SITUATION ANALYSIS: IMPROVING FOOD SAFETY IN THE MAIZE VALUE CHAIN IN KENYA

Report prepared for FAO by

Prof. Erastus Kang'ethe
College of Agriculture and Veterinary Science
University of Nairobi
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Acronyms

CDI/VOCA	Agricultural Cooperative Development Initiative
AGOA	African Growth and Opportunities Act
AGRA	Alliance for Green Revolution in Africa
AOAC	Association of Official Analytical Chemists
ASCU	Agricultural Sector coordinating Unit
CE	Commodity Exchange
CEM	Commodity Exchange Market
CIDA	Canadian International Development Agency
CIGs	Common Interest Groups
CIYMMT	International Maize and Wheat Improvement Center
DANIDA	Danish International Development Agency
DFID	Department for International Development
EACS	East African Community Standards
EAGC	Eastern African Grain Council
EAC	East African Community
EC	European Commission
ELISA	Enzyme Linked Immunosorbent Assay
ERS	Economic Recovery Strategy
EVIRA	Finnish Food Safety Authority
FAO	Food and Agricultural Organization of United Nations
FOASTAT	Food and Agricultural Organization –Statistics
FSD	Financial Sector Deepening Trust
GDP	Gross Domestic Product
GIZ/GTZ	German International Cooperation
GOK	Government of Kenya
Ha	Hectare

HPLC	High Performance Liquid Chromatography
ICTs	Information Communication Technology
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
ISO	International Standards Organization
JICA	Japan International Cooperation Agency
KACE	Kenya Agricultural Commodity Exchange
KARI	Kenya Agricultural Research Organization
KEBS	Kenya Bureau of Standard
KEPHIS	Kenya Plant Health Inspectorate Services
KMDP	Kenya Maize Development Programme
KSC	Kenya Seed Company
KS-EAS	Kenya Standard-East African Standard
KShs	Kenya Shillings
MASL	Meters above Sea Level
MDG	Millennium Development Goals
MoA	Ministry of Agriculture
MOHS	Ministry of Health and Sanitation
MSV	Maize Streak Virus
NAEP	National Development Extension Agency
NALEP	National Agricultural Extension Programme
NCPB	National Cereals and Produce Board
NGO's	Non-Governmental Organizations
NMK	Njaa Marufuku Kenya
NPHL	National Public Health Laboratories
OP	Organophosphate
PRSP	Poverty Reduction Strategy Paper

SGS	Society Generale Surveillance
SIDA	Swedish International Development Agency
SRA	Strategy for Revitalizing Agriculture
T	Tonnes
UNCHR	United Nations Commission for Human Refugees
UON	University of Nairobi
US$	United States Dollars
USAID	United States Agency for International Development
USAID COMPETE	United States Agency for International Development Competitive Trade and Expansion Programme
WFP	World Food Programme
WHO	World Health Organizations
WRS	Warehouse Receipt System

Executive Summary

Maize is a significant food source in Kenya and more than 75% of the local production is provided by small farmers. Unfortunately there is not enough production to satisfy the market demand therefore maize has to be imported. Projections show that this shortfall will only increase in the future. The maize prices have also been increasing in recent years.

The government has a range of initiatives designed to increase maize production levels, but there is not the same amount of effort being given to manage production and trading conditions or establish large storage facilities.

Mycotoxins are an identified food safety problem in Kenya and there have been a number of human and animal illnesses and deaths attributable to aflatoxins. To date pesticides have not been considered a maize food safety problem but it is just possible that this topic has not been well investigated.

A number of seed companies operate in Kenya and they have bred a range of different seed types suitable for the diverse ecological zones in the country. Seed selection is currently done on the basis of potential productivity. To mitigate aflatoxin problems seed developing companies would also need to consider pest resistance, disease and drought tolerance, husk cover and flintiness of the grain.

The FAO/University of Kenya project found that farmers are not aware of the food safety issues associated with mycotoxins. They are also not aware of the harvest, drying and storage techniques necessary to prevent mycotoxin growth.

There are a number of different players involved in the post harvest marketing chain – small independent operations, posho millers, assemblers and dis-assemblers, wholesalers and retailers as well as the consumers. There is a need for capacity development and training for all of those involved in farming and the post harvest chain.

Storage of maize is a problem, particularly for the small farmers and the householders. A warehouse marketing system is one way of controlling storage conditions and product stored in such facilities would be required to be monitored for quality and food safety factors.

There are maize grading standards (EA2:2005 and KEAS 2:2005) which set aflatoxin limits but these standards are only implemented in the formal marketing channels. Most maize in Kenya is sold through informal marketing systems.

The lead government agency is the Ministry of Agriculture, but there are other government agencies with an interest in food safety/quality issues, for example, the Ministry of Health. At present the Kenyan government has is no specific maize policy.

There are a number of aflatoxin research projects going on in Kenya, but it is important that aflatoxin research looks at ways of preventing aflatoxin contamination rather than just remediation of contaminated product. Consideration also needs to be given on what can be safely done with contaminated maize because contaminated grain fed to cows has resulted in elevated levels in the milk supply.

There are currently a large number of Kenyan laboratories (more than 50) who are capable of undertaking aflatoxin analysis, but often they have no control over how and where the sampling is done. Another major problem is that there is no overarching organization responsible for collating the results and watching for the Kenyan aflatoxin trends.

In summary there are a number of areas that need addressing to control the aflatoxin food safety issues associated with maize. These include government initiatives, effective surveillance systems, collaboration between the many stakeholders, research (particularly related to preventative measures), adequate storage facilities and capacity development and training of the stakeholders.

1: Introduction and Purpose of the Report

Maize is both a significant food source in Kenya and a potential cause of food safety issues. This report has been commissioned to understand Kenya's maize production, processing, storage and marketing practices in conjunction with the current regulatory and policy environment so as to determine how together these factors affect the risk of grain contamination.

A full appreciation of these interrelationships will assist stakeholders to determine how and where food safety issues may be best addressed.

2.0 Overview of Kenya's economy and the main GDP drivers in relation to the Maize value chain

Kenya's economic growth has averaged around 3 percent per annum over the last couple of years with an estimated Gross Domestic Product (GDP) of US$ 31.4 billion in 2008. The Kenyan economy is heavily dependent on agriculture (24% of the GDP), but other key industry sectors are manufacturing, tourism, fisheries, mining, energy, telecommunications and finance.

The following are the top four sectors are agriculture, manufacturing, tourism and information communication.

2.1 Agriculture

Agriculture plays a dominant role in Kenya's economy despite the fact that upwards of 85 percent of Kenya is classified as arid or semi-arid (leaving arable land at a mere 15 percent of the total land area) and over-dependence on rain-fed agriculture sector leaves the country vulnerable to the vagaries of weather. Agriculture contributes 65% of total exports (KSHS 194 billion). Coffee and tea are the principal exports; however, flowers and horticulture are playing increasingly important roles as foreign exchange earners. Agriculture also accounts for 18% of the total formal employment of 1.8 million (Kenya Vision 2030)*,* with 75 percent of the population directly or indirectly employed in this sector.

The agricultural sector is divided into four subsectors, namely, industrial crops, food crops, horticulture, and livestock and fisheries. Food crops contribute to 32% of the agricultural GDP, with maize crops contributing 15%.

The key players in Kenya's agricultural production are the small farmers; those cultivating less than 1 hectare of land to produce food mainly for home consumption with their surplus sold for badly needed cash. These farmers are particularly vulnerable to unpredictable rainfall and seasonal rivers, streams and wells. Therefore crop failure is common, leading to food shortages and even to famine.

2.2 Manufacturing

While Kenya is the industrial giant of the region manufacturing still only accounts for about 10 percent of GDP. This underlines the enormous untapped potential of this sector in Kenya's economy. At present this sector is dominated by food processing industries such as grain milling, sugarcane processing and beer production.

The enactment of the African Growth and Opportunity Act (AGOA) by the US Congress helped stimulate exports in new areas such as textiles and as a result exports to the US alone increased more than six-fold from US $44 million in 2000 to US$ 800 million in 2006. The manufacturing sector employs 254,000 people which represent 13% of total employment. The informal sector employs more than 1.4 million people.

2.3 Tourism

At 10 percent of the country's GDP tourism is the third largest contributor to the country's GDP after agriculture and manufacturing. In 2007, the sector's earnings topped US$ 1 billion, making the sector Kenya's largest foreign exchange earner. Two million tourists came to the country in 2007, an increase of 12.5 percent over 2006. The main tourist attractions are the country's world renowned national parks and beaches.

2.4 Whole and Retail Sectors

The wholesale and retail sectors are predominantly informal accounting for 30% to GDP.

2.5 Information Communication

This is a growing industry in Kenya with the main growth in mobile telecommunication which has 12.9 providers. At present Business Processing Outsourcing and "off shoring" is very small accounting for only 0.01% of the GDP.

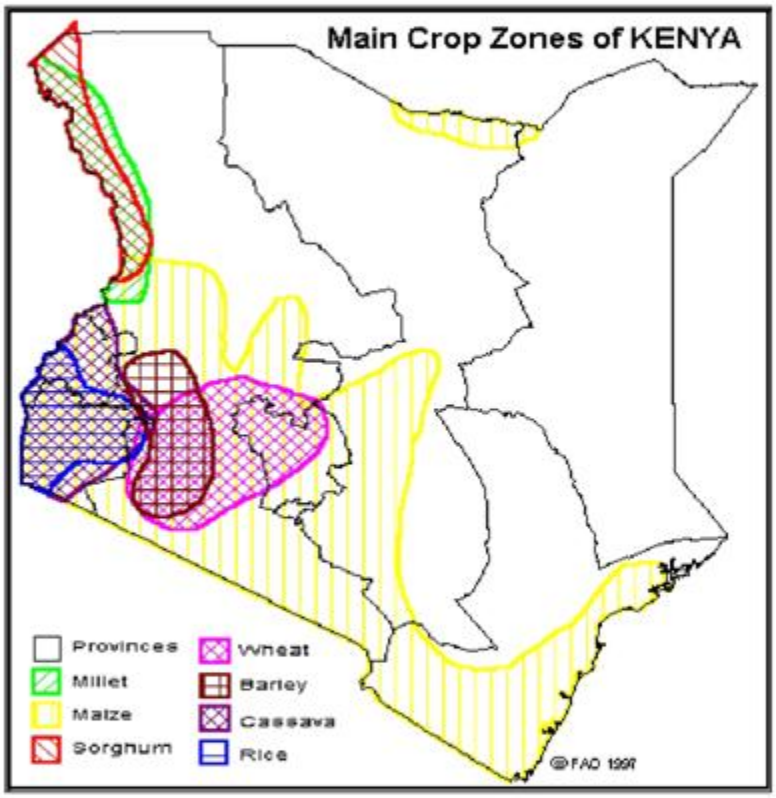
3.0 General maize information - production, imports and exports for last 10 years and projections

3.1 Geographical production regions

According to Kenya Maize Development Programme (KMDP) maize is the primary staple food crop in the Kenyan diet with an annual per capita consumption rate of 98 kilograms contributing about 35% of the daily dietary energy consumption (FAOSTAT).

Therefore maize is grown in many Kenyan agro ecological zones starting from the coast lowlands (1-1250 metres above sea level (masl)) to the high potential highlands (>2100 masl).

Figure 1 shows the main growing areas and Table 1 shows the average production of maize in the eight provinces of Kenya from 2005 – 2009.



Source Grain Report by EPZ (2005+ 2009)

Figure 1: Map of Kenya showing crop growing regions

Table 1: Average maize production from 2005-2009

Provinces	Area Under crop (Ha)	Production (90Kg/bag)	Yield (bags/ha)	Population [a]
Rift Valley	644,895	13,225,039	20.5	10,066,805
Nyanza	262,453	3,711,215	14.1	5,442,711
Eastern	462,401	3,903,141	8.4	5,668,123
Western	225,302	4,163,878	18.5	4,334,282
Coast	129,379	1,079,383	8.3	3,325,307
Central	157,063	1,047,879	6.7	4,383,743
North Eastern	2,525	5,520	2.2	2,310,757
Nairobi	1,053	6,420	14.4	3,138,369

Source: GOK Economic Review of Agriculture 2010 and [a] Kenya Population and Housing Census 2009

3.2 Overview of Kenyan Maize Production

90% of the rural households in Kenya grow maize and production is dominated by small scale farmers who produce 75% of the overall production. The other 25% is grown by large scale farmers.

In recent years there has been an expansion of land used for maize production as evidenced by 1.7 million hectares in 2008 and 1.8 million hectares in 2009. This was actually less than the 2009 Ministry of Agriculture targets which aimed for 2.2 million hectares producing 36 million bags. The available figures showed that 2009 production reached 2.4 million tonnes.

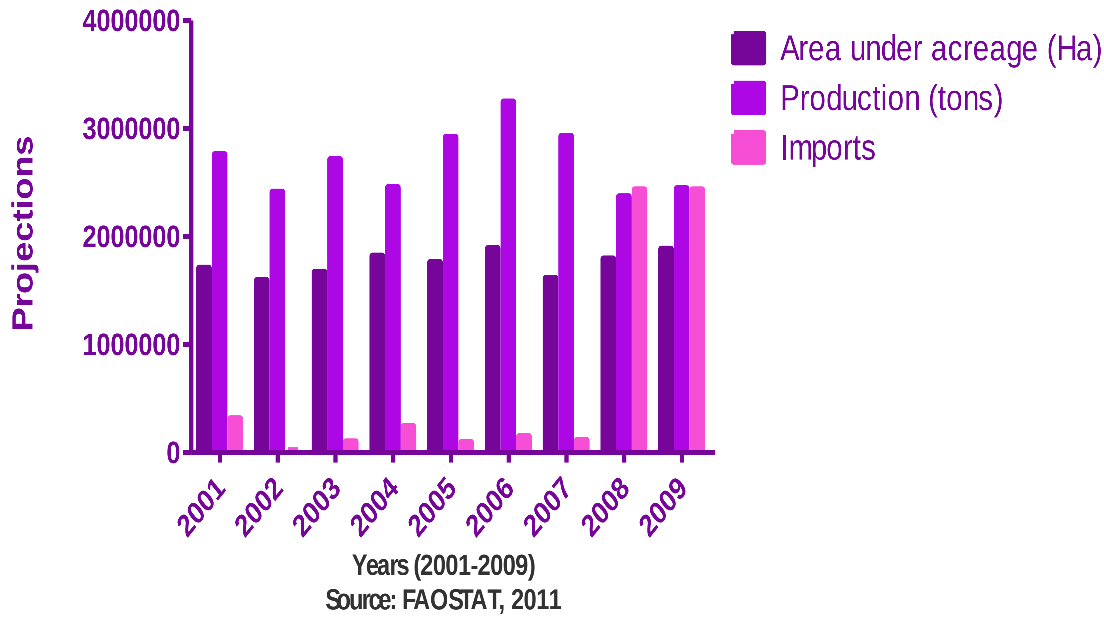


Figure 2: Production and imports of maize in Kenya 2001 – 2009

As shown in Figure 2 Kenyan maize production has been fluctuating (increasing and decreasing) over the last 10 years but there has been an increasing demand due to the high rate of population growth in Kenya (estimated at 2.9% per annum). The national maize production ranges between 24 and 33 million bags per annum which does not keep pace with the domestic consumption levels (e.g. in 2008, the consumption was estimated over 36 million bags).

This maize shortfall is because of the:

i) Increase in urbanization.
ii) High reliance on maize based diets as the staple food (evidenced by the high consumption figures of 98kg/capita/year).
iii) Low per capita production and changing lifestyles.

3.2 Kenyan Maize Importation figures

In the last decade, the country has experienced years of heightened food insecurity, dependence on imports and emergency humanitarian assistance.

The large maize deficit is met through the importation from other countries. The amount of maize that is imported fluctuates depending weather conditions and Figure 2 shows evidence of this with 314,000 Tonnes imported in 2001 and 243,000 T in 2009. However, aside from the weather the maize importations have increased just to keep up with Kenyan consumption patterns, increasing from 2.9% to over 12% in the period 1970 - 1991. Figure 2 clearly shows that maize imports have continually been increasing.

In 2009, Kenya imported 16.8 million bags of maize (GoK, 2011).

3.3 Kenyan Maize Projections

Sadly the national maize supply is expected to further decline due to a combination of crop failure in the predominantly short rains dependent southeastern lowlands coupled with pre- and post harvest losses (20-30%) in Kenya's grain basket (Rift Valley). Food insecurity for farms and urban households outside these major production areas is also high due to the increase in prices of food stuffs and other commodities.

Maize price increases consumers throughout the country. Already prices have nearly doubled, with the price of a 2 kg pack of maize flour going for 60-120 Ksh instead of the previous 50 Ksh. The price of maize in Kenya is among the highest in eastern and southern Africa, and the lowest income quartile of the Kenyan population spends 28% of its income on maize.

With the country's population projected to be 43.1 million by the year 2020, the demand for maize is then likely to be 5 million metric tonnes. This means based on the prevailing maize production rates, that the maize deficit will be around of 1.2 million metric tonnes in 2020. Increased reliance on imports implies that the foreign exchange reserves and resources earmarked for development will be likely diverted for the procurement of food for Kenyans.

The inefficient maize production-marketing system has contributed to economic stagnation and worsening levels of poverty in Kenya. Increased productivity, more efficient markets, and rational government policies could dramatically alter the economic contribution of the maize sub-sector – from being a drag on the economy to becoming a key element in accelerated growth and poverty reduction.

4.0 Maize Food safety and Quality Issues

4.1 General Food Safety and Quality requirements

The availability of safe food improves the health of people and is a basic human right(UNHCR, 2005). Safe food contributes to health and productivity and provides an effective platform for development and poverty alleviation (WHO, 2002).

The FAO (1996) declaration states that " food security exists when all people at all times, have physical and economic access to sufficient, **safe** and nutritious food to meet dietary needs and food preferences for an active and healthy life".

The basic food safety concept is that food will not harm the consumer so long as the intended user guidelines are followed when it is prepared. Conversely, food is potentially harmful whenever it has been exposed to hazardous agents and the intended use guidelines have not been followed (ISO, 2005).

As maize is the staple food of Kenya it is important that any food safety concerns are identified so that appropriate control steps can be taken prevent human health hazards. To date the major health concerns related to maize are:

i) Contamination with pesticide residues used to in maize production and storage.

ii) Fungal toxins that contaminate maize during pre and post harvest periods.

4.2 Pesticides

In 2010 a consignment of maize imported to Kenya was found to contain high levels of Aluminum phosphide, a fumigant used to control fungal growth during shipping. The maize was rejected and reshipped back to the country of origin, but this incident did highlight the need to monitor maize for chemical contaminants to safeguard human health.

The commonest storage pesticides (insecticides) applied as dusting powders are pirimiphosmethyl, an organophosphate (OP) compound mixed with Permethrin (a pyrethroid, common name Actellic). Other dusts powders include malathion (OP), permethrin (pyrethrin), fenitrothion (0p) and fenvalerate (pyrethrin). While these pesticides are used to prolong storage and control pest infestation during storage, no data is available of the residue levels of these pesticides.

The data available that is available on grains shows that the residue levels are highest on the seed testa, therefore residues could be high on whole meals and wholemeal products.

It is possible to use most of the approved agricultural chemicals with little food safety impact, provided good practices are used. However there may need for some investigations to be undertaken to ascertain if these practices are being actively followed in the production chain.

4.3 Mycotoxins

The other major food safety hazard associated with maize is from the mycotoxins that are produced by many species of fungi which contaminate maize during pre and post harvest periods. Currently the primary mycotoxin fungi of concern in the Kenyan maize value chain.

Aflatoxins are toxic metabolites produced by fungal species during their growth under favorable conditions of temperature and moisture. The major aflatoxin producing species are *Aspergillus flavus* and *Aspergillus parasiticus*. The main cereals affected are maize, sorghum, rice and wheat and other crops like groundnuts and cassava. The Aflatoxins produced are classified as B1, B2, G1 and G2. Aflatoxin B1 is the most toxic of the four. While these the toxins do not seem to have physiological functions for the fungus they are now recognized as potential carcinogens, teratogens, mutagens, immune-suppressants and have eostrogenic effects in humans.

Table 2 shows the incidence of aflatoxin poisonings in Kenya during the period 1960-2010.

Table 2: Reported aflatoxin poisoning cases in Kenya (1960-2010)

Year	Those affected	Numbers affected	Locality (Location/District)	Sources of the toxin	Observed complications/ effects	References
1960	Ducklings	16,000	White settler farmer Rift Valley	Aflatoxin contaminated groundnut feed	Death	Peers, & Linsell, 1973
1977	Dogs/poultry	Large numbers	Nairobi, Mombasa/Eldoret	Contaminated products due to poor storage	Death	FAO/WHO/ UNEP, 1977
1981	Humans	12	Machakos	Contaminated maize	Death	Ngindu, *et al.*, 1982

1984/85	Poultry	Large numbers	Poultry farms	Contaminated imported maiize	Death	Ngindu *et al.*, 1982
1988	Human	3	Meru North	contaminated maize	Death and acute effects	Autrup *et al.*, 1987
2001	Humans	3 26	Meru North Maua	Mouldy maize Contaminated maize	Death 16 death	Probst, *et al.*, 2007
2002	Poultry/Dogs	Large numbers	Coast	Contaminated feed	Death	Njapau *et al.*, 2007
2003	Humans	6	Thika	Mouldy maize	Death	Onsongo, 2004
2004	Humans	331	Eastern,Central Makueni Kitui	Aflatoxin contaminated grains	Acute poisoning 125 deaths	Lewis *et al.*, 2005
2005	Humans	75	Machakos ,makueni, kitui	Aflatoxin contaminated maize	Acute poisoning, 75 cases with 32 deaths	Eduardo Azziz-Baumgartner *et al.*, 2005
2006	Humans	20	Makueni, Kitui, Machakos	Contaminated maize	Acute poisoning 10 deaths	Muture & Ogana, 2005
2007	Humans	4	Kibwezi, Makueni	Aflatoxin contaminated maize	2 deaths	Wagacha & Muthomi, 2008
2008	Humans	5	Kibwezi, Kajiado, mutomo	Contaminated maize	3 hospitalized, 2 deaths	Muthomi *et al.*, 2009
2010	Humans		29 districts in Eastern Kenya	Suspected contaminated maize	Price spiraldown and grain trade breakdown unconfirmed dog cases.	Muthomi *et al.*, 2010

Other mycotoxins affecting maize are the fumonisins, though their health effects are less well documented. Preliminary data on the fumonisins suggest that they cause high esophageal cancer rates (Wakhisi et al 2005). Therefore further investigations are required to ascertain if fumonisin rates in maize are an actual public health problem in Kenya.

4.4 Maize grading standards

Since the acute poisoning of the 125 persons in 2004, it has been an on-going challenge to bring the contaminated maize problems in Kenya under control. The Government of Kenya through the Kenya Bureau of Standards and the East African standards harmonization process have established quality standards. This means that there is a mandatory maize grading system for the purpose of trade within the East African community (EAS2:2005) which is also implemented on the Kenyan domestic market by the Kenya Bureau of Standards (known as KS-EAS2:2005) . Table 3 below shows the characteristics that are used to determine the quality and safety for these standards within the East African Community.

Table 3: Grading of Maize in the East African Community

Defects	Maximum limits*	
	Grade1	Grade 2
Foreign matter,% m/m	0.5	1.0
Inorganic matter, % m/m	0.25	0.5
Broken grains, %m/m	2.00	4.00
Pest damaged grains %, m/m	1.00	3.00
Rotten & diseased grains,%m/m	2.00	4.00
Discloured grains, %m/m	0.50	1.00
Moisture, %m/m	13.5	13.5
Immature shrivelled grains, %m/m	1.00	2.00
Filth, % m/m	0.10	0.10
Aflatoxin (ISO 6050)	Total aflatoxin 10ppb, 5ppb B1	Total aflatoxin 10ppb,

		5ppn B1
Total defective grains, %m/m	4.00	5.00

*Source KS-EAS2:2005

A section of both EAS 2:2005 and KS –EAS2:2005 relates to the sampling process. The testing laboratories always indicate the methodology or standards followed in their analytical certificates. Where the testing laboratories were not involved in the sampling they give a disclaimer to show that they cannot guarantee how the physical sampling process was done.

If EAS 2:2005 or KS –EAS2:2005 were adhered to by all this would eliminate the sale of substandard foods that may be harmful to consumers as well as stopping false and fraudulent trade practices. However, unfortunately the above standard specifications are only implemented in the formal maize marketing channels. The bulk of maize is Kenya is sold through "informal channels", where selling occurs from individual to individual or to small traders who do not operate such effective quality control systems.

5.0 Mycotoxin Testing Laboratories

There are a number of private and public testing laboratories with different capacities for testing maize. These laboratories serve a number of clientele who require both national and international requiring aflatoxin testing. There are over 50 KEBS listed laboratories for monitoring various food safety standards (See Annex 2). During the preparation of this report six private (SGs, Polucon, Intertek, Bora Biotek, Unga and Mombasa maize milers) and two public (Kenya Plant health Inspectorate Services (KEPHIS) and National Public health laboratories (NPHL)) were visited. These laboratories carried out routine aflatoxin testing using ELISA and fluorimetric methods.

A number of the laboratories use Gafta methods (No. 130, 24:1) and EAS 79 as the sampling protocols. In other instances the clients do the sampling and bring the samples for analysis. In such circumstances the actual reason for sampling is not known or where and how the samples were taken. For these laboratories the analytical results are confidential, shared only between the clients and the testing laboratory. The laboratories were unwilling to share the reports with others, including government surveillance systems.

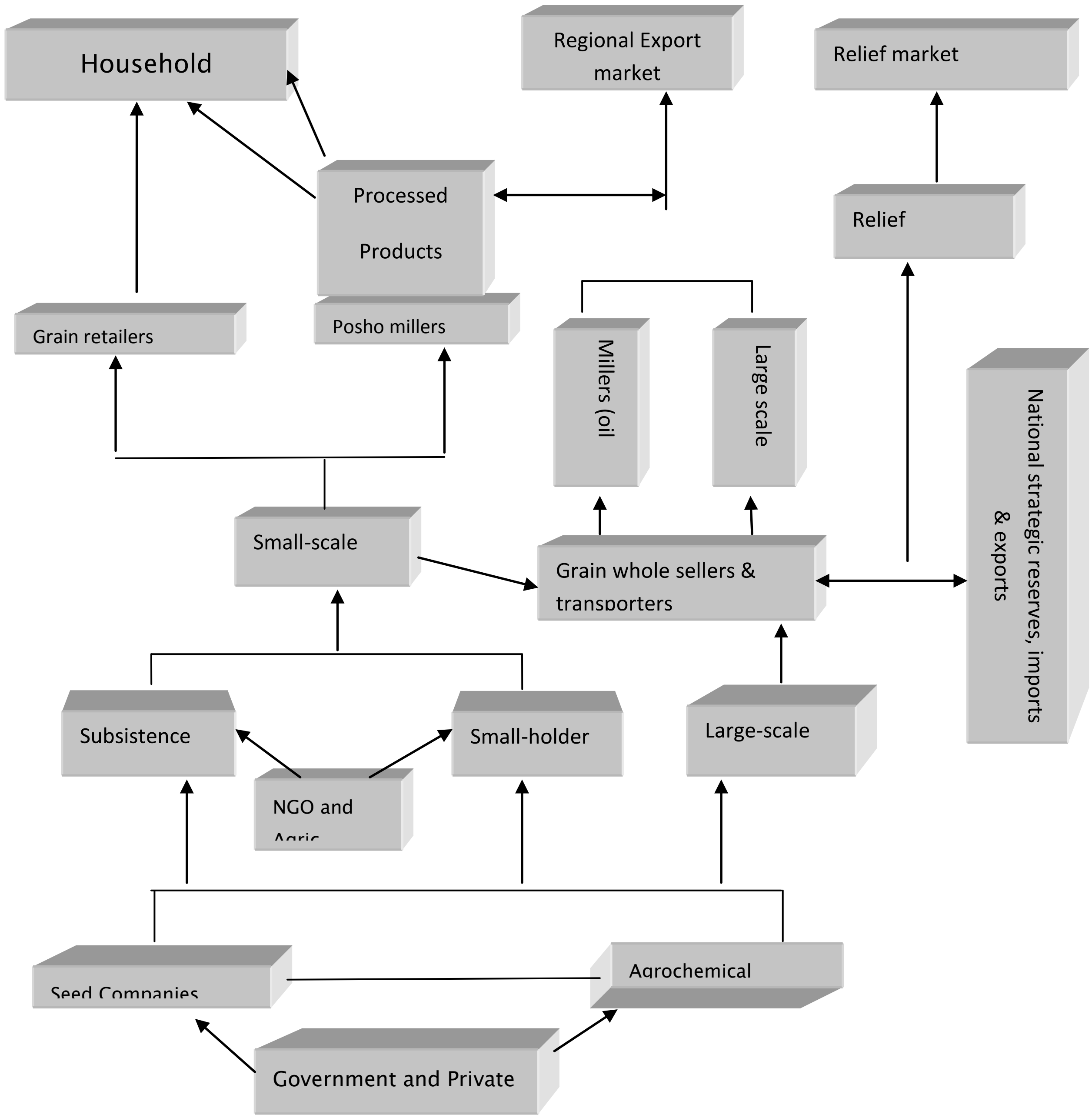
The government testing laboratories visited (KEPHIS and National Public Health labs) also carried out testing for aflatoxin contamination. The sample for analysis were either brought by the clients or they did the sampling themselves. In 2010, one of the laboratories tested 130 maize samples out of which only 47 samples had aflatoxin levels less than 10ppb. The highest level of aflatoxin recorded in that year was 830 ppb. The volumes of maize involved in these testing are not known. The information from the government laboratories indicates that they share data between the KEBS, KEPHIS, NPHL and Ministry of Health and Sanitation.

These findings highlight that the lack of an overarching agency to coordinate data collection (sampling information and analytical results) means that although data is available it does not help the policy makers in using science based evidence for their decision making.

6.0 Maize Value Chain and Main Stakeholder's Overview

6.1 Structure of the value chain

The Kenyan maize sector has many actors in the value chain, including farmers, input suppliers (seed companies, fertilizer and pesticide suppliers), traders, millers, retailers and consumers (Figure 3).



6.2 Seeds and Seed developing companies

6.2.1 General information

Seeds planted in Kenya vary from local landraces to composites and hybrids. Local landraces are poor yielding but have the greater advantage of being suited to the local conditions. They are disease and pest resistant in addition to being more palatable to local tastes. It is also possible that these varieties might be more resistant to fungal attack than the improved composites and hybrids. Composite varieties are certainly better yielding than local landraces, for example, the Katumani composite from KARI which is well suited to the dryland zone. There are now many types of hybrids and it is now easy find types suitable for all agro-ecological zones (See Table 4).

Table 4: Some of the seed varieties adopted by farmers in different ecological zones

Seed Company	Agroecological zones and recommended Seed Varieties			
	Highland Altitude (1500 -2100M 800-1500mm of rainfall)	Medium Altitude (1000 -1700M and 700-1000mm of rainfall)	Lowland altitude (0-1250M and above 400mm of rainfall)	Dryland (1000-1500M and 250-500mm of rainfall)
Kenya Seed	H6213, H6212, H6210, H9410, H629, H628, H627, H626 and H614	H624, H623, H516, H515, H513 and H 511	DH4, DH1, DH01, DH02, DH03 and DH04	Katumani composite and DLC1
Pannar/Pioneer	PAN691 PAN 683 PAM 4M-19	PAN 67, PAN 77 and PAN 63		
Western Seed	WH699, WH 605, WH602, WH 904	WH508, H505, WH504, WH502. Wh403	WH105, WH002, WS909, WS202 WS104, WS 103	Katumani
Monsanto	DK 8071; DK 8031, C5051	DKC 80-53, DKC 80-73, DKC 80-33,		

6.2.2 Historical seed information

A number of seed companies are operating in Kenya and have developed and released seed varieties that favor various regions as shown in Table 4. Between 1964 and 2009 about 164 varieties were released for production by different organizations. See Table 5.

Table 5: Total Seed varieties released by Seed companies (1961-2009)

SEED COMPANIES	TOTAL SEED VARIETIES
1. KARI/Kenya Seed Company	12
2. Kenya Seed Company (KSC)	38
3. Pannar Seed Company	16
4. Pioneer Hybrid	5
5. KARI	40
6. Monsanto	7
7. OCD (Fiada Seeds)	1
8. Lagrotech Seed Company	2
9. Western Seed Company	29
10. Agris Seed Co Limited	3
11. FICA Seed	1

It is recognized that the seed companies' research accomplishments helped to stem a serious outbreaks of MSV since 1964. Remarkable success has also achieved with the development of *Striga*-resistant varieties that suppress the weeds, and other pest-resistant varieties that were released into endemic areas of Kenya. Early, intermediate, and late maturing varieties have been developed with yields up to twice as much as traditional varieties. Early maturing varieties enabled maize production to expand into new areas where the short rainy season had adversely affected maize cultivation in the past. These scientific breeding efforts by the seed companies have certainly helped realize increased maize production.

6.2.3 Current situation with seed companies

There are still a number of seed companies operating in Kenya. For the preparation of this report three companies were visited: Kenya Seed Company a government parastatal and two other international companies (Monsanto, Pannar/Pioneer). The discussions with these companies were to find out what role the seed companies might play in mitigating aflatoxins. In particular discussions were focused on the characteristics the companies use to select seed varieties for release to farmers and how this could impact on aflatoxin control.

Currently the major breeding criterion is maize productivity per hectare. This must be above 5% of the benchmark seed for the new variety seed to be released. Other equally important attributes are pest and disease resistance, drought and low nitrogen tolerance. In addition, other qualities that are considered by all the by seed developing companies are:

1) Fast dry out after physiological maturity.
2) Stay green to enable the stovers to be used as animal feed after the cobs have dried.
3) Multi-cobbing.
4) Husk cover to reduce cob rot.
5) Flintiness (hardness) to increase poundability of the grain.
6) Standability of the plant after drying to enable the farmers (especially large scale) to use combined harvesting.

The characteristics that are important in mitigating aflatoxin susceptibility are pest, disease and drought tolerant, husk cover and flintiness of the grains. These are attributes that the seed developing and bulking companies ought to consider. One drawback in breeding is that these qualities may not be positively related to high productivity per hectare which is currently the single most important criterion for release.

6.2.4 Government policy on maize seed

The government has no policy on maize despite its importance in the Kenyan diet. The seed companies are driven by a business approach that appeals to their clientele; increase in the number of bags harvested per hectare. This has been pushed by efforts of various government policy papers (ERS) that considers having food security as important in development of Kenya. In this regard, the seed companies have concentrated their efforts on high yielding varieties which meet a partial goal of food security – quantity but have compromised on the safety.

However, considering that aflatoxin outbreaks have occurred in the country since 1960 with the highest epidemic levels in 2004, the priority should now be for the development of seed varieties that are less susceptible to fungal attack and aflatoxin accumulation, especially for the Eastern aflatoxin susceptible belt.

It is very likely farmers will be willing to pay for new strains that are resistant to aflatoxin contamination, given the success the seed companies had with selling seed varieties resistant to maize streak virus and *Striga.*

6.3 Farmers

6.3.1 Methodology used to collect information from Farmers

To gather information for this report two farmer groups were visited and focus group discussions held on why they were formed and to ascertain their knowledge and practices on mitigating the aflatoxin menace in maize. The discussions were not structured with a check list to allow coding of responses as it would be if a proper focus group discussion was planned. Instead the interviewer engaged them in discussions to determine their agronomical practices and knowledge on aflatoxins. The groups were represented by their committee members.

The farmer groups visited were Growel Farmers Group in Kiplombe and Kipchamu in Eldoret. Kiplombe group consisted of 40 members who had leased 135 Ha of land and were planting maize as a group on 9 Ha and the rest of land allocated to members to grow maize on individual basis. Kipchamu on the other hand was a community based organization bringing together 14 groups engaged in different activities but members are growing maize on individual basis. Both groups were formed in order to utilize their group strengths in mobilizing maize stocks in order to get an advantage in market price bargaining as they marketed their produce. As group, they are also able to access credit facility in procurement of seeds and other inputs.

6.3.2 Agronomical practices

The two groups interviewed for this report sought advice from government extension officers and other non-governmental organizations in the region (EAGC) on agronomical practices. They procured their seeds and agrochemicals from reputable seed and agrochemical companies who also offered extension services. The groups used agrochemicals to control weeds as hand weeding is not practical on large acreage where maize is growing.

Use of these agrochemicals helped the maize plant grow healthy and therefore resistant to fungal infestation at the pre-harvest period. It is known that plants can be stressed due to weed infestation and adverse weather conditions and that this stress predisposes the plants to fungal infestation.

There is a need though to undertake further scientific projects to investigate how other agronomic practices, for example those related to drought management, can increase or decrease fungal contamination.

6.3.3 Farmers' harvesting practices

During harvesting the farmers cut the maize and make stakes in the field Figure 4 (a) below. The maize was left to dry and the cobs removed later. During this period, the maize cobs are thrown on the ground (Figure 4b) as they remove the cobs from the husks and later picked up for storage before shelling. This practice exposes the maize cobs to fungal spores in the soil and this increases the risk of aflatoxin contamination in later steps in the maize of processing.

Figure 4: Drying maize on stakes in the field (4a) and removing the cobs and placing them on the ground (4b)

Timing of the harvesting for when the maize is mature and dry is critical in helping reduce the moisture levels and therefore the fungal growth and aflatoxin production rates, yet it was identified that the farmers interviewed did not have any idea on when it is best to harvest.

6.3.4. Farmer's drying practices

Maize drying is another critical step in reducing the moisture content, thus preventing fungal growth, aflatoxin production and consequent contamination.

The farmers maintained that maize is dried in the field before cobs are removed. It is further dried while in store before shelling with the use of tractor propelled shelling machines. If the shelling machine is not calibrated for the maize varieties and type (flint or dent maize), it may result in-broken grains that increase the chances of fungal mycelia penetrating the maize grains and grow and producing the aflatoxin. The calibration of these machines is critical if farmers want to further mitigate fungal infestation and aflatoxin contamination.

Maize is further dried before it is bagged for sale especially to markets which have grading systems to check the moisture content. In these circumstances, maize is dried on the ground on canvas thus preventing contact with the soil. In many instances, such maize is dried along the road sides or in open fields where soil is easily brown onto the drying maize on canvas. See Figure 5 and note the passing vehicles and pedestrians. Dust laden with fungal spores from passing vehicles can easily be deposited on the maize drying canvas.

Figure 5: Maize drying on canvas in Moi's bridge Uasin Gishu (5a) and Kibwezi (5b).

6.3.5 Farmers sorting practices

During the interviews, the farmers indicated that they rarely sort and select maize after shelling. Sorting and selection is done in the field when cobs are being removed from the maize stakes. This selection is not adequate as many cobs rotten to various levels may be passed depending on the judgment of those harvesting. The clean maize is usually found to contain rotten and mouldy grains which are not sorted and selected later. The assumption is that the level of rotten grains allowable by the grading system will not be exceeded. The criterion (See Table 3) of 2 and 4% rotten grains for Grades one and two maize respectively should be made stricter to make sure that no rotten maize is allowed at this point, thus reducing the risk of fungal growth and aflatoxin contamination of maize during further storage.

The very rotten cobs are separated from the good cobs and later shelled separately and the grain used for making animal feeds. The practice is to mix one bag of clean maize with two bags of rotten maize, mill and use these as animal feeds. This practice of dilution does not reduce drastically the amount of aflatoxin in animal feeds. It is important to note that milk from areas surrounding the maize growing areas (Eldoret Municipality) was found to contain Aflatoxin M1 and feeds having high levels of total aflatoxin exceeding the allowable limits by FA0/WHO (Kang'ethe and Langat 2010).

6.3.6 Comment on Post Harvest Handling

In the 2004-2006 outbreak, poor post harvest handling especially storage at household level was blamed for the outbreak. While this may have been the case, no tangible progress has been achieved in improving storage facilities at household level. Farmers have constructed cribs (Figure 8) and whether these have had impact in reducing aflatoxin accumulation in maize at household level has yet to be evaluated. The Aflacontrol project samples maize pre harvest and follows the maize during three months of storage at farmer's stores. Provisional results from Aflacontrol project (ACDI/VOCA, 2009) indicate that aflatoxin positive samples with more than 10 ppb increased during the three months of storage (Mahuku, 2011). This is an indication that storage practices are still inadequate at the household level.

Figure 6: Farmers crib for storing maize in Kaunguni, Makindu, Eastern Province

With maize drying being a critical step in the control of aflatoxin, adequate strategies should be developed to ensure that maize is properly dried during storage. With the current vagaries of weather the government should either establish mobile maize drying units or construct driers in specific areas where farmers can access these to have their maize dried at a fee.

6.3.7 Farmer's knowledge of Aflatoxins

Farmers, especially in the Kipcham group did not know what caused aflatoxin, the health effects in humans and livestock and how to mitigate these. This clearly points to the need for greater awareness in the maize growing areas in order to ensure the production, storage and marketing of aflatoxin clean maize.

It is the current government policy that the supply of extension services be demand driven, requiring that farmers must request the services they want from the government officers. This is as a result of very few extension officers manning the divisions. The farmers in the Eldoret area interviewed in this report may have not asked the extension channels to educate them on aflatoxin control strategies. This explains their apparent ignorance. They also are far removed from the aflatoxin prone belt of the eastern region and therefore the devastating effects of acute aflatoxin poisoning experienced in the eastern are also not well appreciated by them.

In summary, although the knowledge of the effects of aflatoxin exists with the extensionist channels (public and private), the current human resource capacity is not adequate to effectively educate all the farmers on this issue.

6.4 Maize traders and bulk handlers

There are small and large scale maize traders in the value chain.

The small traders buy maize directly from smallholder farmers and assemble in bulk to deliver to small market retail traders, large trading companies or maize millers. The small traders may not have a very good understanding on the implications of aflatoxin testing because of the volumes they handle and the clients may not require the assurance that the maize meets the standards on aflatoxin.

The large trading companies sell to National Cereals and Produce Board (NCPB), national or international relief organizations or millers. Export Trading Company Limited, a medium maize trader situated in Eldoret was visited to gather data related to maize traders and bulk handlers. The company carries out manual quality grading checks on any deliveries. After bagging, the stacked bagged maize is fumigated using Aluminium Phosphide every three months.

In order to access the NCPB and the large maize millers' markets the maize trading companies clean, bag, fumigate, grade, test for moisture content and aflatoxin and store the grain until appropriate market conditions are reached for sale

Because traders store maize for long periods before release, quality and safety parameters are essential for a product that meets aflatoxin standards at the time of sale. Some clients who buy from bulk handlers send specialized laboratories to sample the maize in the store, analyze and give a report as to whether it meets the client's specifications. The bulk handlers may not know the reasoning behind the sampling protocols for aflatoxin but they comply with the testing laboratories demands. Laboratories doing these analyses are conversant with the sampling protocol for aflatoxins. They consistently quote the standard they use which specifies the sampling method and results interpretation.

6.5 Maize millers

The Government has identified 8 millers with substantial milling capacities to mill on contract in Nairobi and Thika because there are insufficient maize quantities at other NCPB depots in the country. The millers are Unga Ltd, Uzuri Foods Ltd, Mombasa Maize Millers (Nrb), Pembe Flour Mills, Kabansora Millers, Nairobi Flour Mills, Chania Flour Mills and Capwell Industries. The millers are paid Kshs 1750 per 90kg bag for contract milling. Cost of milling 58,631 bags for the Government would be approximately 11.8 million shillings.

Two maize millers (Unga Ltd and Mombasa Maize millers) were visited. Both companies deal with maize processing for human consumption and animal feeds. The two companies have laboratories that sample and determine the quality of the raw materials before processing and also monitor the quality of products during processing. They also refer their samples to private laboratories for second opinions. Quality of the final product is important because at this step the milled maize is ready for local or regional market. Poor quality and hazardous foods are a liability for the company. These companies said that they rarely have contaminated maize for processing for human food because they have a network of field officers and traders who source maize for them and they understand the quality concerns of the companies. If a consignment does not meet the standards, it is mainly mixed with clean maize and used for animal feed manufacture.

6.6 Processing and Consumption

6.6.1 Traditional Processing

Traditionally, maize is processed by dehulling or pounding using either a stone quern or mortar and pestle. The aim is to remove the outer covering to soften the maize for cooking. Drying milling was also traditionally carried out using water mills. The processed maize is used to make a variety of traditional products such as ugali (thick slurry) and porridge (thin slurries) which is the main staple for most households in Kenya. Traditional processing methods such as dehulling, soaking and cooking maize have been reported to reduce the levels of aflatoxins by 46.6%, 28-72% and 80-93% in maize containing 10.7-270 ng/g of aflatoxin levels in Kenya (Mutungi et al., 2008). The findings of this study indicate that exposure to acute aflatoxin levels is minimized during food processing and preparation. Generally, these processing techniques have been traditionally used for increasing the palatability of different food recipes but can also be promoted as strategies capable of reducing aflatoxin contamination of grains.

6.6.2 Posho milling

The most common type of maize flour processing for human consumption is carried out by small-scale posho millers to produce whole grain maize meal. Posho milling is practiced both in the urban and rural centers and accounts for 60% of the maize meal processing in Kenya. The majority of the posho millers use a simple hammer mill for processing the maize into flour, after cleaning and dusting of the maize. The posho millers depend on the maize brought to mills by the farmers themselves, and therefore require low capital input. This type of milling is considered inefficient and underutilized. However, a number of posho millers are investing in new and modern equipment and technologies to enhance their extraction rates and efficiency of the system. Adoption of improved maize milling technologies by these posho millers would result better marketing opportunities for their products through branding. This would also result in greater chances for maize value addition, fortification of flour and packaging to capture the niche markets. Currently, there has been an increasing number of small- and medium-scale milling enterprises that are involved in maize value addition through blending and fortification in the flour milling process using different cereals and legumes. The millers are blending the maize flour with flours from other cereals (sorghum, millet, rice etc) and legume/pulses (beans, peas etc) to obtain more nutritious products. There has been an increased market demand for such products with the rising awareness of the health promoting properties of the composite flours by consumers.

6.6.3 Wet and dry milling

The main commercial processing of maize in Kenya involves wet and dry milling to produce maize flour, starch, syrups, oil, animal feeds and other by-products. In wet milling maize is softened by soaking in water for 40 hours. The soft grain is milled to break the kernel and release the oil bearing germ and bran. The germ is dried and processed into oil while bran is usually separated and used for animal feeds. The bran is also used in making gluten and starch. The Corn Products Limited situated in Eldoret is the main industry involved in the wet milling of maize. In dry milling, the cleaned maize is soaked in water for 3 hours for conditioning, the germ is separated from the maize and the germ free portion is then ground and sifted to make different types of maize flours. Most of the large-scale millers are involved in the dry milling process.

6.6.4 Preparation and consumption

The most common staples in Kenya are mostly maize-based and are prepared using whole maize meal or whole grain. The whole grain is usually mixed with legumes or pulses (beans, pigeon peas, cowpeas, etc) and vegetables to make 'githeri' and 'irio' in most rural communities. The maize meal and flour are used to prepare 'ugali' or porridges either as a single cereal or combined with other cereals or legumes/pulses. The maize flour is also used to prepare a variety of traditional products using simple processing technologies such as fermentation, drying, roasting, malting and cooking. These foods and products from maize are usually consumed either as daily staple meals or culturally used during festivities. Research has shown that certain traditional household processing and preparation methods such as dehulling, soaking in magadi soda, fermentation, malting, cooking in magadi soda and roasting can significantly reduce the levels of aflatoxins in maize (Fandohan *et al.*, 2005; Mutugi *et al.*, 2008).

6.7 Maize marketing

6.7.1 Maize marketing agents

There are over six categories of marketing agents in the maize marketing chain. These are assemblers, wholesalers, retailers, and dis–assemblers, posho millers and large-scale millers (See Figure 7). In addition, a smaller category of traders using bicycles purchase and bulk maize at the farm level and deliver to the assemblers, retailers, or posho millers.

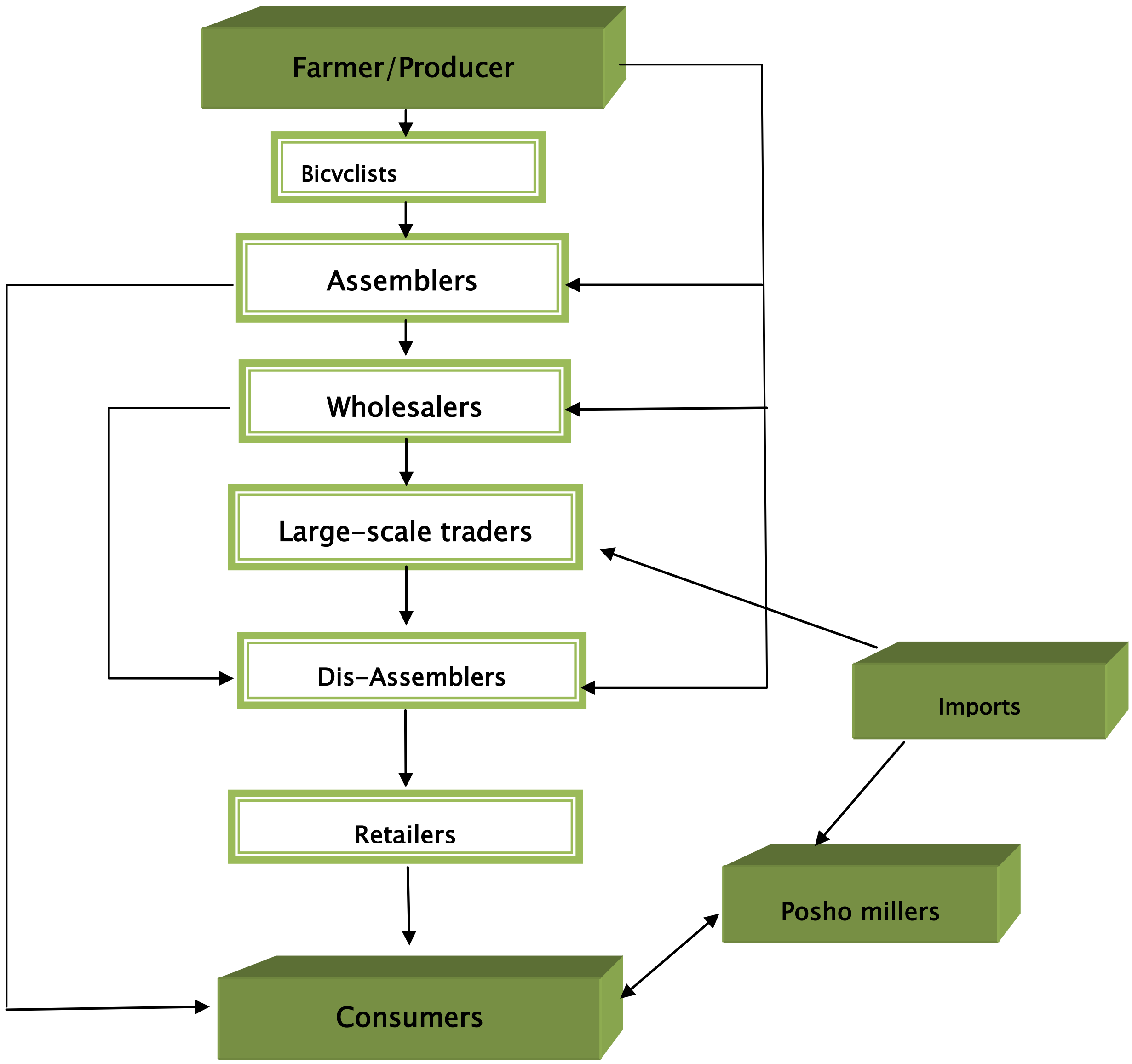


Figure 7: Simplified maize marketing chain

6.7.1.2 Assemblers

Assemblers are usually the first commercial purchasers of maize in the marketing chain. They usually begin as farmers who graduate to the next stage in the system, i.e. bulking up surpluses of neighboring farmers to capture scale economies in transport to local market. Those that are farmers raise their working capital from the sale of their own maize immediately after the harvest.

6.7.1.3 Wholesalers

These are traders who buy maize from surplus districts (usually from assemblers) and transport the grain to deficit areas where they sell to dis-assemblers, retailers or millers. Most wholesalers are also vertically integrated into assembly, as most of the volumes they purchase in the post-harvest months are direct from farmers.

6.7.1.4 Dis-assemblers

This is a category of maize traders who buy maize mainly from large wholesalers in the deficit areas, and break-down the volumes for resale to smaller-scale retailers and final consumers. Dis-assemblers are usually local traders who raise their initial capital from either salaried employment or from their involvement in other business activities.

6.7.1.5 Retailers

This category of market agents consist of those traders who buy and sell in small quantities and were directly selling to consumer for home consumption. Retailers are found in the deficit regions with a few of them in the urban areas. The retailers in the surplus regions are over shadowed in business by the assemblers who take to disassembling and retailing activities during the slack periods.

6.7.1.6 Posho millers

The posho millers are a category of traders involved in the processing of maize grain into maize meal. Posho millers employ a simple hammer milling technology where the germ and the bran of the maize grain are milled together with the kernel into flour. Small-scale millers are specialized in custom milling whereby the customer provides the grain. Some posho millers have invested in dehullers to produce a more refined product.

6.7.1.7 Large Scale Millers

These are processors who deal with large volumes of maize and do their own packaging. These millers are characterized by large-scale, capital intensive, roller-milling technology. Most of the large-scale millers are concentrated in maize deficit areas with a few of them in the surplus regions of Kitale, Eldoret and Nakuru. Most millers acquire maize from wholesalers, farmers, and the NCPB stores depending on the season. In order to cope with the inter-seasonal variations of maize availability or supplies millers hire storage facilities, including silos in the maize surplus areas where maize is stored.

6.7.2 Warehousing receipt system

This is a marketing mechanism used to address seasonality, supply and quality constituency of grains. This is being championed by Eastern African Grain Council (EAGC). Under this system, suitable warehouses will be graded and certified by the EAGC who will be able to receive grains, handle and store grains at fee and issue a warehouse receipt. This system emphasis safety as grains will be graded and tested before acceptance into and out of the warehouses. This system also offers good grain storage facilities. This warehouse receipting system is being introduced in Kenya with support from Financial Sector Deepening Trust (FSD), USAID-COMPETE, Kenya Maize Development Programme (KMDP) and Alliance for Green Revolution in Africa (AGRA).

While the warehousing receipt system is being carried out it is not yet very popular as many smallholder farmers are not aware of its value. It would be one of the best mechanisms available to maize producers. This may be achieved if maize producers formed farmer groups in order to attain the bulk size (minimum of 10 metric tonnes) required touse the warehousing receipt system. If they adopted this approach, they would be able to have a better bargaining power when selling their produce. They would also be able to sell their produce when the market prizes are good in order to make maximum profits. At the moment very few small scale farmers are able to use this facility.

6.7.3 Price Setting Mechanisms

The maize price trend for the year 2010 in major towns of Kenya is shown in Figure 8.

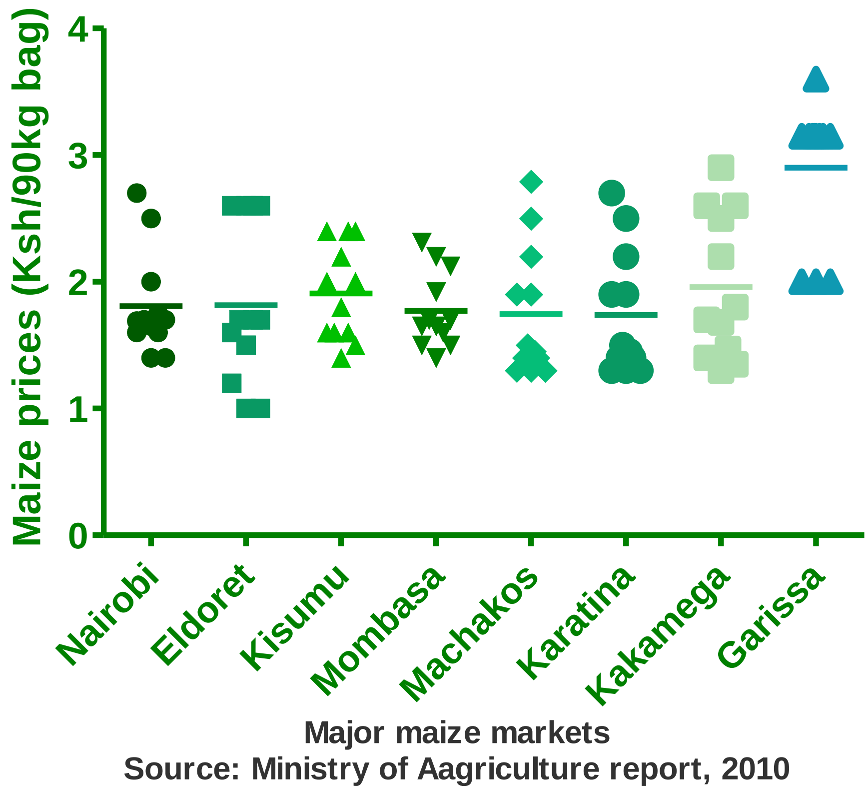


Figure 8: Maize prices trends in major markets in 2011 (Kshs/90kg bag)

The domestic maize prices in the major markets of Nairobi, Mombasa, Nakuru, Eldoret and Kisumu have been on an upward trend since 2002, with sharp increases from 2008. However, between January and August 2009, prices in other markets were increasing while those in Mombasa and Kisumu were generally declining, a situation that may be attributed to a price moderating effect of imports from Uganda and Tanzania.

A comparison of local and import prices in Nairobi over the 2000-2010 period indicates that imported maize was more expensive than domestically produced maize up to February/March 2009, the only time when there would have been an incentive to import maize. Indeed, the waiver granted in January 2009 has restrained the increase in grain prices, with the gap between local and parity prices reducing. The proportion of imports in the stocks held by traders has increased in most markets, being about 80% in Nakuru.

Maize grain and flour prices have shown similar trends between 2000 and 2010. However, beginning late 2008, grain prices have been declining while flour prices have been increasing. This may be attributed to other factors besides grain price, such as poor road and rail infrastructure, high energy costs, and uncertainties in the grain markets in terms of policy. However, retail maize meal prices and marketing margins between maize grain and maize meal have fallen as the year has progressed. This decline may be due to increasingly greater access of imported maize to informal maize trading and processing systems, which are less costly than the industrial milling sector and which compete effectively against it for low and middle income consumers. This is important given that posho mills account for 40% of maize milled in rural areas.

As long as grain is circulating in informal markets, consumers can buy and mill it at neighboring posho mills, ensuring that the less expensive products are available to most low-income consumers.

There is need for strategies that will adequately deal with the evolving food security situation. In the short term, the government needs to expand relief efforts, maintain duty waiver on maize and introduce waivers on wheat and rice, ensure access of imported maize to informal traders and posho millers, and to ensure clearly-defined and transparent rules for triggering government intervention to reduce market uncertainty. Further, there is need to raise awareness and sensitization on diversifying food consumption and to establish regular periodic government-private sector consultations to coordinate decision making on stocks and imports. Ultimately, there is need to emphasize strategies that reduce cost of producing and distributing maize locally such as the improvement of roads and railway infrastructure.

6.7.4 Institutions that affect chain and price setting mechanisms

A historical perspective of maize marketing in Kenya is important in understanding the price setting mechanisms. Maize marketing in Kenya for many years had been under the Maize Produce and Marketing Board and later under the NCPB which was formed to cater for all the product marketing boards. Before liberalization of the sector in 1993, NCPB set the price of maize in the country. Despite the liberalization, NCPB still plays a major role in price setting as it buys maize on behalf of the government for country's strategic grain reserves. NCPB is the single major buyer of maize with a capacity of over 4 million (90kg /bag) bags. The price that NCPB sets scales down to other marketing channels. This price is also influenced by imports from neighboring countries.

A farmer sells maize to a **consumer directly**. The price setting here is dictated by the reason why the farmer wants to sell the maize. If it is for an urgent cause (pay hospital bills, school fees etc) the farmer may be forced to accept what the consumer is offering though low, because other channels may not offer cash at the time of need. For instance, most of the large maize traders pay by cheque and the processing may take few days. Therefore, the farmer may not opt for this client because he needs to obtain the required liquid cash immediately. A producer also sells maize to a **middleman** who assembles small quantities from different producers and sells in bulk to millers or NCPB after sorting and grading. The middlemen capitalize on their market intelligence to pay a lower prize to farmers in order to make profits.

Farmers form **cooperatives or farmer groups** where they consolidate their produce together and achieve the bulk required to sell directly to millers, NCPB or large scale traders at better bargained prizes thus challenging the position of the middlemen (two farmer groups visited fall in this category). This mode also helps to spread the costs of marketing allowing the producer to get a better pay for the produce. Another mode available to the producer, but not very popular, is producing **under contract** for a certain client. This is more for seed companies who need seed bulking and contract specific farmers for this.

There is need for strategies that reduce the cost of producing and distributing maize locally such as subsidizing farm inputs (seeds and fertilizers), improvement in roads and railway infrastructure. These incentives would indirectly ensure that farmers' produce have market access and compete fairly with imported maize. This will encourage the farmers to adopt strategies that ensure their produce meets the safety standards of aflatoxin. If there were price differentials based on quality and safety this would reduce the scourge of aflatoxin maize contamination.

7.0: Food Safety Institutional Framework

Annex four summarizes the mandates and roles of the various ministries involved in the maize value chain.

7.1 Institutions

7.1.1 Ministry of Agriculture

The Ministry of Agriculture (MoA) has the overarching responsibility for maize production, quality and marketing. This stems from its mandate entrenched in the various Acts of Parliament (Agriculture Act Cap 318; Plant Protection Act Cap 324; Seed and Variety Act Cap

326; National Cereals and Produce Board Act Cap 338) that give it the authority to implement the policies and disseminate information on maize growing, storage and marketing. MoA also oversees the Kenya Agricultural Research Institute (KARI) that is empowered to carry out relevant agriculture research in the country of which maize production, quality and marketing is under their mandate. It also oversees the Kenya Plant Health Inspectorate Services mandated to regulate the control of plant diseases and pests, and also inspect and certify seeds for release to the farmers under the Seed and Plant Variety Act. The Ministry also oversees the functioning of Kenya seed Company (KSC) mandated to develop appropriate seed varieties in Kenya.

7.1.2 Ministry of Public Health and Sanitation

This Ministry is mandated to maintain and secure health through implementation of the Public Health Act Cap 242. Its role in the maize value chain is that of seizure and confiscation of any food items that are deemed unfit for human consumption. This is also exemplified under drug and chemical and substance Act Cap 254 and it is under this cap that any crop with chemical residues, the Directors of medical Services and Agriculture could authorize for analysis and possible confiscation and replacement.

7.1.3 Ministry of Commerce, Industry and Trade

This Ministry is mainly mandated to provide food standards under the Standards act Cap 496 which establishes Kenya Bureau of Standards as a statutory agency of the government. In regard to maize, the ministry regulates labeling and weights for the final products of maize under the Weights and Measure Act Cap 513 and Trade Description Act Cap 505.

7.2 National Acts and Regulations governing maize

The maize subsector is governed by a number of acts of parliament and the Ministry of Agriculture has over-arching authority on the implementation of these laws.

7.2.1 The Agriculture Act (Cap 318) empowers the Minister to declare the maize as a scheduled crop (of which it is one of the scheduled crops), to establish crop marketing boards (Maize marketing and produce board was amalgamated to form the National Cereals and Produce board in 1967), set the prices of scheduled crops for efficient agricultural production and control the importation of maize into the country through subsidiary registration. This affects maize growing because it’s an important crop for national food security and also controls marketing and price setting mechanisms for maize and maize products. It also has an impact on the control of maize importations into the country.

7.2.3 Crop Production and livestock act (Cap 321) was established to make provision, control and improve crop production and livestock, and the marketing and processing of thereof. It empowers the Minister to improve the conditions of crops through the methods of production, prevention and destruction. He also has authority to declare the destruction of the crop without any compensation. He can make special subsidiary registration for any crop. This is important for food security since the minister may declare certain individuals to plant maize specifically for the government to national grain strategic reserves.

7.2.4 Plant Protection Act (Cap 324) makes better provision for the prevention of the introduction and spread of disease destructive to plants. The Minister can make rules to prevent and control attack or spread of pests or diseases, in particular and without prejudice to the generality of the foregoing power. This is important for control of pest and diseases that affect maize production, therefore proper strategies can be implemented to curb specific diseases or pest affecting maize.

7.2.5 Seed and Plant Varieties Act (Cap 326) confer power to regulate transactions in seeds including provisions for testing and certification of seeds, empower the imposition of restriction on introduction of new varieties, control of importation of seeds, among other roles. This act is important because it empowers the Minister to regulate the type of seed varieties suitable for specific regions to be developed and released for adoption by the maize farmers. In this regard need to develop maize seed varieties that are tolerant to fungal infection and aflatoxin accumulation could be affected through this act.

7.2.6 Food, Drugs and Chemical Substance Act (Cap 254) is under the authority of Ministry of Health and it makes provision for prevention of adulteration of food and drugs and chemical substances. It allows for establishment of food standards to prevent deception of consumers and also empowers the Minister to establish a board to enforce regulations under this act. Under special registration it also enforces food hygiene. This act has empowered two authorized officers, the Director of Medical Services and Director of Agriculture to have articles analyzed in relation to any matter appearing to him that affect the general interest of consumers and affects the general interest of agriculture in Kenya. This act enforces appropriate standard in regard to sale of high quality and safe maize to consumers. In addition, it important in controlling chemical residues in maize of which aflatoxin is a major concern in Kenya.

7.2.7 Public Health Act (Cap 242) makes provision for securing and maintaining health. It empowers the Public Health officer to prohibit importation of any article of food which is not clean, wholesome or sound and free from any disease or infection or contamination and the seizure and disposal by destruction or otherwise of any other such articles imported. It also empowers him to inspect and examine and supervise the preparation, storage, keeping and transmission of article of food intended for sale or export and contains an ingredient which is diseased or unsound or unfit for human consumption or which has been exposed to any infection or contamination. This act allows for seizure and compensation of contaminated foods. It is under these powers the Ministry of Health proposed for seizure and replacement of aflatoxin contaminated maize.

7.2.8 Trade Description Act (Cap 505) prohibits mis-descriptions of goods, services, accommodation and facilities provided in the course of trade to prohibit falls or misleading indications as to the price of goods and to confer powers to require information, instructions relating to goods to be marked on or to accompany the good or to be included in advertisement and for purposes incidental to and connected with the above. This act is under the Ministry of Commerce.

7.2.9 Weights and Measures Act (Cap 513) consolidates the law relating to the use, manufacture and sale of weights and measures and to provide for introduction of international systems of use and for connected purposes. These two Acts would apply to sifted maize from millers in regard to their correct weights and labeling for efficient marketing.

7.2.10 National Cereals and Produce Board Act (Cap 338) regulates and control the marketing and processing of maize, wheat and scheduled agricultural produce and to establish a National Cereals and Produce Board. The board may direct that maize be sold or bartered by producers in such quantities and prices subject to such conditions. This act empowers the Minister for Agriculture in consultation with the board to fix the prices of the agricultural produce. It displays the prices of maize. The Minister is empowered to export or authorize the exportation of maize. This act is preserves and procures maize for the government strategic grain reserve in order to sustain food security and national relief programmes.

7.3 Policies

7.3.1 Strategy for Revitalization of Agriculture (SRA) is a policy that was launched in 2004 by the government and is intended to transform agriculture into a more competitive sector capable of attracting investment and providing higher incomes and employments. In order to achieve this, an inter-ministerial policy unit, the Agricultural Sector Coordination Unit was formed to ensure activities of the sector ministries (MoA, Livestock Development, Cooperative Development & Marketing, Ministry of fisheries development, Ministry of Water and Irrigation, Ministry of Lands, Ministry of Environment and Mineral Resources, Ministry of

Regional Development Authority, Ministry of Forestry and Wildlife, Ministry of Special Development of Northern Kenya and other Arid Lands) were SRA compliant. The policy has received funding from DFID, DANIDA, CIDA, GTZ, USAID African Development Bank, EC, Finland, FAO, IFAD, JICA, Netherlands, WFP and World Bank. The following six fast track interventions have been chosen to hasten implementation of SRA:

- Review and harmonize the legal regulatory and institutional framework
- Restructure and privatize non-core functions of parastatals and ministries
- Improve access to quality inputs and financial services
- Improve delivery of research, extension and advisory support
- Improve access to both domestic and external markets
- Formulate food security and programs

ASCU in the 2009/10 financial year spent KShs 142million on various activities designed to operationalize the unit.

The maize subsector has benefited from this policy by improved access to research and extension, quality input and financial services which have led to increased maize yields and acreage under the maize crop.

7.3.2 Economic Recovery Strategy (ERS) for health and employment creation was launched in 2003 under the Ministry of Planning and Development. The central focus for this strategy is job creation through sound micro-economic policies, efficient public service delivery and an enabling environment for private sector to do business and public policies that reduce cost of doing business. It's main aim is to ensure effective implementation, monitoring and evaluation framework. It also aims at facilitating the active participation of private sector, civil society and communities. Some of the strategies that the government has put into place to reverse the declining agricultural performance include enactment of the Tea Act, Sugar Act, Cotton Act and review of Coffee Act. The interventions under this strategy for the agricultural sector will witness consolidation of over 60 statutes governing the agricultural sector into a single registration therefore, promoting efficiency, health and self governance. It will also improve extension to provide cooperative extension services with other extension service providers. In addition, it will raise productivity of farmers through access to affordable credit and the government will revitalize irrigation schemes to facilitate participation of farmers irrigation development. The effects of this have been increased milk and maize production. The core poverty programmes have received KShs 153,729 million from the exchequer.

7.3.3 Poverty Reduction Strategy Paper (PRSP) is a government paper in collaboration with World Bank and was launched in 2005. Its aim is to reverse the declining agricultural output by promoting productivity, growth and lower the cost of agricultural inputs particularly in small holders and subsistence farmers who contribute 70% of marketed agricultural production. The strategy aims at improving agricultural research and extension, and access to credit and insurance. In lowering agricultural inputs the government is targeting reforms to improve competition in input distribution and marketing. In this regard, subsidies in fertilizers and seed supplies to farmers have been implemented by the government. This has led to increase in farmer yields. Due to this strategy, in the year 2006- 2007, the country achieved more than 3,000,000 MT of maize production and also the highest area acreage of 1,800,000 Ha in 2009

7.3.4 The National Food Safety Policy

Kenya has not had a national food safety policy; however a draft national policy on food safety has now been developed and is expected to be enacted soon. The draft policy attempts to harmonize and coordinate food quality inspectorate activities by the various regulatory authorities. Some of the goals are: -

a) Building capacity for the food control system.
b) Identifying food safety challenges.
c) Creating awareness to the general public and other stakeholders on food safety.

With regards to aflatoxin, this draft policy specifically identifies aflatoxin poisoning as a major challenge which needs to be addressed in order to guarantee safety and food security.

7.3.5 Kenya Food Security and Nutrition Policy

The purpose of this strategy is to specify measures and actions to be implemented so as to ensure food security and nutrition which affirms access to nutritionally adequate and safe food as a right of each individual living in Kenya. This calls for a comprehensive multisector approach that integrates the economy, agriculture and other related sectors.

One of the programme areas under this draft policy is food safety/ quality control. Under this section a number of issues related to food safety have been addressed. These include storage. Kenya loses 30-40% maize, 50% fruits and 7% milk due to poor storage. The paper calls for building capacity for development and management of appropriate storage facilities, implementing measures that facilitate renting or disposal of underutilized public storage facilities. This is aimed at reducing post harvest losses and contamination (aflatoxin) which has caused health risks in the past. This six year project started in 2008 is expected to spend KShs 249,250 million by 2014. The budget has been factored in the government expenditure.

8.0 Aflatoxin food safety projects

Annex two summarizes the international and international research projects in Kenya currently focusing on Mycotoxins. The following sections summarize the major products:

8. 1 Aflacontrol project

The project aims at reducing the spread of aflatoxin in maize and groundnut value chains and is led by IFPRI. It also seeks to increase the understanding of the economic and health impacts of aflatoxin contamination, identify and promote cost effective methods and technologies available to reduce contamination of food and feed. The project has partners form International Maize and Wheat Improvement Center (CIYMMT), University of Pennsylvania, USA, United States Uniformed Health Services, Kenya Agricultural Research Institute (KARI) and Agricultural Cooperative Development Initiative (ACDI-VOCA). The project is funded by Bill and Melinda Gates Foundation. The sampling is being done in Mbere (Embu), Makueni, Homabay, Kisii and Rongo at the household level using ELISA kits for analysis. The data available indicates that 52% out of 341 samples were contaminated with aflatoxin with 24% having aflatoxin levels above 20ppb. Maize from farmers' stalls in Kisii and Rongo had low aflatoxin level compared to similar samples obtained from Makueni and Mbere. Some samples exceeded 9,000 ppb.

Aflacontrol has sent out policy briefs and held inception and one year national workshops to disseminate the information. Mostly this was aimed at the Ministries of Agriculture and Public Health who are the key institutions involved in mitigating aflatoxin in the country.

8.2 Purchasing for progress (P4P) Programme (WFP)

The WFP is a United Nations humanitarian organization involved in the distribution of relief food locally during emergency situations. WFP buys food from Kenyan farmers and part of this is also exported to other countries. The WFP purchasing for progess programme enables WFP to buy maize from small-scale farmers giving them access to fairer prices hence putting more money into small-scale farmers and improves their livelihood. Although WFP tries to purchase its grain supply locally, it normally relies on commercial farmers and traders who can supply the large quantities needed. Before any purchase WFP checks the aflatoxin level in the grains before procurement. Data available shows that WFP purchased nearly 700 T and out of this some had high levels of aflatoxin reaching 890 ppb. Those consignments with high aflatoxin levels were rejected as tests are carried out before purchases are done. However, in the majority of the procurement aflatoxin levels reached 2-9 ppb. The limit for acceptable is 10 ppb. Most of these tests were analyzed using the ELISA technique in a number of laboratories. The main purpose of analysis for WFP is mainly to ensure food safety of the relief food they are distributing. Adherence on standards required by the programme ensures that the farmers enforce safety regulations if their produce is to get into this market. This testing programme has enabled the Marenyo cereal bank and Transmara farmers to access to high paying markets for their produce.

8.3 Research institutions

Aflatoxin prevention and control research is focusing on genetic characterization, development of biocontrol technologies and effective agricultural management. The Kenya Agricultural Research Institute (KARI) is currently carrying out research on a local non-toxic form of fungus that could be biologically used to control maize contamination in collaboration with USDA and IITA. The project is funded by multi donor funding and the remedy is expected to save Kenya from food insecurity and avert maize farmers losses worth million of shillings as experienced in the past.

A biocontrol agent has been developed to eradicate the aflatoxin contamination of maize. Scientists at the International Institute of Tropical Agriculture (IITA) have found that non-toxic producing (atoxigenic) strains of *Aspergillus* can be used to radically reduce aflatoxin producing *Aspergillus* species thus reduce pre and post harvest contamination of maize. Eight strains have been identified from thousands of strains collected from mouldy maize stored by farmers in Nigeria that could reduce aflatoxin contamination by as much as 99.8% in field trials. A large scale testing in multiple sites in Kenya is being conducted to test the efficacy of the multiple strains as biocontrol agent. The project at its initiation stage and no data is available.

A project on capacity building on food and feed safety focusing on health risks associated with biological contaminants between the University of Nairobi and MTT-Agrifood Research, Finland with collaborations from Egerton University, KARI (Kenya) and EVIRA in Finland is ongoing. The main aim of this project is to assess the levels of exposure to aflatoxin and fumonisins at household level, agronomic practices that predispose households to aflatoxin poisonings and the characterization of the fungal species found in maize and soils from two sites from the Rift valley and Eastern regions of Kenya. Toxigenicity of these species will be done using ELISA HPLC and molecular typing. The project has completed sample collection fromm two bench mark sites (Nandi and Makueni) and has embarked on laboratory analysis. Aflatoxin and fumonisin analysis involves screening with ELISA kits and confirmation with HPLC. Fungal isolation involves use of standard microbiological methods. Results from the study will be disseminated to farmers, extension officers, policy decision makers at county, national and also involve parliamentary committees on agriculture and health. No results are available from this project yet.

Postharvest researchers have developed effective and simple machines and tools that reduce processing time and labor as well as production losses. Recently, the research to enhance the nutrient content of maize to combat malnutrition and diseases caused by micro-nutrient deficiency has been carried out in the University of Nairobi. The University researchers are developing mycotoxin-resistant varieties in collaboration with advanced laboratories to minimize the health hazards of these toxins. Extension services offered by the researchers include insect control in fields and stores, timely harvest, avoiding grain damage during threshing by using hand shellers, rapid grain drying to safe moisture levels, good storage structure (cribs) to avoid water and insects and sorting to remove contaminated grains. (See Annex three for a summary of the objectives of each of the above projects).

Most of the projects carried out by the international and national research centers are in conjunction with the sector ministries' departments. The reason is that once results are available the government will upscale these to the farmers through its extensive extension arm. However, the relationship between government ministries and scientists is still embryonic. When Ministry staff are confronted with an issue they only consult the research centers under their Ministry's mandate - rarely do they consult scientists at universities and international centers. What is missing is a public – private "think tank" or forum that could be called upon to offer advice when situations arise.

8.4 The Njaa Marufuku Kenya (NMK)

The programme was started in 2005 by Agriculture Sector Ministries with support from FAO and the MDG center to provide an overall strategic framework for a 10-year action plan for hunger eradication in Kenya. It was formulated to fast track the fulfillment of MDG 1 – reduce by half the number of extremely poor and hungry people in the country by the year 2015. The Ministry of Agriculture is the focal point in implementing this programme. One of their core projects is dealing with smallholder and community services development where farmers receive extension services and training to diversify their household incomes. Food insecurity is being addressed by introduction of drought resistant crops varieties and trainings on post harvest handling facilities.

The programme is in its third phase and will have spent about $ 8.5 billion by 2015.

8.5 National Agriculture and Livestock Extension Programme (NALEP)

NALEP is a national programme funded by SIDA and operating in no less than 43 Districts, located in 5 Provinces. The NALEP approach is in line with the Kenya Government policy on decentralization as well as on agriculture as documented in the Strategy for Revitalization Agriculture (SRA) and the National Agricultural Extension Policy (NEAP). Relevant opportunities are identified and Common Interest Groups (CIGs) are formed based on farmers´ choices. These

CIGs are the foundation for NALEP extension service provision. Basically this programme is involved in dissemination technologies to farmers which aims at reaching 1/2 million farmers per year. Most farmer groups have managed to improve their production and food security considerably. About 72% of the farmers have experienced an increase in their agriculture production and 80% have been offered new opportunities in agriculture.

The NALEP GoK and NALEP SIDA offer support to farmers organized in CIGs in the region of KShs 120- 150,000 and 350- 400,000 KShs respectively. The agricultural areas that have received this support include sunflower and fruit trees projects.

8.6 Water master plan

Out of the total land area in Kenya, about 11.65 M Ha receive medium to high rainfall. About 7 million Ha of the land is useful for agricultural production. In 2003 the area under irrigation was 105,800 Ha which accounted for 1.5% of the total area under production. Horticultural crops take up 65% of land under irrigation while other crops including maize take up 35% of the irrigated land.

The Water Master Plan aim is to improve land utilization through irrigation and strengthening institutions involved in the implementation of the Water Master Plan. This will lead to achieving goals in self sufficiency in food production, wealth creation, income generation and foreign exchange earnings. One of the off shoots of the plan is the revival of the Bura Irrigation Scheme in Tana River district. An additional 40,000 hectares were irrigated to produce 370,000 bags of maize and 600,000 bags of rice. The programme has increased opportunities in production, processing and marketing of maize and rice produce thus reducing the dependence on huge food imports that squander valuable foreign exchange.

While this scheme resulted in increased maize production with a bumper harvest there were no adequate storage facilities. Therefore, approximately 238 bags of maize produced in the Bura Irrigation and Settlement Scheme were found to contain toxin levels of aflatoxin between 890 and 3,800 ppb resulting to a total loss of more than Sh12 million in the deal with WFP from 90 farmers in October, 2009.

Because the government is concerned about food security it has put in place mechanisms (strategies, policies and programmes) that are geared to increasing maize productivity, but it is still lacking a clear policy which would further guide production, storage, processing and trade. Increasing productivity without simultaneously addressing storage and processing capacities is potentially a significant problem. The Government and the maize sector need to learn from the milk sector when production was increased resulting in milk being thrown away because there was no capacity to process it.

8.7 Private sector programmes

Most private sector farmers rarely test their maize for aflatoxin contamination unless it is demanded by the buyers. Most of the maize traders also do not test for aflatoxin, but they do often carry out thorough manual quality checks of the deliveries to ascertain that they meet the quality criteria for maize grading. Again testing is only carried out when the buyer demands aflatoxin tests and then the maize sampling is done by private laboratories appointed by the buyer.

Millers have their own laboratories where all raw material deliveries and final product testing is done. The two maize millers (UNGA limited and Mombasa Millers Limited) visited stated that they rarely have raw material samples exceeding the 10 ppb limit. This is as a result of careful and strict field quality officers who select maize for purchase. If a batch exceeds 10ppb it is channeled for animal feeds processing.

The millers use Kenya Bureau of Standards (KBS) and the East African Community Standards (EAS 79) for sampling maize for aflatoxin while analysis is done using ELISA method and VICAM fluorimeter (AOAC 991.31). Analytical data obtained by the millers is not shared with anybody but is only for the company use.

8.8 Initiatives to promote food safety

8.8.1 National Food safety Coordinating Committee

This is a multi-sectoral committee charged with the responsibility of addressing food safety issues in the country. The majority of past issues handled by this group were those raised on exported produce through the alert system. The committee has developed the draft food safety policy, which awaits enactment. The Ministry of Agriculture through the Agricultural Secretary chairs the committee while the Ministry of Public Health and Sanitation hosts the secretariat. Others members include Ministry of Livestock development, Kenya Dairy Board, the Public Health laboratories, Kenya Plant Health Inspectorate, Kenya Bureau of Standards, universities among others. The body has not been entrenched through an act of parliament therefore it does not have an overarching responsibility to collect, collate, analyze and disseminate information in respect to aflatoxin. This will only be possible if this entity is transformed into a national food safety agency through an act of parliament.

8.8.2 Commodity Exchange Market

Commodity Exchange (CE) is a marketing system that:

- Links sellers and buyers of agricultural commodities
- Provides relevant and timely marketing information and intelligence
- Provides a transparent and competitive market price discovery mechanism
- Harnesses and applies information and communication technologies (ICTs) for rural value addition and empowerment.

For trade to take place under the commodity market, the buyer must be assured of safety and quality. A food safety and quality assurance mechanism is necessary in order to transact business under this marketing system. Products procured and sold using a warehouse receipt, would then be assured of quality and safety. This ensures that sellers in the market understand and implement food safety procedures in order for the produce to be acceptable to trade in this market. This system targets the bulk handlers. The system is being promoted by Eastern Africa Grain Council but is out of the reach for small holder farmers at the moment that cannot provide the volumes of grains required to participate. Community cereal storage banks would offer alternative storage for smallholder farmers where standards could be observed and safety assured not only for subsistence during seasons with poor harvest but also act as a market access avenues during bumper harvest seasons where surpluses could be offered for sale. Safety aspects enforced during the participation in such community storage banks would trickle down to the village and household level where food safety is of major concern, especially with aflatoxin.

Parallel to the establishment of warehouse receipting, the Ministry of Finance is trying to set up a commodity stock exchange to make the commodity exchange market more professional. Kenya Agricultural Commodity Exchange Limited (KACE) is operating a commodity exchange at rural market level targeting individual farmers using ICT technologies. However, at present there are no food safety considerations, nor any sampling and testing undertaken by KACE.

8.9 Institutional gaps and capacities

Most of the mechanisms for implementing registration and programmes targeting maize are under the Ministry of Agriculture. There is not much inter-ministerial overlapping with regard to maize regulation and policies. Most of the programmes under the MoA have been targeting increased maize productivity.

However, there have not been similar efforts to address issues concerning safety and quality emanating from increased productivity. A case in point is the Bura Irrigation Scheme where farmers experienced huge losses of maize worth Kshs12 million due to aflatoxin contamination. This could have been averted if extension messages and farmer training on proper postharvest maize handling had been implemented.

Food safety can be achieved through continuous monitoring and surveillance which requires heavy investment in terms of testing facilities and trained personnel. However, this capacity is lacking in the ministries due to insufficient budgetary allocation but there is capacity within the private sector and research institutions so this could be harnessed to ensure that monitoring is done. Although private capacity exists, sustained monitoring and surveillance for food safety is a public good and is the responsibility of the Government therefore there is a need for public/private partnerships.

Despite the formation of the National Food Safety Committee the lack of national Food Safety Authority means that they is no overarching authority responsible for collecting and collating all information on aflatoxin prevalence, control and management.

9.0 Discussion

Due to the evolving food security situation in Kenya there will be the need for the Government to devise strategies that deal with the situation. Therefore, in the short term, the government needs to expand relief efforts, maintain duty waiver on maize, introduce waivers on wheat and rice, ensure access of imported maize to informal traders and posho millers, and follow clearly-defined and transparent rules for triggering government intervention to reduce market uncertainty. Further, there is need to raise awareness and sensitization on diversifying food consumption and to establish regular periodic government-private sector consultations to coordinate decision making on stocks and imports. Ultimately, there is need to emphasize strategies that will reduce the cost of producing and distributing maize locally such as the improvement of roads and railway infrastructure

Increasing maize market prices are condemning vulnerable groups to food insecurity with the potential to start eating unsafe maize. The current government price setting mechanisms while procuring grains for the strategic reserve should not be higher than that of imported maize. The low prices of imported maize should stabilize the market prices so that the informal marketing sector that deals with the bulk maize can continue to offer safe foods.

While the government has put in place food security mechanisms (strategies, policies and programmes) that are geared to increasing productivity in the maize sector the maize subsector is still lacking a clear policy which would guides production, storage processing and trade. Government programmes cannot just focus on productivity without giving consideration to addressing other key factors, such as adequate storage and processing facilities.

Despite the aflatoxin problem being recognized for many years, including the loss of lives, the Government has not put in place any official aflatoxin surveillance and monitoring programmes. It is necessary that a Food Safety Authority or government ministry is mandated to carry out monitoring and surveillance and inform on the alfatoxin status in Kenya. Currently a reorganization of NFSCC would be necessary to give it the legal teeth and budget to carry out the necessary surveillance and monitoring.

For the aflatoxin surveillance and monitoring to succeed there is the need for laboratories to test and analyze samples. It is not necessary to establish new capacities (laboratories) as there are many public and private laboratories available to handle aflatoxin analysis. What is needed is identification of such laboratories which have the competences to provide the services amd recognition that these laboratories are also stakeholders in this value chain. NFSCC could in conjunction with KEBS register these laboratories them while assessing their capacities and competences and provide a list to all stakeholders of those deemed competent to undertake aflatoxin analyses.

It is also important that both the private and public laboratories are harnessed to provide analytical information which could inform decision makers on aflatoxin satusthe situation and allow for risk management steps when necessary. This information is currently held confidentially in laboratories so there is a need to establish a data base where all the certified testing laboratories can input their data to help government decision making.

To date most of Kenya's strategies have been to curb aflatoxin once it has been detected in the food chain. These efforts come when it is too late. There is a need for a proper preventative programme to address the aflatoxin problem in Kenya which would lead to reduction in aflatoxin in maize at the beginning of production, not focusing on treatment at the end.

Seed developing companies do not currently seem to know they could play a role in mitigating aflatoxins. They should refocus their endeavors to developing seed varieties that have characteristics that mitigate fungal attack and aflatoxin accumulation. This would provide another tool in the farmer's arsenal to mitigate aflatoxin problems.

In the past aflatoxin outbreaks, poor handling practices and storage facilities have been singled out as the main causes of the maize contamination. At most households, maize threshing is by beating the maize. This practice causes damage to the grains making it easy for fungal mycelia to penetrate the grains and grow and eventually produce aflatoxins. Creating awareness and promoting the use of affordable, cost effective hand shelling machines which reduce the rate of damaged grains should form part of the activities in the training proposed in the farmer field schools.

With maize drying being a critical step in the control of aflatoxin, adequate strategies should be developed to ensure that maize is properly dried during storage. The government should either establish mobile maize drying units or construct driers in specific areas where farmers can access these to have their maize dried at a fee. The cost of using cheaper drying and green technology should be researched.

Dry storage is critical. Maize storage in polypropylene bags causes moisture build up thus increasing the risk of aflatoxin accumulation, so storing maize in sisal and jute bags should be promoted. Though these are more expensive than polypropylene bags by a factor of five (KSHS 20:100), the advantage of reducing the risk of aflatoxin is worth the investment. Another technology available at household level is use of metal grain silos for storing maize (Figure 9 below). These are available in different sizes to meet the needs of small scale farmers.

Figure 9: Metal grain silos for small scale storage

The government should come up with simple storage structures that are affordable by farmers and householder for storing maize. Community grain storage banks could be established at community level where farmers will be taught to practice proper handling practices. Similar models intended for the communities to gain market and credit access have been established in Transmara under the USAID-Competitive and trade expansion programme (USAID COMPETE) programme and in Yala, the Marenyo cereal bank. These bring small scale farmers together to bulk their maize, store and sell at higher prizes. In order to achieve this, they must do proper sorting, cleaning and drying to make sure the maize meets the EAS2:2005 set standards. This approach could be used for storage purposes where communities come together to bulk their maize for proper storage and later access it later for subsistence use at home. During the aflatoxin outbreak in 2005, the Ministry of Agriculture through National Cereals and Produce Board tried this approach. All that is needed is to cascade this downwards to village level. Practices learnt and infused here would definitely percolate to household level leading to improved food safety.

The “warehousing receipting system” is available for large scale farmers with bulk supplies to store. If small householder farmers were able to bulk their produce they could enter the market. This, together with the commodity exchange market, might allow many players into the maize marketing chain. Trading under these systems would ensure safety standards are met with a fixed control point for sampling and testing.

Efforts have been made to educate and train farmers on proper handling practices but much of this training has been done after the detection of the aflatoxin contamination. This does not help to prevent the contamination. Future endeavors should be targeted at proper timing during throughout the whole maize growing cycle.

The current government policy on demand driven services is hurting farmers who have little or no knowledge of aflatoxin. These farmers cannot request for services if they do not know their problems exist. Aflatoxin issue should be given same priority that was afforded Avian Influenza and Rift Valley Disease in creating awareness and surveillance. This will give everyone an opportunity to hear messages targeting aflatoxin and the recommended mitigation strategies. Kipcham farmers were not knowledgeable on aflatoxin despite having over 5,000 90kg/bags of maize ready for sale kept in different farmer households.

Training of farmers and other actors in the maize value chain in aflatoxin management could be done through the Farmer Field Schools (FFS). Farmer Field Schools are platforms for improving decision-making capacity of farming communities and stimulating local innovation for sustainable agriculture though community-based, non-formal education to groups of 20-25 farmers through self-discovery and participatory learning principles. FFS provides opportunities for learning-by-doing. Government extension officers, subject matter specialists or trained farmers can facilitate the learning process, encouraging farmers to discover key agro-ecological concepts practiced in the field. The emphasis of farmer field schools is on empowering farmers to implement their own decisions in their own fields based on a scientific understanding of the aflatoxin contamination of maize. This would develop farmer's capability in preventing aflatoxin problems as well as assist farmers develop critical and informed decisions on maize policies and regulation.

A few studies have been done that have demonstrated the importance of traditional food preparation technologies in reducing aflatoxin levels in contaminated maize. While more studies are required to evaluate these findings, these technologies could be promoted as mitigation strategies that would reduce exposure. A curriculum in the FFS on these technologies would promote safety at household level.

Future endeavors to manage the aflatoxin issue in Kenya should adopt a stakeholder approach. Aflatoxin contamination has been shown to occur at all stages of the maize value chain necessitating active involvement of all the concerned stakeholders. In addition, strategies should be developed to facilitate sharing of data generated from different key points in the value chain to allow an integrated approach in the detection of maize contamination nationally. This will also assist in the efficient formulation of sustainable working maize policies both in the public and private maize sectors. Consequently, there is an urgent need for a national workshop to bring together these stakeholders to develop the strategies that would inform on policy.

The fact that there is no forum for public and private sector to converge to offer solutions during aflatoxin outbreaks means that expertise that exists in the private sector and among other stakeholders is not harnessed. During the Rift valley fever disease outbreak and the avian flu scare, there was seen a rare formation of district disease surveillance reporting forum that brought together experts from all sectors to address the outbreak and anticipated scare. Aflatoxin problem currently requires such concerted effort to address how to mitigate the problem. Such an approach would require political will to invest resources to collectively search for solutions to aflatoxin problem.

While the 2004 and 2010 aflatoxin crises have raised attention on the maize aflatoxin contamination it should not be forgotten that other hazards can affect the maize value chain and are for the moment very badly documented. All the three dusting compounds used to preserve maize contain organophosphorous and pyrethrins. There is no data on the prevalence of pesticide residues in maize food products due to these dusting compounds despite their widespread use. Although it is known that some have no human toxicity at levels recommended for use and are easily degraded, studies documenting prevalent residue levels of these compounds are important in order to offer advice to consumers on handling and processing of maize dusted with the compounds.

Although 40 years ago, maize was always part of agronomic associations (cultivated together with a mix of peas, beans, sweet potatoes and other cereals), the rapid urbanization and changing life patterns have induced a simplification of meals, based on one staple: maize. Nowadays, Kenya is highly dependent on maize as a staple food. This is exemplified by the fact that maize contributes about 36% of energy consumption per capita food intake per day. Maize growing is mainly dependent on reliable rainfall or well coordinated irrigation schemes. Low self-sufficiency is attributed to a wide array of causes including lack of productivity enhancing technologies, high incidence of pests and diseases, erratic climatic conditions and difficulties in accessing credit. Kenya is food insecure whenever maize crop fails leading to massive maize imports and relief food distribution making majority of the population vulnerable to consumption of unsafe maize contaminated with aflatoxin. There is need to create awareness and promote alternative crops that are adapted to various agro-ecological zones which are drought tolerant to reduce reliance on one crop.

10.0 Recommendations

1) Government issues – it is recognized that the Government must deal with Kenyan's food security issues. However, the following are options to be discussed and considered:

a) Maintaining a duty waiver for imported maize.

b) Ensuring that all informal traders and posho millers have access to imported maize.

c) That the cost of local grain is not higher than imported products to stabilize the price.

d) Transparency around the rules for government interventions to reduce uncertainty.

e) Work could be undertaken on the country infrastructure, for example, roads to better distribute maize.

f) A government policy on maize which guides production, processing and trade.

g) That policies focus on aflatoxin preventative policies rather than simply treatment systems for aflatoxin contaminated products.

2) Surveillance and Monitoring systems – there is a need for a national Food Safety Authority or similar to monitor mycotoxin compliance issues and make timely reports to appropriate stakeholders.

Such surveillance could integrate a laboratory notification system.

3) Laboratories – there is a need to keep an up to date list of accredited laboratories that have the capacity to undertake aflatoxin analyses.

4) Data sharing – there needs to be a system of sharing appropriate information between the stakeholders to ensure an understanding of Kenya's mycotoxin status along with appropriate management tools.

5) Capacity Development and Training

a) There is a need to help farmers understand the techniques which will prevent initial aflatoxin contamination. An option for such an education programme is through the Farmers Field Schools.
b) All other appropriate stakeholders throughout the maize chain should be educated on mycotoxins and mitigation strategies.
c) Consideration should be given to a national stakeholder's meeting to raise awareness.

6) Seed production - there is a need to sensitize seed developing companies on the importance of developing seed varieties that have characteristics which mitigate fungal attack and aflatoxin accumulation.

7) Technology and Research

a) Need for aflatoxin resistant seed production suitable for all areas of Kenya.

b) There is a need for development and the use of affordable, cost effective hand shelling machines which will reduce the rate of damaged maize.
c) Need for strategies and systems for the cost effective drying of grain, particularly for the small scale farmer.
d) It is important that research focuses on aflatoxin preventative strategies and not just treatment options to deal with contaminated maize products.

8) Storage

a) There needs to be simple, inexpensive storage facilities available for local household use.

b) The option of community grain storage facilities need to be explored.

c) There should be the promotion of suitable storage materials e.g. sisal and just bags as opposed to unsuitable polypropylene bags.

d) Encouragement should be given to large scale farming operations to use the warehouse receipt system. It is possible that if local co-operatives were made up of small scale farmers they could also use the warehouse receipt system. The use of a warehouse receipt system would enable the establishment of a food safety critical control point, at which point the maize could be assessed for mycotoxin contamination.

9) Diet diversification - there is a need to encourage the diversification of the diet of Kenyans. This will reduce both the reliance on maize and the exposure to levels of contamination.

10) Further analysis of the food safety issues associated with maize – there is a need to further investigate all the potential food safety issues associated with maize, for example, the use of pesticides and the contamination with fumonisins.

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Annex 1: National maize variety list (Species: Zea mays L.)

Variety name/code		Year of release	Owner (s)	Maintainer & seed source	Optimal production altitude range (Masl)	Duration to Maturity (months)	Grain yield (t ha-1)	Special attributes
1	H632	1964	KARI/Kenya seed co.	KARI/Kenya seed co	1200-1700	5-7	6-8	Large Kernel dent
2	H622	1965	Kenya seed co./ KARI	Kenya seed co./ KARI	1200-1700	5-7	6-8	Large Kernel dent
3	H511	1967	Kenya seed co./ KARI	Kenya seed co./ KARI	1000-1500	4-5	4-6	Medium maturity
4	KAT CB	1967	Kenya seed co./ KARI	Kenya seed co./ KARI	900-1350	3-4	3-5	Early maturing
5	H512	1970	Kenya seed co./ KARI	Kenya seed co./ KARI	1200-1600	4-5	5-7	Large kernels
6	CCM	1974	Kenya seed co./ KARI	Kenya seed co. Ltd	1-1200	4-5	5-7	Heat tolerant
7	H625	1981	KARI/Kenya seed co	Kenya seed co./ KARI	1500-2100	6-8	8-10	Prolific Good husk cover

8	H614D	1986	Kenya seed co./ KARI	Kenya seed co./ KARI	1200–1500	6–9	8–10	Stable over locations and seasons Semi flint
9	H611D	1986	KARI/Kenya seed co	KARI/Kenya seed co	1700–2400	6–9	7–8	Frost tolerant
10	H612D	1986	KARI/Kenya seed co	KARI/Kenya seed co	1500–2100	6–8	7–9	Semi flint
11	H613D	1986	KARI/Kenya seed co	KARI/Kenya seed co	1500–2100	6–8	8–10	Semi-flint
12	H626	1989	Kenya seed co./ KARI	Kenya seed co./ KARI	1500–2100	6–8	8–10	Flint
13	PH1 (Pwani)	1989	Kenya seed co.	Kenya seed co.	1–1200	3–4	5–7	Tolerant to lodging/strong stalks Drought tolerant
14	DLC1	1989	Kenya Seed Co/ KARI	Kenya Seed Co/ KARI	800–1200	2–3	2–4	Flint very early
15	PAN 5195	1995	Pannar	Pannar Seed Co.	1000–1800	4–5	5–6.3	Prolific Tolerant to maize streak virus
16	H627	1995	KSC/KARI	KSC/KARI	1500–2100	6–8	9–12	Semi-flint
17.	DH01	1995	Kenya Seed Co.	Kenya Seed Co.	9900–1400	3–4	4–6 green	Early, stays green Co.
18	DH02	1995	Kenya Seed Co.	Kenya Seed Co.	1200–1600	4–5	6–8	Good standability
19	DH02	2000	Kenya Seed Co.	Kenya Seed Co.	900–1500	3–4	5–6	Stays green ,, Good standability

20	CG4141	2000	Monsanto	Monsanto (K)	900-1700	4-5	4-7	Tolerant to Striga
21	C5051	2000	Monsanto	Monsanto (K)	1000-1800	4-5	5-8	Moderately tolerant to maize streak virus, easy to shell
22	H623	1999	Kenya seed Co.	Kenya seed Co.	1200-1700	5-7	7-9	Prolific, large dent kernels
23	H 628	1999	Kenya seed Co.	Kenya seed Co.	1500-2100	6-8	9-12	Flint
24	KH600-11D	2000	KARI	KARI	1500-1800	6-9	7-8	Good standability stable performance
25	KSTP 94	2000	KARI	KARI Kakamega	1350-1800	4-4	4-6	Tolerant to striga
26	CG4141	2000	Mosanto	Mosanto K.	900-1700	4-5	4-7	Earliness Fast dry down
27	H629	2000	Kenya Seed co.	Kenya seed Co.	1500-2100	6-8	9-11	Semi dent
28	DH03	2000	Kenya seed Co.	Kenya seed Co.	900-1500	3-4	5-6	Stays green Good Standability
29	C5051	2000	Monsanto	Monsanto K.Ltd	1000-1800	4-5 months	5-8	Moderately tolerant to maize streak virus Easy to Shell
30	PAN5355	2000	Pannar Seed	Pannar Seed K.Ltd	1000-1800	4-5	5-5-9	Moderate MSV resistance
31	H515	2000	Kenya Seed Co.	Kenya Seed Co.	1200-1500	4-5	6-8	Lodge resistant
32	H6211	2011	Kenya Seed Co.	Kenya Seed Co.	1500-2100	6-8	9-14	Early,Short semi flint
33	H6212	2001	Kenya Seed Co.	Kenya Seed Co.	1500-2100	6-8	10-15	Short,Semi flint Resistant to ear rot
34	FS6500	2001	OCD (Faida Seeds)	OCD(Faida Seeds)	1500-2200	5-7	8-9	Tolerant to maize streak virus Good yielder Flint Kernels

35	KH634A	2001	KARI	KARI Kakamega	1400-1800	3-5	5-6	Resistant to blight,Grey leaf spot
36	KH600-15A	2001	KARI	KARI-Kitale	1800-2500	6-8	7-8	Good stand ability
37	KH600-16A	2001	KARI-Kitale	KARI-Kitale	1800-2500	6-8	7-8	Stable Good Standability
38	PAN99	2001	Pannar Seed Co.	Pannar Seed(K)	1000-2000	5-6	7-8	Grey leaf spot tolerant Drought tolerant
39	PAN5243	2001	Pannar seed company(S.A)	Pannar Seed(K)Ltd	800-1800	4-5	7-8	Tolerant to grey leaf spot and northern leaf blight prolific
40	PAN67	2001	Pannar Seed company (S.A)	Pannar Seed (K)Ltd	800-1600	4-5	5-6	Resistant to maize streak virus Tolerant to low soil nitrogen
41	H516	2001	Kenya Seed Co.	Kenya Seed Co.	1200-1500	4-5	7-9	Resistant to blight,rust and lodging
42	43.DH04	2001	Kenya Seed Co.	Kenya Seed Co.	900-1500	3-4	5-6	Short stature
43	44.DH05	2001	Kenya seed Co.	Kenya Seed Co.	900-1500	3-4	5-7	High yielding and early maturing
44	45.PAN691	2001	Pannar Seed Co.	Pannar Seed (K)Ltd	1700-2400	6-9	7-8	Grey leaf spot tolerant Good standability Low ear placement
45	46.Maseno Double Cobber	2002	Lagrotech Seed Co.	Lagrotech Seed Co.	1000-1600	3-4	4-6-8	Prolific-frequency of 30%-80%) flint kernels

46	PHB30H83	2002	Pioneer Hibred Zimbabwe	Pioneer Hibred Zimbabwe	1000-2000	5-6	8-11	Grey leaf spot tolerant Ear rot resistance
47	H6213	2002	Kenya Seed Co.	Kenya Seed Co.	1600-2200	6-8	10-15	High yield Drought tolerant
48	WH699	2002	Western Seed Co.	Western Seed Co.	1700-2200	6-8	7-9	Tolerant to smut
49	WH 904	2002	Western Seed Co.	Western Seed Co.	1000-1700	5-6	6-9	Tolerate to streak virus
50	WS 909	2002	Western Seed Co.	Western Seed Co.	0-1500	4-5	6-9	Tolerant to striga
51	H6213	2002	Kenya Seed Co.	Kenya Seed Co.	1600-2200	6-8	9-14.5	Semi-flint
52	H518	2002	Kenya Seed Co.	Kenya Seed Co.	1400-1700	4-5	7-9	Resistant to GLS, Rust, Blight
53	KH 600-17A	2002	KARI	KARI	1600-2300	5-6	7-11	Good standability
54	KH 600-18A	2002	KARI	KARI	1600-2300	5-6	8-12	Good disease tolerant
55	PAN 683	2003	Pannar Seed Co.	Pannar Seed Co.	2000	6-7	6.9	Late maturity excellence standability excellence tip cover, resistant to grey leaf spot
56	PAN 33	2003	Pannar Seed Co.	Pannar Seed Co.	800-1800	5-6	5.3	High yielding
57	WH 501	2003	Western Seed Co.	Western Seed Co.	1300-1700	5-6	7-9	Suitable for low input production, Tolerant to grey leafspot, maize streak virus & northern leafblight

58	WH502	2003	Western Seed Co.	Western Seed Co.	1000–1700	4–5	6–9	Very tolerant to maize streak virus, tolerant to grey leafspot, northern leafblight, striga, drought and low soil nitrogen tolerant
59	WH504	2003	Western Seed Co.	Western Seed Co.	1000–2000	4.5–5.5	6–9	Tolerant to maze steak virus, grey leafspot & northern leaf blight green stem, at harvest suitable for fodder, tolerant to drought & low soil nitrogen
60	WH505	2003	Western Seed Co.	Western Seed Co.	500–2100	4.5–5.5	6–9	Tolerant to maze steak virus, grey leafspot & northern leaf blight green stem, at harvest suitable for animal fodder, tolerant to low soil nitrogen
61	WH509	2003	Western Seed Co.	Western Seed Co.	1000–1700	5–6	6–9	Tolerant to maize steak virus, grey leafspot & northern leaf blight, tolerant to drought
62	WH403	2003	Western Seed Co.	Western Seed Co.	1000–1500	4.5	5–8	Tolerant to leaf diseases, green stems at harvest suitable for animal fodder
63	WS102	2003	Western Seed Co.	Western Seed Co.	0–1200	3–3.8	2–3	Tolerant to maize steak virus, drought & low soil nitrogen
64	S103	2003	Western Seed Co.	Western Seed Co.	0–1500	3–4	3–4	Tolerant to maize steak virus, grey leafspot & northern leaf blight, drought & low soil nitrogen

65	H519	2003	Kenya Seed Co.	Kenya Seed Co.	1200-1700	4-5	6.5	Prolific resistant to ear rots, rust, grey leaf spot, northern leaf blight, stem & root lodging compared to H513; semi-dent
66	H520	2003	Kenya Seed Co.	Kenya Seed Co.	1400-1700	4-5	4.5	Better resistant to northern blight, rust, ear rot, stem & root lodging, semi-flint. Good husk cover
67	H521	2003	Kenya Seed Co.	Kenya Seed Co.	1000-1600	4-5.5	4.5	More tolerant to grey leaf spot. Resistant to ear rot, root & stalk lodging than H513; semi-dent
68	H522	2003	Kenya Seed Co.	Kenya Seed Co.	1200-1600	4-5	6.3	Tolerant to grey leaf spot, resistant to ear rot, root & stalk lodging; semi-dent
69	H523	2003	Kenya Seed Co.	Kenya Seed Co.	1200-1600	4-5	6.6	Better yielding than H623, tolerant to grey leaf spot , resistance to root & stalk lodging; semi-dent
70	DH 8	2003	Kenya Seed Co.	Kenya Seed Co.	900-1500	3-4	4.9	Good performance in low yielding environments, resistant to ear rot, tolerant to maize streak virus, good grain quality, best for mid-altitudes
71	PHB 30G97	2003	Pioneer Hibred Zimbabwe	Pioneer Hibred Zimbabwe	1200-2000	4-5	6-9	Resistant grey leaf spot, ear rots, tolerant to MSV, good grain quality, best for mid altitudes

72	Lagrotech early	2003	Lagrotech Seed Co.	Lagrotech Seed Co.	Below 1500	2.7-3.5	2.3	Good ear cover, early maturing, striga tolerant, drought escaping
73	Simba 61	2003	AgriSeed Co. Ltd	SEEDCO Zambia	1800	4.5	7-10	Tolerant to MSV and GLS
74	DK 8071	2003	Monsanto	Monsanto	1500-1700	5	6-9	Flint grain
75	DK 8031	2003	Monsanto	Monsanto	900-1700	4-4.7	6-8	GLS tolerant
76	KSH6214	2003	Kenya Seed Co.	Kenya Seed Co.	1600-2100	6-7	9-12	Tolerance to GSL, leaf blight, lodging resistant. early maturing
77	KSH624	2004	Kenya Seed Co	Kenya Seed Co	1500-1800	5-6	8-11	Tolerance to GSL, leaf blight, rust. High yielding
78	DH10	2004	Kenya Seed Co	Kenya Seed Co	800-1400	3-4	5-6	Resistant rust, ear rots, and lodging, good husk cover, short stature
79	DH09	2004	Kenya Seed Co	Kenya Seed Co	1000-1500	3-4	3-5	Resistant to root & stalk, lodging; good husk cover high yielding
80	PAN 15	2004	Pannar Seed Co.	Pannar Seed Co.	800-1800	4-5	4-6	Resistant to blight, rust, ear rot, MSV, GLS. Good husk cover & standability
81	SC Duma 41	2004	AgriSeed Co. Ltd	SEEDCO Zambia	800-1800	4-5	6-7	Resistant to ear rot, rust, MSV, mottle virus, drought & early maturity
82	SC Duma 43	2004	AgriSeed Co. Ltd	SEEDCO Zambia	800-1800	4-5	6-7	Resistant to ear rot, rust, MSV, mottle virus, drought & early maturity

83	FICA 4	2004	FICA Seeds	FICA Seeds	800-1800	4-5	6-7	Resistant to rust, MSV, GLS, blight, good husk cover, drought, striga tolerant
84	DKC 80-53	2004	Monsanto (K) Ltd	Monsanto (K) Ltd	900-1700	4-5	5-8	Tolerant to MSV, GLS. Good standability, wide adaptability& prolific
85	DKC 80-73	2004	Monsanto (K) Ltd	Monsanto (K) Ltd	1500-1700	5-6	7-10	Tolerant to MSVt, GLS. Diplodia & Good husk cover
86	DKC 80-33	2004	Monsanto (K) Ltd	Monsanto (K) Ltd	900-1700	5-6	6-8	Resistant to GLS, good standability
87	WS 202	2004	Western Seed Co.	Western Seed Co.	0-1500	3-4	3-5	Resistant to MSV, drought, low soil nitrogen
88	KH500-21A	2004	KARI	KARI Muguga	1600-2000	5-6	7-8	Good standability, husk cover, Resistant to MSV, head smut, early maturing
89	KH500-31A	2004	KARI	KARI Muguga	1800-2100	6-7	6-7	Resistant to rust, MSV, blight, stays green (for fodder)
90	KH500-32A	2004	KARI	KARI Muguga	1300-1800	5-6	6-8	Resistant to blight, rust, MSV
91	KH500-33A	2004	KARI	KARI Muguga	1400-1800	5-6	7	Resistant to blight

92	KH500-34A	2004	KARI	KARI Muguga	1300-1800	5-6	6-8	Early maturing, Resistant to blight, rust, MSV
93	KK SYN-1	2004	KARI	KARI	1500-1800	3-4	4-5	Wide adaptability, Responsive to low input environment, Resistant to MSV
94	KK SYN-2	2004	KARI	KARI	1500-1800	3-4	5-6	Wide adaptability, Responsive to low input environment, Resistant to MSV
95	KH 631Q	2004	KARI	KARI	1000-1500	4-5	5-7	Quality protein maize, good husk cover, Resistant to GLS, ear rot, rust, blight
96	EMB 204	2004	KARI	KARI	1000-1500	5-6	7-8	Quality protein maize, good husk cover, Resistant to GLS, ear rot, rust, blight
97	Ua Kayongo 1	2004	KARI	Western Seed	1200-1600	4-5	4	Resistant to striga
98	KH 600-20A	2005	KARI	KARI Kitale	1800-2300	5-6	8-9	Good standability, good resistance to blight
99	PAN 4M-21	2005	Pannar Seed (PTY) Ltd	Pannar Seed (PTY) Ltd	1000-1500	4-5	4-5	Drought tolerant, flint grain, good husk cover, double cobber
100	SC Punda Milia 53	2005	AgriSeed Co. Ltd	SEEDCO Zambia	1800-1900	5-6	8-13	Good standability, tolerant to grey leaf spot & MSV
101	SC Simba 63	2005	AgriSeed Co. Ltd	SEEDCO Zambia	1200-1800	3-4	5-10	Drought tolerant, tolerant to grey leaf spot, MSV, blight & ear rot

102	PHB 30G19	2006	Pioneer Hi-Bred Seeds	Pioneer Hi-Bred Seeds	1000-1800	5-6	8-10	Tolerant to grey leaf spot, low ear replacement, Good husk cover & standability, lodging resistant
103	PBH 30V53	2006	Pioneer Hi-Bred Seeds	Pioneer Hi-Bred Seeds	1200-2000	5-6	8-11	Resistant to grey leaf spot, tolerant to MSV, low ear replacement, good husk cover
104	SC Tembo 73	2006	AgriSeed Co. Ltd	SEEDCO Zambia	1800-1900	5-6	8-12	Good standability, tolerant to grey leaf spot & MSV
105	SC Tembo 71	2006	AgriSeed Co. Ltd	SEEDCO Zambia	1800-1900	5-5.5	8-13	Tolerant to MSV & GLS. Good standability
106	SC Punda Milia 51	2006	AgriSeed Co. Ltd	SEEDCO Zambia	800-1600	4-4.5	6-8	Tolerant to MSV & GLS. Good standability, wide adaptability
107	WH 602	2006	Western Seed Co.	Western Seed Co.				
108	WH 101	2006	Western Seed Co.	Western Seed Co.				
109	WH401	2006	Western Seed Co.	Western Seed Co.				
110	WH 402	2006	Western Seed Co.	Western Seed Co.				
111	WH 507	2006	Western Seed Co.	Western Seed Co.				
112	WH 508	2006	Western Seed Co.	Western Seed Co.				
113	DH 06	2007	Kenya Seed Co	Kenya Seed Co	900-1500	3-4	4-6.5	Good standability, Good husk cover
114	DH 11	2007					4-6.5	

115	DH 12	2007	Kenya Seed Co	Kenya Seed Co	900-1400	3-4	4-6	Tolerant to blight & rust, resistant to stalk lodge
116	Ua Kayongo 24-5	2007	KARI	KARI Embu	1000-1500	4-5	4-2	Tolerant to herbicide for striga control, GLS & MSV, drought tolerant, good ear replacement
117	Ua Kayongo 3	2007	KARI	KARI Embu	1000-1500	4-5	4.3	Tolerant to herbicide for striga control, GLS & MSV, root & stalk lodging
118	EV 04271	2007	KARI	KARI	1500-2100	4-5	4-5	Resistant to rust, good standability
119	PH 5	2007	Kenya Seed Co	Kenya Seed Co	0-1250	4-5	6-5	Resistant to lodging, ear rot, rust, good husk cover, good standability
120	WS303	2007	Western Seed Co.	Western Seed Co.				
121	PAN 4M-19	2008	Pannar Seed (PTY) Ltd	Pannar Seed (PTY) Ltd	900-1500	3-4	4-6	Flint, drought tolerant, early maturing, fast dry down, good standablility
122	PAN 4M-17	2008	Pannar Seed (PTY) Ltd	Pannar Seed (PTY) Ltd	900-1500	3-4	4-6	Flint, drought tolerant, early maturing,
123	PAN 69	2008	Pannar Seed (PTY) Ltd	Pannar Seed (PTY) Ltd	1200-1700	4-5	7-10	High yielding wide adaptability, good standablility, tolerant to leaf diseases
124	PAN 57	2008	Pannar Seed (PTY) Ltd	Pannar Seed (PTY) Ltd	1200-1700	4-5	6-8	Flint, tolerant to leaf diseases

125	PAN 7M-97	2008	Pannar Seed (PTY) Ltd	Pannar Seed (PTY) Ltd	1400-1700	4-5	7-10	High yielding, good standablility, prolific
126	PAN 8M-91	2008	Pannar Seed (PTY) Ltd	Pannar Seed (PTY) Ltd	1400-2000	5-6	8-10	Excellent GLS & rust tolerance, good for silage, prolific
127	PAN 7M-89	2008	Pannar Seed (PTY) Ltd	Pannar Seed (PTY) Ltd	1400-2000	5-6	8-10	High yielding, tolerant to leaf diseases
128	KH500-35E	2008	KARI	KARI	1200-1600	4-5	7	Resistant to GLS, MSV, rust & blight, stay green, good stalk for animal feed
129	KH500-36E	2008	KARI	KARI	1200-1800	4-5	7	Resistant to MSV, rust & blight, flint
130	KH500-37E	2008	KARI	KARI	1200-1800	4-5	8	Resistant to MSV, rust & blight
131	KH500-39E	2008	KARI	KARI	1200-1800	4-5	8-9	Resistant to GLS & blight
132	KEMBU 214	2008	KARI	KARI	1200-1600	4-5	7	Tolerant to stem borer
133	KH500-40E	2008	KARI	KARI	1200-1800	4-5	7	Resistant to insects, tolerant to drought & low N
134	KH500-44E	2008	KARI	KARI	1500-2100	4-5	6.95	Tolerant to MSV, early

135	KH500-22A	2008	KARI	KARI	1200-2100	4-5	6.9	Tolerant to MSV, early
136	KH500-43A	2008	KARI	KARI	1200-2100	4-5	6.5	Tolerant to MSV, double cobber, high foliage (dual purpose)
137	KK BS-04	2008	KARI	KARI	All striga infested regions	4-5	5-5.5	Tolerant to striga, drought & low N, resistant to rust 7 GLS, Good standability
138	KDH4 SBR	2008	KARI	KARI			5.15	Resistant to stem borer, tolerant to drought & low N
139	KDH5 SBR	2008	KARI	KARI			4.77	Resistant to stem borer, tolerant to drought & low N
140	KDH6 SBR	2008	KARI	KARI			5.06	Resistant to stem borer, tolerant to drought & low N
141	KDH414-01 SBR	2008	KARI	KARI			5.15	Resistant to stem borer, tolerant to drought & low N
142	KDH414-02 SBR	2008	KARI	KARI			4.77	Resistant to stem borer, tolerant to drought & low N
143	KDH414-03 SBR	2008	KARI	KARI			5.06	Resistant to stem borer, tolerant to drought & low N
144	KH600-23A	2008	KARI	KARI	1800-2500	5-6	8.6-14.8	Resistant to GLS, rust & blight, less lodging

145	KH600-24A	2008	KARI	KARI	1800-2500	5-6	8.6-14.8	Resistant to GLS, rust & blight, less lodging
146	KH600-24A	2008	KARI	KARI	1800-2500	5-6	8.7-14.9	Resistant to GLS, rust & blight, less lodging
147	KS-DH14	2008	Kenya Seed Co	Kenya Seed Co	800-1300	3.5-4.5	5.0-6.5	Drought tolerant, lodging resistant, stays green
148	KS-H6216	2008	Kenya Seed Co	Kenya Seed Co	1500-2100	6-7	8.0-9.5	Lodging resistant, flint kernels
149	KS-H524	2008	Kenya Seed Co	Kenya Seed Co	1200-1500	4-5	7.5-8.5	Resistant to GLS, rust & ear rot
150	KS-H6217	2008	Kenya Seed Co	Kenya Seed Co	1500-2100	6-7	8.5-10	Lodging resistant, flint kernels
151	KH-DH13	2008	Kenya Seed Co	Kenya Seed Co	800-1800	3.5-4.5	4.5-7.6	Good husk cover, drought tolerant, resistant to ear rot, GLS, blight & rust
152	KS-H6502	2008	Kenya Seed Co	Kenya Seed Co	1300-1800	5-6	7.5-9.0	Resistant to rust, lodging resistant & tolerant to GLS & blight
153	KS-H6503	2008	Kenya Seed Co	Kenya Seed Co	1300-1800	5-6	7.5-9.0	Resistant to rust, lodging resistant, tolerant to GLS & blight
154	PHB 30D79	2008	Pioneer Hi-Bred Seeds	Pioneer Hi-Bred Seeds	1000-18000	5-6	7-11	Good tolerance to blight & MSV, resistant to GLS, strong stalks
155	WH002	2008	Western Seed Co.	Western Seed Co.				
156	WS105	2008	Western Seed Co.	Western Seed Co.				
157	WS202	2008	Western Seed Co.	Western Seed Co.				

158	WH404	2008	Western Seed Co.	Western Seed Co.				
159	WH301	2008	Western Seed Co.	Western Seed Co.				
160	WH302	2008	Western Seed Co.	Western Seed Co.				
161	WH405	2008	Western Seed Co.	Western Seed Co.				
162	WH605	2008	Western Seed Co.	Western Seed Co.				
163	WH601	2009	Western Seed Co.	Western Seed Co.	1500-2100	5-6	6-9	Tolerant to GLS & blight, lodging resistant, good husk cover
164	WS204	2009	Western Seed Co.	Western Seed Co.	800-1400	3-4	3-4	Tolerant to GLS, MSV, blight, drought, low N, striga resistant

Annex 2: Current projects dealing with Aflatoxin in Kenya.

Project	Objectives	Geographical area of coverage	Timeframe	Actors	Donor Funding
AFLASAFE	- Develop pesticides to control aflatoxin	On station testing trials – Kiboko	On trial	IITA, USDA, KARI	USAID
AFLACONTROL (Employing the scope of cost-effective afaltoxin risk reductioon startegies in maize and groundnut value chains to improve market access and health of the poor in Africa)	- Economic cost-effectiveness analysis (loss on health, income and trade) - Perceptions on aflatoxin and willingness to pay by consumers - Identify level of aflatoxin along the value chain - Develop cost effective technologies for aflatoxin control - Communication and advocacy for dissemination of results	Nyanza (Kisii and Homabay) Eastern (Mbeere, Embu, Makueni and Machakos)	?	IFRI, KARI, ACDI/VOCA, CIMMYT, ICRISAT, EAGC, Univesity of Pittsburg, insitut d' Economie Rurale, Uniformed Health Serrvices, University of the Health Services	Bill and Melinda Gates Foundation
SAFE-FOOD, SAFE DAIRY (Building capacity to improve safety in the feed-dairy	- Assess the levels of exposure to aflatoxin and fumonisins at household level, - assess agronomic practices that predispose households to	Makueni, Kibwezi, Nandi (North, Cenral,	3½ years	UON (Kenya) MTT-Agrifood research (Finland)	Ministry of Foreign Affairs (Finland)

chain with special focus on health risk associated with biological contaminants)	aflatoxin/fumonisin poisonings - Characterize the fungal species found in maize and soils - To strengthen institutional capacities to improve safety through training and infrastructure to test for mycotoxins	South)		KARI (Kenya) EVIRA (Finland) Egerton University (Kenya)	
Aflatoxin survey of Kenyan maize and development of novel diagonistics	- Conduct a small-scale survey of aflatoxin in maize in food supply of small-holder farmer - Develop novel, diagonistics techniques - Build aflatoxin testing capacity at the Hub (BECA)	?	?	Cornell and Maryland University Sygenta	Cornell Centre for Sustainable future (US$ 16,500)
KAPP Project, 2011 (Mitigating mycotoxin hazards in maize and maize products)	- Determine areas of food continuum and regions prone to mycotoxin contamination - Develop tools for recognition and detection of mycotoxin - Develop and validate mycotoxin management strategies - Package and disseminate appropriate information and technologies for management of mycotoxins	?	2 years	CAVS (Lead institution) NPHLS (MoH) NARL (KARI) ACDI-VOCA (KMDP) Plant Protection Services Subdivision (MoA)	Kenya Agricultural Productivity Project (Ksh, 7,622,900)

	contamination by extension				
Aflatoxin contamination management along the maize value chain in Kenya.	–Create awareness of aflatoxin contamination of maize along the value chain –Formulate strategies for control of aflatoxin along the maize value chain	Eastern Kenya and North rift Valley	1yea r	KARI. Kenya National federation of Agricultural Producers [KENFAP], University of Nairobi and MTT Agrifood Research Finland	PAEPARD € 30,000
Improving food safety in East and West Africa through capacity building in research and information dissemination	-Improved methods for reducing risk for mycotoxin (including aflatoxin) contamination in staple crops identified and disseminated	Eastern and Western Kenya	4 year s	ILRI, MTT, university of Nairobi	Ministry of foreign Affairs Finland
Strategies to reduce Aflatoxin levels in Maize	To assess the effect of plant and *Trichoderma* extracts on growth of *Aspergillus flavus and A. parasiticus* on maize kernels	Laboratory based study	2 year s	University of Nairobi	National council of Science and Technology

during storage	To assess the effect of plant and *Trichoderma* extracts on aflatoxin production in maize kernels. To determine the application dose of the plant extract and biocontrol agent required to control fungal growth				Kenya. $ 2,500.00

Annex 3. List of testing Laboratories with Capacity to test for Aflatoxin

	Testing Lab	Scope
1.	Kenya Bureau of Standards (KEBS) – Testing laboratories	Materials, Chemical and microbiology analysis
2	Kenya Plant Health Inspectorate Service(KEPHIS)	Analytical chemistry laboratory
3	Kenya Medical Research Institute (KEMRI)	Biomedical research
4	National Public Health Laboratories Services	Chemical and microbiology analysis
5	Kenya Agricultural Research Institute (KARI)	Food, horticulture and livestock
6	Kenya Revenue Authority – NAIROBI	Chemical and microbiology
7	Tusker Brewery Laboratory – NAIROBI	Microbiology
8	GlaxoSmithkline – NAIROBI	Chemicals (organic & inorganic) Microbiology, Food
9	Mumias Sugar Factory Laboratory – MUMIAS	Food
10	Homegrown Microbiology Labs JKIA – NAIROBI	Microbiological analysis

11	Cadbury Kenya Ltd - NAIROBI	Microbiology, Food
12	Nestle Food Kenya- NAIROBI	Microbiology, Food
13	SGS Kenya Ltd – MOMBASA & NAIROBI	Chemicals (organic & inorganic),Agricultural, Microbiology, Food, Petroleum, Environmental
14	Dawa Pharmaceuticals Ltd. – NAIROBI	Microbiology
15	Government Chemist Department - MOMBASA	Microbiology, Food, water, forensic Science Labs
16	CAMRC- KEMRI/ Wellcome Trust Research Unit – KILIFI	Microbiology, Medical, Clinic
17	Analabs Ltd. – KANGEMI, NAIROBI	Agricultural, Microbiology
18	Government Chemist Department - NAIROBI	Chemicals(organic & Inorganic), Agricultural, Food, Petroleum, chemical Toxicology
19	Intertek Caleb Brett – MOMBASA	Petroleum analysis, Chemical(inorganic) Foods
20	Polucon Services (K) Ltd – MOMBASA	Microbiology, Food, Petroleum products
21	Karlsmarts Laboratory Services- NAIROBI	Microbiology
22	Quest Laboratories	Food and chemical
23	Prolab Limited	Food and chemical
24	Jomo Kenyatta University of Agriculture and	Food, materials, environment

	Technology	
25	Coca cola Industries(BSK Kenya Ltd)	Food
26	University of Nairobi	Chemical, microbiology, veterinary services
27	ABS TCM Ltd.	Animal feed analyis
28	Bora Biotech Ltd.	Food Testing Lab
29	NAS Airport Services Ltd.	Microbiological analysis

Annex 4: Roles and mandates of Government Institutions

Ministry	Legislation	Mandate
Ministry of Agriculture	Agricultural Act – Cap 318	– Scheduling of crops – Setting prices for scheduled crops

		- Control of maize importation
	Crop Production & Livestock Act – Cap 321	- Improvement of maize & livestock production, marketing and processing - Allows destruction of crops without compensation
	Plant Protection Act – Cap 324	- Prevention of introduction and spread of plant diseases
	Seed & Plant Varieties Act – Cap 326	- Regulates transactions in seeds - Testing and certification of seeds - Restriction of importation of new varieties
	National Cereals & produce Board Act – Cap 338	- Regulates and controls produce and marketing of maize - Sets price marketing mechanisms - Preserves and procures national grain strategic reserves for the Government
Ministry of Public Health & Sanitation	Food Drugs & Chemical Substance Act – Cap 254	- Prevention of adulteration of food & drugs and chemical substances - Enforces food hygiene - Allows for analysis of agricultural produce that

		affects consumers - Control chemical residues in foods
	Public Health Act – Cap 242	- Prohibits importation of unwholesome food - Seizure and disposal of unwholesome foods - Seizure and compensation of contaminated foods - Empowers minister to enter, inspect and seize of storage facilities
Ministry of Trade	Trade & Description Act – Cap 305	- Labeling of products
	Weights & Measures Act – Cap 513	- Use, manufacture and sale of weights and measures