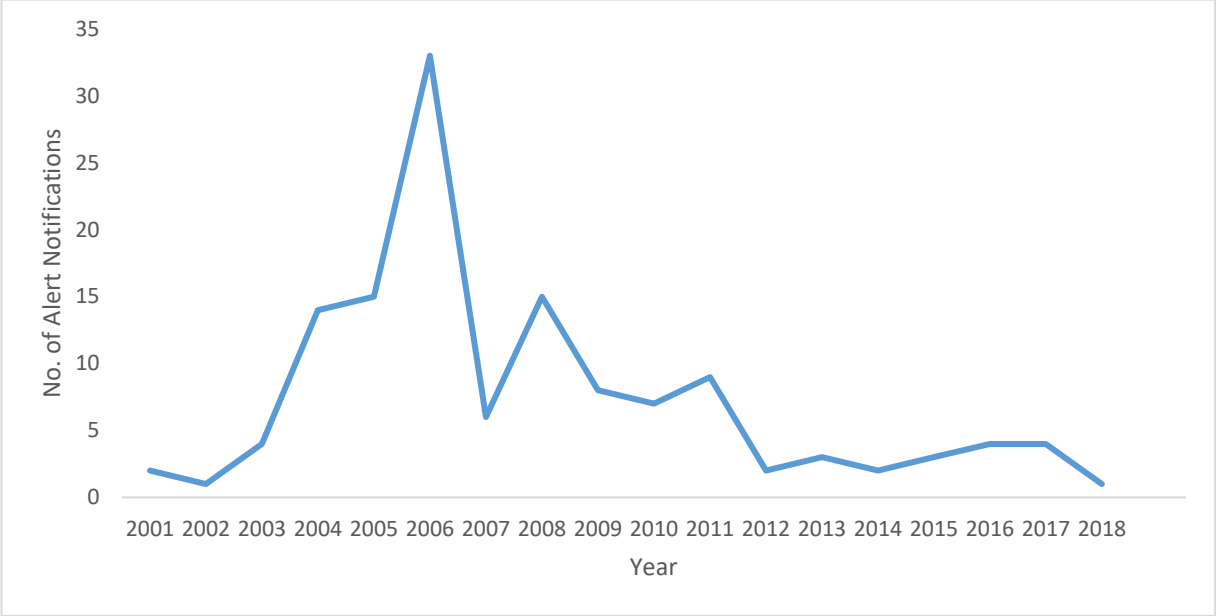
| | | |
|---|---|---|
| **khebab powder)** | | |
| **Cereal-based products intended for infants and young children** | 52% exceeded the EU limit of 4 ppb | Blankson et al. (2019) |
| **Maize, groundnut** | 15% of maize exceeded 15ppb, and 11% of groundnut samples exceeded the Ghana standards | Agbetiameh et al. (2018) |
| **Commercial Weanimix** | 18% of the samples exceeded codex limits of 10 ppb | Omari and Anyebuno (2020) |
| **Homemade Weanimix** | 83% of the samples had total aflatoxins above 20 ppb. Range: 7.9 -500ppb | Kumi et al. (2014) |
| **Groundnut paste** | 35% exceeded Ghana's standard | Ghana Standards Authority (GSA) (2018) |
| **Raw maize** | 28% exceeded Ghana's standard | GSA (2018) |
| **Tom brown** | 12% exceeded Ghana's standard | GSA (2018) |
| **Agushie** | 13% exceeded Ghana's standard | GSA (2018) |
| **Rice** | 4% exceeded Ghana's standard | GSA (2018) |
| **Groundnut** | Mean total aflatoxins was 164 ppb | Waliyar et al., 2013 |
| **Maize** | 33.3% exceeded 20 ppb | Gruber-Dorninger et al. (2018) |
| **Finished feed** | 54.4% exceeded 20 ppb | Gruber-Dorninger et al. (2018) |

Table 4 summarises the level of aflatoxin B1 detected in groundnut paste exported from Ghana to the EU for which alert notifications were issued. The levels range from 2.9 ppb to 622 ppb with eight (8) of the notifications having aflatoxin B1 levels between 2.9 ppb and 4 ppb. Although these latter levels fall within Ghana's acceptable levels, they were not in compliance with the EU maximum limit of 2 ppb for aflatoxin B1 in groundnut paste. In total, over 40 notifications showed levels of aflatoxin B1 above the codex standard of 10ppb for processed foods. Fig. 3 shows the number of alerts issued by the EC's RASFF on aflatoxins in products exported from Ghana to the EU. Ghana was mentioned among the top 10 countries with a high incidence of aflatoxins in groundnut and maize products in 2004. Consequently, in 2006, the European Commission carried out a mission in Ghana to investigate the control measures Ghana has in place for aflatoxins.

*Table 4: Number of alert notifications and level of aflatoxin B1 detected in groundnut paste exported from Ghana to the EU (2004-2018)*

| Year | Range (minimum & maximum levels) | No. of alerts |
|---|---|---|
| 2004 | 9.5 - 263 | 12 |
| 2005 | 4.3 – 273 | 14 |
| 2006 | 3.5 – 140 | 19 |
| 2007 | 31 – 52 | 3 |
| 2008 | 9.2 – 173 | 4 |
| 2009 | 2.9 – 194 | 9 |
| 2010 | 18 – 622 | 3 |
| 2012 | 85.9 - 152 | 2 |
| 2013 | 38.9 | 1 |
| 2016 | 33.0 | 1 |

Figure 1: Number of alert notifications on aflatoxins issued per year by the RASFF




*Source: Graph produced from data from RASFF database*

## 2.2 Overview of the Aflatoxin Policy

Ghana faces several food safety challenges including microbial and chemical contamination such as aflatoxins and pesticide residues in grains and legumes (Ministry of Health, 2013). There are also practices such as food adulteration, misuse of food additives, and unhygienic food handling practices, which compromise food safety and negatively impact public health (Omari et al., 2018). Aflatoxin contamination poses health and economic concerns and accounts for losses of about 18% of Ghana's annual maize production. To better coordinate and facilitate efforts to minimise aflatoxin contamination and its socio-economic effects in Ghana, a National Policy for Aflatoxin Control in Food and Feed has been developed and approved by Cabinet. The policy prescribes options, technical approaches, operational activities, and roles and responsibilities for the key stakeholders in the food value chain.

The process for the formulation of the aflatoxin policy was led by the Science and Technology Policy Research Institute of the Council for Scientific and Industrial Research (CSIR-STEPRI). The Institute undertook a situational analysis of issues related to aflatoxins including their prevalence, health, and economic effects, strategies for controlling the toxins as well as an in-depth audit of relevant policy and legal documents on aflatoxins and food safety in general. The situational analysis also covered teaching and research capacities as well as knowledge, attitudes, and practices of value chain actors on aflatoxins and their management. This was necessary to put into perspective the past and present situation of the country's efforts in addressing the aflatoxin problem.

A workshop was organised to share findings, validate the situational analysis report and discuss key issues and strategies relevant to the aflatoxin policy. This resulted in the identification of seven thematic areas. The stakeholders involved in this workshop include farmers, traders, processors, Ministries, Departments and Agencies (MDAs), Development Partners, Academic, and Research Institutions, Private Sector Organisations, Civil Society and Non-Governmental Organisations, Parliamentary Select Committee on Food and Agriculture and representatives of different Stakeholder Groups in the food, health, and trade sectors.

An in-house team was constituted by CSIR-STEPRI to draft the policy based on the thematic discussion points from the stakeholder workshop. The draft policy was reviewed by the National Steering Committee for Aflatoxin Control (NSCAC), which has membership from 17 institutions namely Ghana Grains Council; Consumer Protection Agency; Farmers Organisations Network in Ghana (FONG); Ghana College of Physicians and Surgeons (Faculty of Public Health); Parliamentary Select Committee on Food, Agriculture and Cocoa Affairs; Food and Drugs Authority FDA); CSIR-STEPRI; Nutrition and Food Science Department, University of Ghana; Ghana News Agency (GNA); Kwame Nkrumah University of Science and Technology (KNUST); EatSafe Ghana (an NGO); Ministry of Food and

Agriculture (MOFA); Ministry of Environment, Science, Technology and Innovation (MESTI); Ministry of Trade and Industry (MOTI); Ministry of Health (MOH); Ministry of Finance; and Ghana Standards Authority (GSA).

The review comments from the NSCAC further helped the CSIR-STEPRI team to fine-tune the document. The draft policy was circulated to stakeholders for comments after which a face-to-face review and validation workshop was held to present the draft document to stakeholders for discussion and comments. The reviews, comments, and discussions provided additional inputs into the formulation of the final policy and action plan for aflatoxin control. The policy was reviewed again by the NSCAC followed by professional editing. Furthermore, the draft policy was presented to the Ministers and key technical staff of MESTI, MOFA, MOTI, and MOH for their comments and endorsement. Finally, the policy and implementation plan were reviewed by the National Development Planning Commission to ensure that they aligned with the recently developed national guidelines for policy development. Alongside this policy, a Technical Regulation for Aflatoxin Control in Maize (TECHNICAL REGULATION, 2020, L.I. 2428) has been developed and enacted by Parliament in December 2020.

The Ghana National Policy for Aflatoxin Control in Food and Feed explicitly addresses issues on aflatoxins. The vision of the Policy is to improve harmonization and coordination of activities among all stakeholders for effective management and control of aflatoxins in food and feed. The Policy addresses seven strategic objectives with the overall goal of protecting human and animal health and increasing the income of farmers, the food industry, and value chain actors. The objectives are to:

1. Facilitate the development, harmonization and enforcement of policies, legislations, and standards for aflatoxin control;
2. Increase public awareness, advocacy, communication, and demand for aflatoxin-safe food and feed;
3. Strengthen research and technology transfer on aflatoxins;
4. Strengthen surveillance systems for the detection of aflatoxin-related foodborne diseases;
5. Develop mechanisms for strengthening consumer protection;
6. Increase domestic and international trade in aflatoxin-safe products; and
7. Mobilise resources for aflatoxin-related activities.

To facilitate the implementation of the Policy, a five-year Action Plan (2021-2025) and a Resource Mobilization Plan have been developed. However, the effective implementation of the policy and its action plan requires major inputs from four key ministries, namely, the Ministry of Food and Agriculture (MOFA); Ministry of Trade and Industry (MOTI); Ministry of Health (MOH); and Ministry of Environment, Science, Technology, and Innovation (MESTI). Each of these Ministries is expected to play a lead role in the implementation of specific aspects of the policy in line with their mandates. The Implementation Plan provides further details about the roles and responsibilities of these four ministries and their agencies as well as other stakeholders.

To further optimise the implementation of the policy, the National Steering Committee for Aflatoxin Control (NSCAC) has been formed and inaugurated to, among others, contribute to both domestic and international resources mobilisation efforts, spearhead awareness creation on aflatoxins among policy makers and other stakeholders, facilitate coordination of aflatoxin activities among various ministries, departments and agencies, and seek partnerships with local and international.

The policy is expected to be implemented with funds and resources from different sources. The government of Ghana's budgetary support to MDAs and MMDAs will constitute a major source of funding. To this end, MDAs and MMDAs will be encouraged to incorporate aflatoxin control activities in their annual work plans and budgets. Through solicited and unsolicited proposals, additional funding will be sourced from development partners and donors. Furthermore, support will be sought from the private sector and through public-private arrangements especially for digital solutions, capacity building and infrastructural development. Other sources of funding NGOs and CSOs involved in health, nutrition, agriculture, food safety and human rights activities.

# 3.0 Overview of the P-IMA Framework

The STDF has developed a framework to help inform and improve SPS planning and decision-making processes. The P-IMA framework offers an evidence-based approach to inform and improve SPS planning and decision-making processes. It helps to link SPS investments to public policy goals including export growth, agricultural productivity, and poverty reduction. In the process, P-IMA encourages public-private dialogue, boosts transparency and accountability, and improves the economic efficiency of investment decisions. The P-IMA user Guide uses a multi-criteria decision analysis (MCDA) approach, as well as computer software (D-Sight) to help derive priorities.

Specifically, P-IMA aims to generate a set of evidence based SPS priorities that gives the best return on investment and can be mainstreamed into national investment frameworks and/or leverage external resource mobilization. The rationale behind the framework is that priorities need to be established on the basis of a range of economic and social considerations that may, at least on the face of it, be difficult to reconcile. In turn, this assumes that the rationale for investments in SPS capacity-building is not just compliance with the export market SPS requirements per se, rather, the economic and social benefits that might flow from such compliance, whether in terms of enhanced exports, incomes of small-scale producers and/or vulnerable groups, promotion of agricultural productivity and/or domestic public health, etc. The framework provides an approach for different decision criteria to be taken into account even though they may be measured in quite different ways.

The framework employs a highly structured process that aims to be applied in a wide variety of contexts and to provide various diagrammatic and numerical outputs. The framework and its practical implementation are described in detail in a P-IMA user's guide freely available on the STDF website[2]. Below, is a relatively brief outline of the stages of the framework, with a particular focus on how they were implemented in Ghana on the Aflatoxin Policy Implementation Plan.

## Stage 1: Compilation of Information Dossier

The first stage of the analysis involved the compilation of a comprehensive dossier of existing information on the SPS challenges facing agri-food exports and the associated investment needs. In so doing, the aim was to ascertain what work had already been undertaken to identify capacity-building investment options and the definition of priorities for related investments. In Ghana, this stage was already covered by the scoping assessment which informed the policy formulation. Also, a well outlined investment activities were already listed in the implementation plan.

## Stage 2: Definition of Choice Set

The next step in the process is to clearly define the SPS constraints being faced and identify the SPS Investment Options to address these challenges. In order to do this, a two-day stakeholder's workshop was held from 6-7 July 2022. The Participants list of this workshop can be found in Annex 2. The workshop comprised of training of key stakeholders on the P-IMA framework. These two days were also dedicated to the consolidation of the Aflatoxin Investment Options and defining the Decision Criteria and Weights. Participants were grouped based on the key objective areas of the policy to consolidate bankable investment areas under the specific objective that are mutually exclusive. The Investment Options that were included are listed and defined in Table 5 below:

*Table 5: Aflatoxin Policy Investment Options*

| | Consolidated Investment Options |
|---|---|
| **1** | Institutional Strengthening to ensure successful implementation of the aflatoxin policy |
| **2** | Increase public awareness, advocacy, communication and demand for Aflatoxin-Safe food and feed |
| **3** | Strengthening research and technology transfer on aflatoxin |
| **4** | Strengthening surveillance systems for the detection of aflatoxin-related diseases in humans, livestock and fish |
| **5** | Strengthen the capacity of value chain actors in pre-& post-harvest aflatoxin management for Market Access |

*Source: Consolidation of activities from the Nation Aflatoxin Policy Implementation Plan*

[2] https://www.standardsfacility.org/sites/default/files/P-IMA_Guide_EN.pdf

## Stage 3: Definition of decision criteria and weights

In the second stage of the stakeholder workshop, respondents were asked to define an appropriate set of criteria to drive the priority-setting process and to assign weights to these. First, participants were presented with a series of potential decision criteria and asked which (if any) should be excluded and whether any potentially important criteria were missing. To define the decision weights, the workshop participants were each asked to assign 100 points amongst the seven decision criteria agreed on. The scores of participants were then collated, and an average weighting calculated. The final agreed weightings are reported in table 6 below.

*Table 6: Decision Criteria and Weights for Priority Setting Framework*

| Decision Criteria | Decision Weights |
|---|---|
| Cost of Investment | 11 |
| Public Health | 26 |
| Income | 13 |
| Post-harvest loss | 13 |
| Agriculture Productivity | 14 |
| Employment | 8 |
| Food & Nutrition Security | 15 |
| **Total** | 100 |

*Source: Authors' Construction*

## Stage 4: Construction of Information Cards

Having identified the choice set of SPS investment options and the decision criteria and weights to be applied in the priority-setting exercise, information was assembled into a series of information cards. The aim of these cards is not only to ensure consistency in the measurement of each decision criterion across the investment options, but also to make the priority-setting exercise more transparent and open to scrutiny.

First, the specific nature of each of the SPS investment options was described in some detail on the basis of existing documentation, consultation with stakeholders, etc. and are set out in Section 4. The metrics to be employed for each of the five decision criteria were then defined, taking account of currently available data and the range of plausible ways in which each of the criteria might be represented. Table 7 sets out the final metrics. Note that the choice of metrics involves a sometimes-difficult compromise between the availability and quality of data, and the imperative to employ continuous quantitative measures. While the cost element is estimated by reviewing and collating the costs in the implementation plan, other decision criterion were measured collectively by stakeholders during the working session based on available data and information. However, it is important to recognize that the aim of the framework is not to provide a final and definitive prioritization of the investment options. Rather, the priorities that are derived should be revisited on an on-going basis and revised as more and/or better data for the decision criteria become available.

Information cards for each of the aflatoxin investment options were then compiled. These are reported in Annex 1. Each card presents data for the seven decision criteria, measured according to the scales outlined in table 7. For each criterion, details are provided of how measures for each of the decision criteria were derived. There is also an indicator of the level of confidence in the measure reported. Where there is a lack of underlying data and/or these data are of dubious quality, a low or medium level of confidence is indicated. Conversely, where fairly rigorous and comprehensive prior research is available, a high level of confidence is reported. These confidence measures need to be considered in interpreting the results of the prioritization exercise, and in considering how the analysis might be refined in the future.

*Table 7: Decision Criteria Measurement Metrics*

| Decision Criterion | Details | Measurement |
|---|---|---|
| **Cost of investment** | Monetary costs of investments to upgrade SPS capacity | Absolute value ($) |
| **Public health** | Changes in domestic public health, through food safety, occupational exposure to hazards, etc. and changes in protection of natural environment | Positive (+1); Low Positive (+2); Medium Positive (+3) Large positive (+4), Very Large Positive (+5); No Impact (0); Negative (-1); Low Negative (-2); Medium Negative (-3) Large Negative (-4), Very Large Negative (-5) |
| **Income** | Changes in the income of value chain actors as a result of the specific investment | |
| **Agriculture Productivity** | Impact on the agriculture production and productivity | |
| **Employment** | How many people are likely to be impacted as a result of the investment | |
| **Food and nutrition security** | Impact on food availability of nutritious food | |
| **Post-harvest losses** | The contribution of the specific investment option to post-harvest loss reduction | Yes/No |

*Source: Construction by Authors*

## Stage 5: Review of Information Cards

Following from stage 4, the information cards were further subjected to further verification by the core national team, which comprises of the STEPRI and AGRA team including the National Data consultant, to ensure accuracy and confidence in the data and information in the cards.

## Stage 6: Derivation of quantitative priorities

The formal priority-setting analysis involved the use of outranking through the D-Sight software package. The mechanics of the analysis are described in some detail in the user guide of the framework. The inputs to the model are the data assembled in the information cards. For most of the decision criteria, preferences were modelled using a level function since these were measured using categorical scales. However, the cost of investment was measured continuously and modelled using linear functions. Two models were estimated using D-sight:

- Baseline model (main result) using decision weights derived in Stage 3.
- Equal weights model in which all of the decision criteria are weighted equally.

The baseline model is considered to provide the main set of priorities, in that it uses the full set of information derived through Stages 1 to 4. The equal weights model was estimated in order to examine the extent to which the derived priorities are sensitive to changes in the decision weights; if the broad ranking of the investment options remains generally the same under the scenarios presented by these models, we can be reasonably confident that the results of the framework are robust.

## Stage 7: Validation

The final stage of the priority-setting analysis is completed with this report on the results of the analysis. The aim of the validation process was to ensure that the results of the priority-setting framework were broadly in accordance with expectations, or that unexpected rankings can be explained through the pattern of data in the information cards. To facilitate this process, the draft report was disseminated to stakeholders by email with a request for comments. Furthermore, the preliminary results were presented at stakeholders' validation workshop on 12th October 2022, of which the participants are reported in Annex 4.

# 4.0 Brief Description of the Aflatoxin Policy Investment Options

## 4.1 Institutional strengthening for successful implementation of the aflatoxin policy

Aflatoxin is known to be a cancer-causing organism found in agricultural products which can be transmitted to humans through food consumption. Empirical evidence suggests a high-level incidence of aflatoxin in Ghana's food chain, however, there is limited knowledge, and weak institutional capacity of regulatory bodies and citizens to control and/or manage aflatoxins. Some of the documented evidence of challenges to aflatoxin management are observed to be lack of empirical data on the effects of current laws on aflatoxin control, insufficient structures and support for the implementation of aflatoxin laws, policies, and standards, insufficient national aflatoxin standards and regulation for food and feed. Furthermore, low stakeholder participation in policy formulation processes all contribute to a lack of buy-in and ownership, particularly at the local level. Value chain actors have a weak understanding of the needs of standards while inspection and enforcement are challenging because of the protracted bureaucratic procedures for getting products tested, registered, and authorized, as well as the lack of information on actors throughout the value chain, particularly those operating in the informal sector.

To address these challenges to ensure effective management of aflatoxin in Ghana's food system, it is crucial to strengthen institutions to successfully implement the aflatoxin policy. This could be achieved through project interventions. Thus, the investment option 'Institutional Strengthening to ensure successful implementation of the aflatoxin policy' will seek to:

- Develop human resource capacity of the policy implementing agencies including training of personnel from the various implementing Ministries, Departments and Agencies (MDAs), and allied stakeholders incl. private sector
- Develop infrastructure – procurement of machines, equipment, laboratories, offices, regents, etc.
- Support the Aflatoxin Steering Committee to perform their functions including coordinating activities of the various implementation partners and monitoring to ensure that each MDAs or agency performs their roles
- Create awareness – knowledge dissemination activities on standards, regulation, media campaigns, and other regulatory requirements through workshops, training, fora, etc. at local, regional, and national level
- Develop standards, legal framework and requirements to develop and meet standards
- Gender mainstreaming – women and youth inclusion
- Strengthen traceability, alert & emergency response systems

## 4.2 Strengthening the capacity of value chain actors in aflatoxin management for market access

In addition to the public health benefits of effective aflatoxin control, Ghana stands to earn substantial foreign currency from food exports. However, the presence of aflatoxin in the country's food chain has restricted the export of these food commodities. It's observed that because of aflatoxin contamination, Ghana has limited access to high-value markets (such as the food industry and exports). There is a lack of knowledge among consumers and value chain actors about aflatoxin, its effects on people and animals, and how to prevent or reduce it. Other challenges are insufficient infrastructure for managing aflatoxins along the value chain, high cost of technologies, and insufficient financial incentives for value chain actors to produce and market aflatoxin-free food and feed products. Furthermore, the high costs associated with product certification and registration and the general unsanitary conditions along the food supply chain (at the farm, market, homes, etc.), which make it difficult to achieve safer food trade. Addressing these challenges to open market opportunities, both local and international levels will require investment in:

- Development of training modules and delivering training to value chain actors on various pre- and postharvest aflatoxin control practices and other market requirements to enable them produce aflatoxin-free products for both local and international markets.
- Provision of resources to support the uptake of aflatoxin management technologies. These include improved planting materials, packaging materials and financial resources.
- Development and provision of infrastructure such as storage facilities and dryers.

## 4.3: Strengthen research and technology development and transfer on aflatoxins

As the whole world moves towards a knowledge-based economy, society is looking up to knowledge-based institutions to facilitate the process of churning out business ideas and R&D support to techno-enterprises. This has become more prominent in developed economies where R&D drives economic growth. Research is needed to generate new technologies and provide a solid evidence base to support informed decision-making regarding better aflatoxin prevention and control. Research is also needed to provide evidence for advocacy to influence policy. There is therefore a need for more research that is better targeted and coordinated and that involves end-users from the onset. Furthermore, research evidence is needed to inform decisions about the establishment of appropriate facilities and infrastructure for the surveillance, safe storage, handling and transport of food, as well as awareness raising targeting agricultural value chain actors and consumers. Other outputs for strengthening research and technology development and transfer on aflatoxins include:

- Support research for the generation of knowledge and development of mitigation measures (pre- and post-harvest) as well as dissemination of research outputs.
- Improve the knowledge capacity of researchers and extension officers.
- Provide infrastructure in research institutions for aflatoxin research. These include laboratory equipment.
- Rapid testing of aflatoxin levels by extension officers (providing rapid testing kits).
- Upscale or promote adoption of existing aflatoxin control technologies.
- Research on epidemiological studies on the health/nutrition effects of aflatoxin.

## 4.4 Strengthen surveillance systems for the detection of aflatoxin-related diseases in humans, livestock, and fish

Aflatoxin-producing fungi cause contamination of food and feed resulting in health hazards and economic losses. It is imperative to develop workable control measures throughout the food chain to prevent and reduce aflatoxin contamination. A major problem that hampers aflatoxin management is the limited capacity for monitoring, reporting, and communicating about aflatoxin-related diseases. There is an inadequate health-related database to inform policy and regulations. So, the establishment of a database for the country is required. In Ghana, the risk assessment and monitoring system for aflatoxins do not fully operate to gather information needed to guide policy decisions and interventions. Therefore, there is a need to strengthen risk assessment, disease monitoring, and communication. Other outputs for strengthening surveillance systems for the detection of aflatoxin-related diseases in humans, livestock, and fish include:

- Integrate aflatoxin & related disease testing in existing labs
- Fund research into aflatoxin-related diseases
- Establish traceability systems for value chain actors
- Establish regional aflatoxin surveillance systems
- Build capacity for health and epidemiological professionals

## 4.5 Awareness creation on the dangers of aflatoxins and their mitigation measures

Awareness about aflatoxins is generally low. This hampers initiatives to decrease contamination along value chains, reduce consumption of contaminated foods, create an enabling policy and institutional environment, and ensure that aflatoxins receive the needed attention and investments. Even if smallholder farmers know about aflatoxins and the risks they pose, they do not know how to minimize the risk of contamination during growing, at harvest or during post-harvest. Small-scale traders, transporters and processors do not have the knowledge or facilities to handle food products in ways that minimize further contamination, nor do they have the capacity to differentiate batches that contain high levels of aflatoxins from batches that are safe. There is therefore a need for scientists and communication specialists to work together to develop clear, evidence-based actionable messages and information targeted at specific audiences. Such messages and information must be delivered using the media formats and language most appropriate and accessible to the target audience. In doing so, care needs to be taken to avoid causing fear and panic among the public, which might cause markets to collapse. The huge increase in access to modern communication channels, such as mobile phones, television, FM radio stations, and the internet offers good opportunities. Clear information that can be understood by non-technical audiences is needed to support advocacy

and awareness campaigns. In addition, the role of consumer associations in ensuring accountability of industries regarding food safety, dissemination of information related to food safety and implementation of national food safety programmes need to be promoted.

This investment option, therefore, seeks to increase public awareness, advocacy, communication and consumer demand for aflatoxin-safe food and feed to address the following key issues in aflatoxin control and prevention:

1. Limited awareness by stakeholders of the dangers that aflatoxins pose, how contamination occurs, and the measures they can take to reduce contamination.
2. Low prioritization of aflatoxin control and prevention by policymakers and development partners in comparison to broader food security issues.
3. Limited expertise in advocacy, communication and low involvement of advocates and champions in the campaign against aflatoxins.
4. Translating technical and scientific information into local languages is a challenge.
5. Inadequate media reportage on aflatoxin issues.
6. Insufficient information, education and communication (IEC) materials on aflatoxins.
7. Insufficient funding and resources for public awareness creation, advocacy and communication activities.
8. Limiting aflatoxin education to few and specific higher educational programmes.
9. Generally low understanding of scientific issues.
10. There is little or no opportunity to take feedback from consumers/people who have received training.
11. Limited number of food safety-oriented consumer organisations

The following key activities are envisaged under this investment:

i. Organize awareness programmes for stakeholders on the dangers posed by aflatoxin contamination.
ii. Promote aflatoxin awareness at the community level using community structures.
iii. Encourage peer-to-peer education on aflatoxins.
iv. Promote the use of effective tools and channels (e.g. drama, videos, visuals etc.).
v. Sensitize the Parliamentary select committees on agriculture, science and technology, health, and trade on aflatoxin issues.
vi. Organize training for media and stakeholders on science and risk communication.
vii. Organise training for local languages translators on facts on aflatoxin, e.g. GBC Adult education platform, regional Radio programmes.
viii. Encourage consumer associations in promoting and ensuring accountability of industries regarding food safety, dissemination of information related to food safety and implementation of national food safety programmes.

It is expected that addressing the key issues through the activities will produce the following outcomes:

1. Development of pictorials, leaflets, posters, pamphlets, billboards on the dangers of aflatoxins.
2. Knowledge of parliamentarians, policy makers, development partners enhanced.
3. Community level education/ sensitization enhanced.
4. Standardised fact sheets on aflatoxin in seven local languages.
5. Consumer complaints documented, mapped and feedback given.
6. Consumer protection strengthened

# 5.0 Results

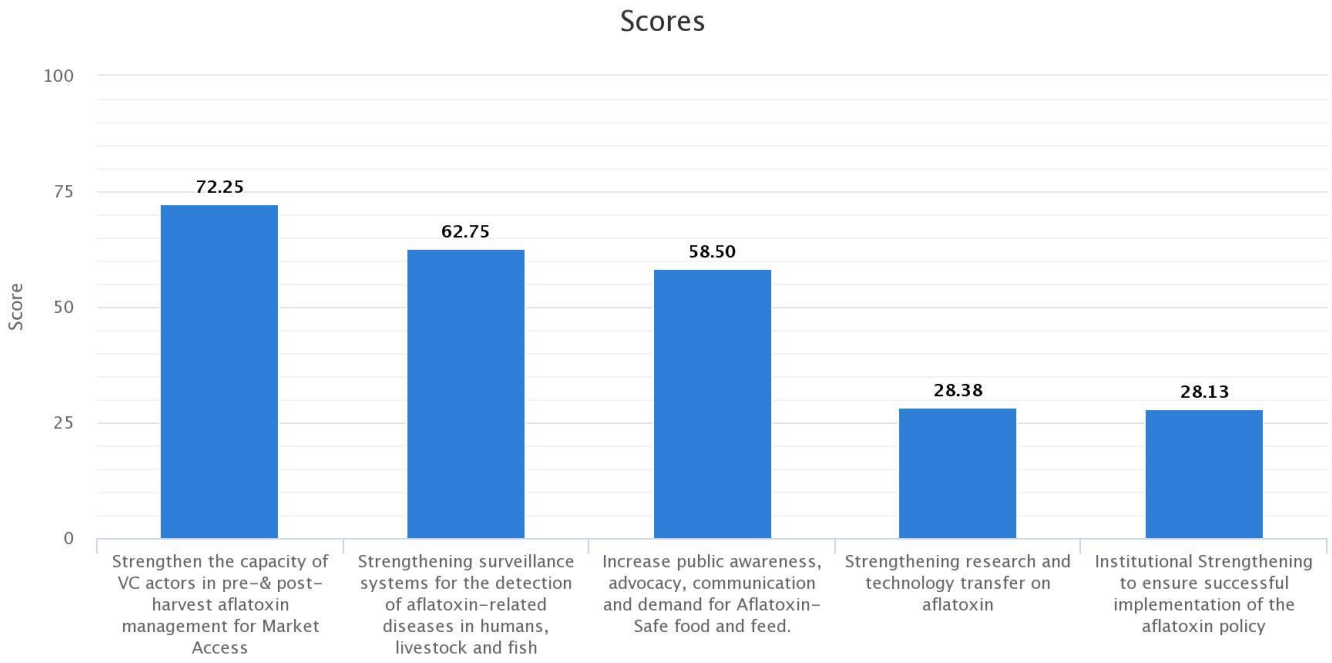
Figure 2 below presents the result of the prioritization of the investment options consolidated under the national aflatoxin policy implementation plan. This prioritization uses outranking approach in the D-Sight software package[3] based on the decision criteria and weights agreed by stakeholders. The result shows that strengthening the capacity of value chain actors in pre- and post-harvest aflatoxin management for market access ranks the best (with a score of 72.25) considering the benefits that might accrue over the various decision criteria such as improving income, public health, agriculture production, post-harvest losses, employment, and food and nutrition security. Strengthening surveillance systems for the detection of aflatoxin-related diseases in humans, livestock, and fish, ranked second with a score of 62.75 out of 100, followed by increasing public awareness, advocacy, communication and consumer demand for aflatoxin-safe food and feed.

[3] http://web.d-sight.com/

On the other hand, strengthening research and technology transfer on aflatoxin, and institutional strengthening for successful implementation of the aflatoxin policy ranked the lowest. It should, however, be noted that these rankings do not suggest that a low ranked option is not important for implementation, but rather, it simply shows that, in terms of priority, based on assigned costs and flow of benefits, a lower ranked option is not the best option to be implemented first given limited resources.

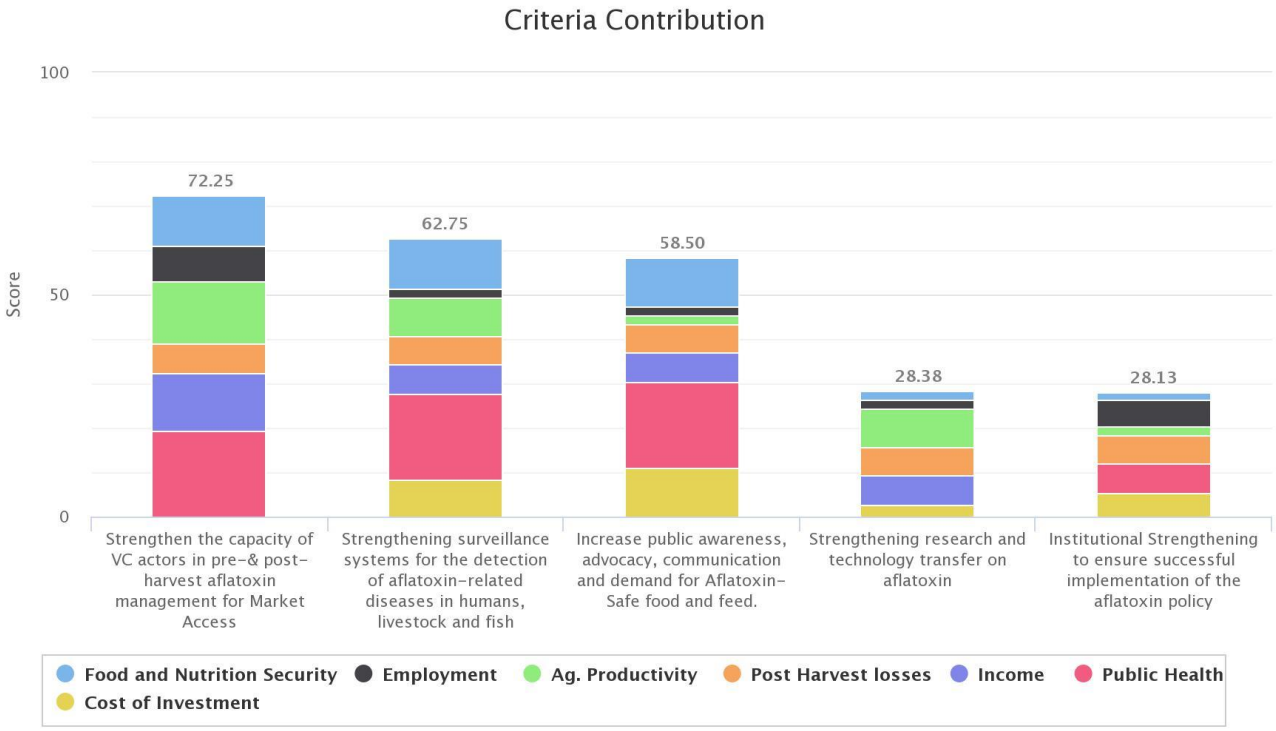
Figure 3 explains how the different decision criteria and their weights contribute to the overall performance of each of the investment options. In effect, it is noticeable that the top ranked options have greater contribution from almost all decision criteria than the lower ranked options. The decision criteria having the greatest impact on the ranking, and especially the position of the top-ranked options are the impact on **public health**, and **food and nutrition security.**

*Figure 2: Baseline Model - Main results of the prioritization*




*Source: Authors' Construction using D-Sight Software*

*Figure 3: Baseline Model – Main results of the prioritization – Criteria contribution*

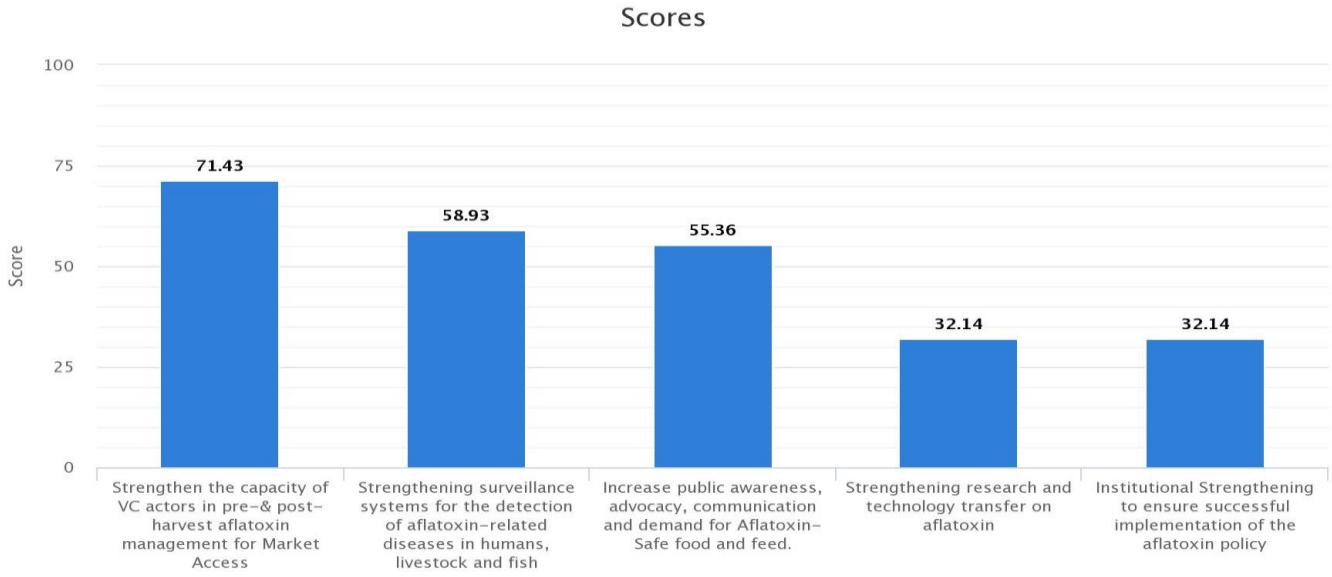



*Source: Authors' Construction using D-Sight Software*

To test the resilience of the main result, we employ a sensitivity analysis by setting the weights on all decision criteria equal. The result (figure 4) shows that the rankings of the investment options did not change, confirming the result in the main analysis is resolute. There is, however, slight changes in the scoring of the investments options indicating the influence that the weights in the main results had on the

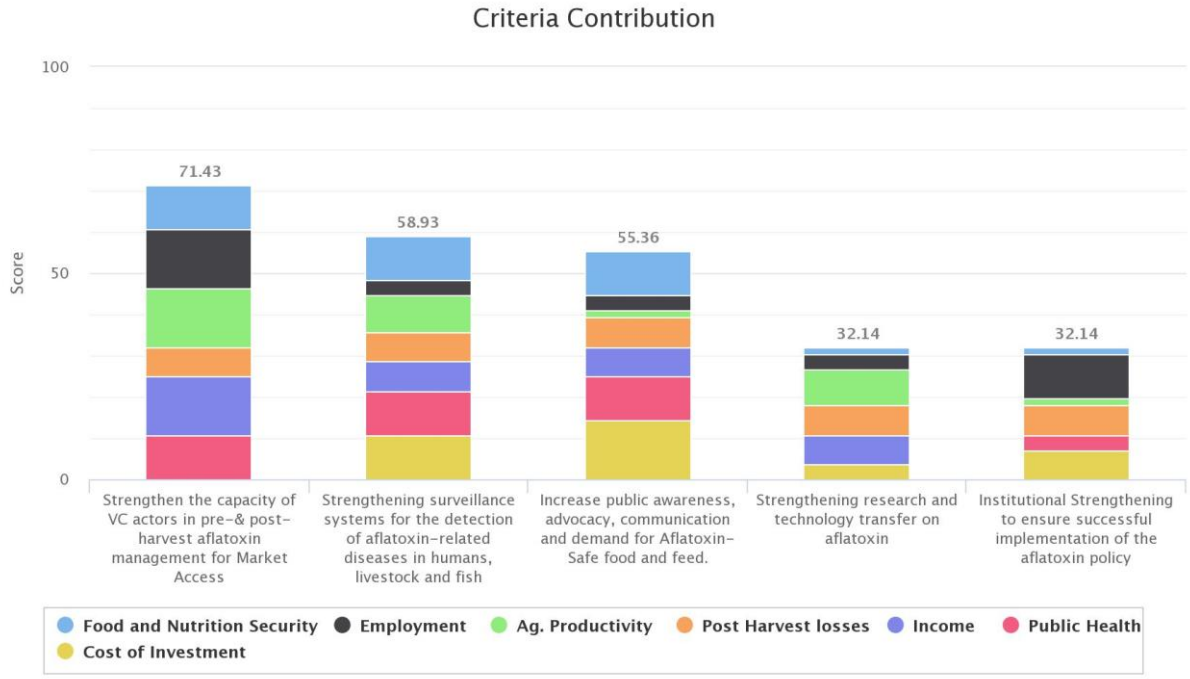
performance of the ranking of the investment options. For instance, option one in the main analysis recorded a score of 72.25 as against 71.43 in the equal weights analysis. Also, there is quite an increase in the scores of the bottom ranked options from 28 to 32 but not enough to change their positions.

*Figure 4: Sensitivity analysis – equal weights of decision criteria*




*Source: Authors' Construction using D-Sight Software*

*Figure 5: Sensitivity analysis – equal weights of decision criteria – Criteria contribution*




*Source: Authors' Construction using D-Sight Software*

# 6.0 Conclusion

The analysis contended significantly with consolidating the several activities in the implementation plan of the policy to ensure meaningfully and viably unique investment options. In so, doing some activities were discarded or merged. It should be noted that the lists under these investment options may not be exhaustive but a reflection of what is believed to be more critical, and at the point of developing proposals these can be expanded.

Overall, as shown in table 8 below, we found that investing into strengthening the capacity of value chain actors in pre- and post-harvest aflatoxin management for market access, as well as strengthening surveillance systems for the detection of aflatoxin-related diseases in humans, livestock and fish ranked well than the remaining three investment options across the various decision criteria. On the other hand, the investment options related to strengthening research and technology transfer on aflatoxin, and institutional strengthening to ensure successful implementation of the aflatoxin policy does not compete well on the basis of the selected decision criteria. Again, it should be noted that the low ranking of an investment option does not presuppose that the option is not important for implementation, but rather, it simply shows that, in terms of priority setting the option does not come first given limited resources.

*Table 8: Ranking of Investment Options*

| Rank | Alternative | Score |
|---|---|---|
| **1** | Strengthen the capacity of value chain actors in **pre-& post-harvest aflatoxin management** for Market Access | 71.43 |
| **2** | Strengthening **surveillance systems** for the detection of aflatoxin-related diseases in humans, livestock and fish | 58.93 |
| **3** | Increase **public awareness**, advocacy, **communication** and demand for Aflatoxin-Safe food and feed | 55.36 |
| **4** | **Institutional Strengthening** to ensure successful implementation of the aflatoxin policy | 32.14 |
| **5** | Strengthening research and technology transfer on aflatoxin | 32.14 |

Source: *Authors' Construction using D-Sight Software*

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# Annexes

## Annex 1 – Information Cards of Investment Options

### 1.1 Institutional Strengthening to ensure successful implementation of the aflatoxin policy

| Decision Criterion | Value | Details | Confidence |
|---|---|---|---|
| **Cost of Investment (US$)** | 1,385,000 | Human resource development, infrastructure, National Aflatoxin SC, standards development, and gender mainstreaming *(see annex xxx for detailed costing)* | High |
| **Public health (-5 to +5)** | 4 | Safer products due regulatory efficiency, strengthening public health interventions | High |
| **Income (-5 to +5)** | 2 | Reduced post-harvest loss and more produce for sale | High |
| **Post-Harvest Loss (Yes/No)** | 1 | It will reduce post-harvest loss | High |
| **Productivity (-5 to +5)** | 1 | Increased productivity due knowledge transfer to farmers | Medium |
| **Employment (-5 to +5)** | 2 | Strong institutions will translate into better outputs and expansion in industry and employment | Medium |
| **Food and Nutrition Security (-5 to +5)** | 3 | Improved infant nutrition a result of reduced aflatoxin presence | High |

## 1.2 Increase public awareness, advocacy, communication

| Decision Criterion | Value | Details | Confidence |
|---|---|---|---|
| **Cost of Investment (US$)** | 1,090,000 | Knowledge dissemination, aflatoxin modules in higher/tertiary educational programs, consumer driven advocacy, aflatoxin communication *(see annex xxx for detailed costing)* | High |
| **Public health (-5 to +5)** | 5 | Increased knowledge and change in culture and behaviour at the household level | High |
| **Income (-5 to +5)** | 3 | Increased compliance resulting in increased markets access – both domestic & International | High |
| **Post-Harvest Loss (Yes/No)** | 1 | Reduction in PHL due to increased knowledge about effective control measures | Medium |
| **Productivity (-5 to +5)** | 1 | Minimal impact | Medium |
| **Employment (-5 to +5)** | 1 | Increase output/income may lead to industry expansion and more employment | Medium |
| **Food and Nutrition Security (-5 to +5)** | 5 | More consumer knowledge & access to safe products | High |

## 1.3 Strengthening research and technology development and transfer on aflatoxin

| Decision Criterion | Value | Details | Confidence |
|---|---|---|---|
| **Cost of Investment (US$)** | 1,730,000 | New technologies & knowledges development and dissemination, integration of aflatoxin into education curriculum, coordination and collaboration among researchers, etc., improve capacity of researchers, etc. *(see annex xxx for detailed costing)* | High |
| **Public health (-5 to +5)** | 3 | Safer products | High |
| **Income (-5 to +5)** | 3 | New technologies will increase output and access to premium markets and hence a higher income | Medium |
| **Post-Harvest Loss (Yes/No)** | 1 | New technologies will result in more effective controls and management | High |
| **Productivity (-5 to +5)** | 3 | New technologies will result in more effective controls and management and expansion in output | Medium |
| **Employment (-5 to +5)** | 1 | Minimal impact | Medium |
| **Food and Nutrition Security (-5 to +5)** | 3 | Increase knowledge resulting in increased availability and nutrition dense products | Medium |

## 1.4 Strengthening surveillance systems for the detection of aflatoxin-related diseases in humans, livestock and fish

| Decision Criterion | Value | Details | Confidence |
|---|---|---|---|
| **Cost of Investment (US$)** | 1,250,000 | Include aflatoxin-related diseases in the list of food borne diseases, build capacity of health & other professionals, traceability system, regional aflatoxin surveillance systems & digital database on prevalence, etc. *(see annex xxx for detailed costing)* | High |
| **Public health (-5 to +5)** | 5 | Generate evidence for diagnostic and treatment | High |
| **Income (-5 to +5)** | 3 | Increase prevention due to detection and treatment particularly of livestock and fish hence increasing output | Medium |
| **Post-Harvest Loss (Yes/No)** | 1 | Increase prevention due to detection and treatment particularly of livestock and fish hence reducing output loss | Medium |
| **Productivity (-5 to +5)** | 3 | Increase prevention due to detection and treatment particularly of livestock and fish hence increasing output | Medium |
| **Employment (-5 to +5)** | 1 | Increase prevention due to detection and treatment particularly of livestock and hence increasing output and more employment | Medium |
| **Food and Nutrition Security (-5 to +5)** | 5 | Increase prevention due to detection and treatment particularly of livestock and fish hence increasing output | High |

## 1.5 Strengthen the capacity of VC actors in pre-& post-harvest aflatoxin management for Market Access

| Decision Criterion | Value | Details | Confidence |
|---|---|---|---|
| **Cost of Investment (US$)** | 2,220,000 | Training and awareness of value-chain actors on pre & post-harvest technologies. *(see annex xxx for detailed costing)* | High |
| **Public health (-5 to +5)** | 5 | Increased aflatoxin-free products | High |
| **Income (-5 to +5)** | 4 | Increased output and premium market access | High |
| **Post-Harvest Loss (Yes/No)** | 1 | Increased knowledge/skills will reduce product loss | High |
| **Productivity (-5 to +5)** | 4 | Reduction in product losses and mortality rate | High |
| **Employment (-5 to +5)** | 4 | Increased income resulting in expansion in industry | High |
| **Food and Nutrition Security (-5 to +5)** | 5 | Higher outputs due to mitigation and control | High |

# Annex 2: Participants list of Stakeholders Workshop on 6-7 July 2022

# Annex 3: Participants List of the Policy Launch and Validation Workshop on 12th October 2022

| No. | Name | Institution/Organisation |
|---|---|---|
| 1 | Dr Cecilia Akotia | FAO |
| 2 | Janet A. Mensah | MOFA |
| 3 | Juliet Onyame | MOH |
| 4 | Florence S. Kuulg | AMA |
| 5 | Edith Gavor | MOH |
| 6 | Aworgu Agaslor | MOFA |
| 7 | Bridgelli Addo | DAES/MOFA |
| 8 | Kingsley Buabshi | GEPA |
| 9 | Dr H. A. Talor | MOH |
| 10 | Godfred Frempond | CSIR-STEPRI |
| 11 | George Akonor | WFP |
| 12 | Dr Justice Kumi | NMIMR |
| 13 | Edwin Tamakloe | Edmills |
| 14 | Millicent Tamakloe | Edmills |
| 15 | Elizabeth Adu-Agyei | MOFA/PPRSD |
| 16 | Professor Charles Tortoe | CSIR-FRI |
| 17 | Kwesi Wih | PPRSD/MOFA |
| 18 | Dorothy Effah | AGRA |
| 19 | Eric Benstil Quaye | PPRSD/MOFA |
| 20 | Professor R. T. Awuah | KNUST |
| 21 | Daniel Njiwa | AGRA |
| 22 | Blaise Ouattara | FAO |
| 23 | Daniel Agbetiameh | KNUST/IITA |

| | | |
|---|---|---|
| **24** | Sylvia Baah Tuahene | CSIR-STEPRI |
| **25** | Emily Boahen | GBC |
| **26** | Boakye A. Boakye | GEA |
| **27** | Mavis Apeta | MOFA |
| **28** | Emma Hammond | GHS |
| **29** | Hon. John Osei Frimpong | Parliament |
| **30** | Paul Omari | Eatsafe Gh. (NGO) |
| **31** | Mavis Akufobbea | CSIR-STEPRI |
| **32** | King-David Amoah | FONG |
| **33** | Nana Yamoah | CSIR-STEPRI |
| **34** | Melvin Spreij | WTO/STDF |
| **35** | Rankine Asabo | CSIR-STEPRI |
| **36** | Ransford Kabu | CSIR-STEPRI |
| **37** | Jeff Ekow Cobbah | CSIR-STEPRI |
| **38** | Mark Antonio | ADB |
| **39** | Russ Nicely | US Embassy |
| **40** | George Anyebuno | CSIR-FRI |
| **41** | Derry Dontoh | GSA |
| **42** | Selina Lawer Amgle | CSIR-STEPRI |
| **43** | Richmond Gasu | CSIR-STEPRI |
| **44** | Dr Emmanuel K. Tetteh | CSIR-STEPRI |
| **45** | Lamptey Julius | GNCCI |
| **46** | Andrea Appiah | Liver Cancer Foundation |
| **47** | Decordi Nelson | CSIR-INSTI |