Client: AFLASTOP **-** ACDI/VOCA, ASI

Assignment: Environmental Impact Assessment for the Proposed Evaluation of Maize Storage Technologies on Development of Postharvest Aflatoxin Contamination in Makueni and Meru Counties

Report Title: Environmental Impact Assessment Study Report

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Table of Contents

Acronyms

ASI	-	Agribusiness Systems International
BMGF	-	Bill & Melinda Gates Foundation
EA	-	Environment Audit
EIA	-	Environmental Impact Assessment
EMCA	-	Environmental Management and Co-ordination Act, 1999
EMP	-	Environmental Management Plan
ESIA	-	Environmental and Social Impact Assessment
GOK	-	Government of Kenya
HIV/AIDs	-	Human Immunodeficiency Virus
KEBS	-	Kenya Bureau of Standards
KARI	-	Kenya Agricultural Research Institute
NEMA	-	National Environment Management Authority
NCPB	-	National Cereals and Produce Board
PACA	-	Partnership for Aflatoxin Control in Africa
TOR	-	Terms of Reference
USAID	-	United States Agency for International Development
WFP	-	World Food Programme

Executive Summary

Introduction

Based in Washington, D.C., ACDI/VOCA is a nonprofit international development organization that delivers technical and management assistance in agribusiness, financial services, enterprise development, community development and food security in order to promote broad-based economic growth and vibrant civil society.

AflaSTOP, the project awarded to The Meridian Institute and funded by USAID and the Bill & Melinda Gates Foundation (BMGF), is co-implemented by ACDI/VOCA and ASI. AflaSTOP aims to develop and commercialize technologies for post-harvest storage and drying of staple grains to help prevent and control the incidence of aflatoxin. The project will identify existing, commercially viable, small-scale storage and develop new drying technologies that will help to reduce aflatoxin contamination at the farm level, improving crop handling and management practices. Such technology will also reduce post-harvest losses, increasing the nutritional values of crops consumed by smallholders as well as the volume available for consumption and sale. AflaSTOP will develop commercialization strategies for proven solutions. AflaSTOP will promote the scaling-up of proven technologies across Sub-Saharan Africa by synthesizing and distributing lessons learned to different countries.

Smallholder farmers in Eastern Africa normally dry their grain down to between 15 – 18 percent moisture and put it into small-scale storage structures - either a room in the house, or a small wooden external structure. Higher than advised moisture levels for storage along with the warm climate provides favorable conditions for *Aspergillus* ssp. fungi to propagate resulting in continuing aflatoxin contamination.

The IFPRI implemented AflaCONTROL project provided evidence on the pervasiveness of aflatoxin in the food and products Kenyans were consuming on a regular basis, which has been shown to have significant health and nutrition consequences. Kenya law defines the safe level of aflatoxin for food products to be 10ppb. AflaCONTROL showed that aflatoxin levels above 10ppb were common in both the east and west of the country. Kenya experienced the worst outbreak of aflatoxicosis in the world in 2004, with 317 identified cases and 125 deaths. Aflatoxicosis causes liver failure and is linked with consuming extremely high levels of aflatoxin in food. AflaCONTROL collected samples with aflatoxin levels over 1,700 ppb. Chronic exposure to aflatoxin is linked to liver cancers, stunted growth and development in children, and immune system disorders.

Despite these risks, many farmers and consumers of maize based products:

- Are unaware of the link between aflatoxin and health;
- Lack knowledge on how aflatoxin proliferates in their foods on and off the field;
- and more importantly, what aflatoxin is.

Lack of knowledge of or access to technologies or skills that could reduce aflatoxin growth is pervasive. Kenyan farmers, like most African farmers, harvest maize, sell a portion, and retain as much as possible in storage to meet on going household consumption needs. Typically maize comes off the field with moisture levels of between 16 - 20% moisture. Farmers lay the maize out in the sun for a few days, but this only brings about a reduction of around 1 - 3% of the moisture content depending on where the moisture levels started and the environmental conditions. The grain is then often stored into rooms or stores not suitable to either the grain or the weather conditions. The stores are primarily made of wood and raised off the ground with minimum spaces

between the boards (based on AlfaSTOP survey data in Eastern Kenya; Makueni; 46% raised stores, 20% stores, 33% rooms in a house). None of the structures observed had proper airflow, which would have removed heat and humidity from the maize while in store and all the built stores had metal roofs which would increase the temperature inside the store. *Aspergillus* flourishes in warm humid conditions. AflaCONTROL demonstrated that while the grain was being contaminated in the field, contamination levels continued to increase once the grain was harvested and placed in storage. In fact, in Makueni, AflaCONTROL showed that while 43% of household had aflatoxin levels above 10ppb at harvest, after one month of storage 87% of households were now affected.

AflaSTOP survey data reported that only 7% of the farmers surveyed in Makueni actually experienced mold on their maize, something they associate with aflatoxin. While moldy maize can indicate that the grain has not been stored in ideal conditions, it is not indicative of the presence of aflatoxin, which cannot be seen, smelt, tasted or destroyed through cooking. Even when fed to livestock, aflatoxin will remain present in the meat, eggs, and milk.

On average in a good harvest year a household member in the surveys AflaSTOP carried out consumed 178kg in Eastern Province and 186kg in N Rift. Each day, women collected maize to eat from the store with storage periods lasting up to 24 weeks in Eastern and up to a year in North Rift. As a result the day-by-day contamination level the family is being exposed to in their daily meal of maize increases. Babies are weaned on maize meal porridge amongst other food. Only 31% of people in the survey in Eastern thought some of the sicknesses they experience might be from the food they consumed.

In the operation phase of this proposed project, a small quantity of contaminated grain (approximately 29 metric tons (mt) per district) will be procured from the local community (in the market place/or from farmers selling direct to project staff) during the harvesting period. This grain will be placed in the different storage devices inside a number of small stores (6 m x 4 m), rented in the market centers. This grain will be periodically sampled and tested for aflatoxin over 6 months. After this period, the remaining maize will be destroyed to prevent humans or animals from accidently eating the contaminated maize grain.

The storage behavior component of this project will fill an important data gap, namely the lack of evidence about the effectiveness of available farm-level storage technologies in controlling aflatoxin during storage. It is a well-documented fact that, without proper drying, handling, and storage, aflatoxin contamination increases during storage. AflaSTOP intends to demonstrate which storage devices currently available are most effective at controlling aflatoxin for farm level dry maize (~15% moisture) and good storage moisture levels (13.5% max) and will work with in-country stakeholders to market the successful technologies. This information will help farmers reduce incidence of aflatoxin in maize-based products: a problem that continues to affect millions of people in Kenya.

AflaASTOP will use a market-led approach for implementation, coordinating closely with the Partnership for Aflatoxin Control in Africa (PACA).

All environmental concerns associated with new projects must be addressed in the light of the existing regulations to ensure any conflicts are resolved through a planned and integrated formulation of mitigation measures. It is therefore currently mandatory for this project to carry out an Environmental Impact Assessment (EIA) to enhance sustainable environmental management. This report provides relevant information and environmental consideration on the project to enable the proponent to seek approval from National Environment Management Authority (NEMA) for implementation of the proposed project.

The Kenyan Environmental (Impact Assessment and Audit) Regulations of 2003 require that all proposed projects listed in the Second Schedule of the Environmental Management and Co-ordination Act, 1999 must undertake an Environmental Impact Assessment study and submit the report to the NEMA. AflaSTOP has contracted Ecoserv Consultants, a firm of experts registered by NEMA, to conduct the Environmental Impact Assessment study for the AflaSTOP program.

The Project / Program

The program, AflaSTOP, will test storage devices to try to manage aflatoxin through storage of maize grain in Makueni and Meru Counties. The project will be implemented in small, rented storage facilities in selected trading centers over a 6 month period. More specifically, the project will buy contaminated grain from the local area and then place it in different types of storage devices (e.g. small silos made of metal or plastic, and different types of bags). Every month, the project will test the grain in each storage device in order to verify if any of them prevent further aflatoxin contamination. If any of the storage devices are successful in controlling the level of aflatoxin, they will then be promoted by the AflaSTOP project to develop and commercialize new technologies for postharvest storage for smallholder farmers of staple grains to help prevent and control aflatoxin.

Project Justification

Maize is an important food crop in Kenya, consumed by all communities. It is planted in one out of every two acres of land under crop production. Efforts to increase production such as use of fertilizers, weed control, insect and disease control have continued to increase yields, but post-harvest handling of the produced grain remains rudimentary.

During storage, the poorly prepared grain is vulnerable to further contamination by mycotoxigenic fungi which include *Aspergillus, Fusarium* and *Penicilum*. Such fungi activity leads to mycotoxin production. Mycotoxins cause significant economic loses associated to human health, animal production and trade. Aflatoxins B1, B2, G1 and G2 are produced by strains of *Aspergillus flavus, Aspergillus parasiticus* and *Aspergillus nomius* with aflatoxin B1 being the most common.

In Kenya, aflatoxin poisoning has been occasionally reported causing both disease and death in animals and humans. The first reported outbreak of aflatoxicosis in Kenya was reported in 1978; many outbreaks have since been reported with the worst in 2004 in which 317 cases were reported with 125 deaths in Eastern province, Kenya. Maize from the affected area contained as much as 4,400 ng/g aflatoxin B1, which is >400 times the 10ng/g tolerance level set by KEBS.

Aflatoxin contamination in maize has been associated with drought and stress to growing plants combined with high temperatures as well as insect injury, poor harvesting practices and improper storage.

This project will provide data on the small scale storage technologies best suited for agro climatic zones of Meru and Makueni counties that will prevent further aflatoxin contamination of maize. These areas have been reported to have most outbreaks of aflatoxicosis in Kenya, the most virulent strain of *aspergillus* is found in Makueni and therefore devices found to work here can be rolled out throughout the country.

The EIA Study

In compliance with the Environmental Management and Co-ordination Act No 8 of 1999, Section 58 and legal notice No 101 of the Environmental (Impact Assessment and Audit) Regulations, 7 to 8 of 2003, the proponent of a project is required to undertake an environmental impact assessment (EIA) prior to implementation of project as specified in the second Schedule of the Act.

For this project, the proponent undertook a project (Scoping) report (**NEMA/PR/5/2/11488**) which was submitted to NEMA. In a letter dated **1st October 2013**, NEMA communicated its decision and directed the proponent to initiate an EIA study to facilitate in depth evaluation of potential impacts associated with the project.

In order to commence the study, the Act requires that the firm of experts appointed by the proponent, in agreement with NEMA, develops Terms of Reference (TOR) for the study, which will be approved by NEMA. These TOR were developed and submitted to NEMA for approval. On 8th October 2013, NEMA approved the TOR submitted by the Experts and which has formed the basis of this study.

The ultimate goal of the EIA Study was to identify the anticipated environmental impacts resulting from proposed evaluation of maize storage technologies on development of postharvest aflatoxin contamination in Makueni and Meru Counties that is determined on the basis of the baseline conditions established during the review of AflaSTOP's documents and additional information obtained from other documents. Potential impacts are anticipated on waste management, health and safety aspects among others. Guided by the Kenyan EIA regulations (Kenya Gazette Notice No. 56 of 13 June 2003), the following are the key issues that have been covered in this environmental impact assessment study;

(i) A comprehensive description of the proposed project including its objectives, preliminary designs (as availed by the Client), proposed project implementation and anticipated by-products among others,
(ii) Description of the project areas such as to cover the location, environmental setting, social and economic issues, as well as national development plans, etc.,
(iii) Policy, legal and institutional framework within which the proposed project will operate,
(iv) An overview of the anticipated impacts from the project to physical environment, social status and general benefits to the national economy,
(v) Appropriate mitigation measures and action plans have also been suggested for incorporation into the project implementation and facilities operations thereafter.

General Findings

i. Six stores have been identified in Makueni county and six stores in Meru county for storage of maize by the Proponent. The stores are strategically located within the town centers and are easily accessible.
ii. In Makueni County, the metal silo and plastic silo are already placed inside the store. The stores have been lined with a canvas lining on the floor for trap any contaminants.
iii. All stores are safely locked with metal doors and windows fitted with a metal grills.
iv. Administration officers (Chiefs) in each of the areas visited during the study are aware of the project and have been informing local communities about the project.

Anticipated Impacts

The charts below illustrates the key impact indicative parameters applied in the assessment associated with the project implementation and post-implementation phases

Impact Aspect	Potential project related Issues Investigated	
	Environmental Significance	**Human Health and Safety Significance**
Waste Management	Potential Impact **Low Negative** ▪ Investigate waste management capacity availability to handle the contaminated maize at end of the project ▪ Safety and security of the contaminated maize during disposal	Potential Impact **Low negative** ▪ Suitable incineration capacity to undertake the job safely
Handling contaminated grain	Potential Impact; **low negative** ▪ Decontamination of transportation trucks	Potential Impact **Low Negative** (reversible) ▪ Potential human inhalation or ingestion of spores or aflatoxin from within stores or when handling the maize ▪ Safety and security of the contaminated maize during storage, and transportation and disposal Potential Impact; **medium positive** ▪ Potential improved health of the population due to use of storage that reduces the increase of aflatoxin levels in stored maize.
Drainage	Potential Impact **Low negative** ▪ Disposal of wash waters from cleaning of transportation trucks, grain dryer, stored and large equipment. ▪ Potential run off of wash water into the neighbouring areas and receiving rivers	Potential Impact; **Low - medium** ▪ Potential run off poorly prepared wash water into the neighbouring areas and receiving rivers
Ecological	Potential Impact; **Medium positive** Reduced presence of *aspergillus* spores due to reduced growth of *aspergillus* during storage.	

Impact Aspect	Potential project related Issues Investigated	
	Social Significance	**Economic Significance**
Social	Potential impact; **High Positive** ▪ Improved health ▪ Reduced occurrence of aflatoxin outbreaks	Potential Impact; **High positive** ▪ Improved food security ▪ Employment creation as maize and other grain storage containers are locally produced and sold through local networks
Economic Linkages	Potential Impact; **High Positive** ▪ Employment creation in rural areas	Potential Impact; **High Positive** ▪ Improved trading opportunities ▪ Increased safe food to sell

Conclusion

In conclusion the environmental risks surrounding this project are low, the maize procured will come from the area it will be stored in for six months, and at the end of the project the maize will be transported to a NEMA licensed incinerator and disposed appropriate as per Kenyan regulations. The wash water from cleaning the large scale equipment could have negative impacts if not properly diluted, but it is the same treatment as most households use to clean sinks, toilets etc.. The health risks for workers undertaking activities for this project are low and the project has in place protective measures to protect those that might be at greatest risk. If contaminated maize was stolen by thieves breaking into the stores, or collecting grain from a truck which had spilled its load there are potential high health risks if this maize was then eaten, particular towards the end of the project when maize has been stored for up to 6 months and aflatoxin levels will have increased from around 50ppb to an unknown (at this point) level (while it is not acceptable it is common occurrence that people are eating maize with levels between 10 - 100ppb for everyday meals). The project has a number of security measures to prevent this happening but cannot guarantee it will not happen.

Proposed mitigation measures including strict adherence to developed handling protocols for the contaminated grain, environmental management and monitoring plan will reduce the potential for the minor human or ecological adverse impacts that may arise from the project. Implementation of the formulated mitigation measures of the negative impacts will ultimately result in minimization of the impacts such that we as consultants do not believe there will be grounds to object to the project. The grain quantities to be used during the operation phase are small relative to the grain production in the areas of study.

This project will go a long way to address the millennium goals of food security, and health, with many value chain benefits and alignment with the country's 2030 vision. The proposed project, incorporating mitigation measures is consistent with the Kenya government policy to provide food security and health to its people. It is imperative to note that we recommend the project for licensing, with all mitigation measures recommended to be implemented in total.

Chapter 1: Project Background

1.1 AflaSTOP Project

AflaSTOP aims to develop and commercialize technologies for post-harvest storage and drying of staple grains to help prevent and control the incidence of aflatoxin. The project will identify and market existing, commercially viable, small-scale storage and develop new drying technologies that will help to reduce aflatoxin contamination at the farm level, improving crop handling and management practices. Such technology will also reduce post-harvest losses, increasing the nutritional values of crops consumed by smallholders, as well as the volume available for consumption and sale. AflaSTOP will then promote the scaling-up of proven technologies across Sub-Saharan Africa by synthesizing and distributing lessons learned to different countries.

The research and development component of this project will fill an important data gap, namely the lack of evidence about the effectiveness of available farm-level storage technologies in controlling aflatoxin during storage. It is a well-documented fact that, without proper drying, handling, and storage, aflatoxin contamination increases during storage. AflaSTOP will demonstrate which storage devices are most effective at controlling aflatoxin. This information will help farmers reduce incidence of aflatoxin in maize-based products that continues to affect millions of people in Kenya.

Smallholder farmers in Eastern Africa normally dry their grain to a moisture level of between 15 to 18 percent and then put the maize into small-scale storage structures, which could be a room in the house, or a small, wooden structure separate from the house. In general, these storage spaces have poor airflow, which allows for a build-up of heat and humidity - both of which create ideal conditions for the growth of mold. Higher than advised moisture levels for storage, along with the warm climate, further contribute to favorable conditions for the growth of *Aspergillus* fungi, which if present results in increased aflatoxin contamination in staple grains as well as many other agricultural products.

In 2004, Kenya experienced the worst outbreak of aflatoxicosis in the world, with 317 identified cases and 125 deaths. Aflatoxicosis causes liver failure and is linked with consuming extremely high levels of aflatoxin in food - AflaCONTROL collected grain samples that were contaminated with aflatoxin levels at over 1,700 ppb. Even at much lower levels, chronic exposure to aflatoxin is linked to liver cancers, stunted growth and development in children, and immune system disorders.

From 2008 to 2011, The International Food Policy Research Institute (IFPRI) & ACDI/VOCA implemented the AflaCONTROL project, which provided evidence on the pervasiveness of aflatoxin in the maize that Kenyans were consuming on a regular basis. Such contamination has been shown to have significant health and nutrition consequences, and while Kenyan law defines the safe level of aflatoxin for food products to be 10 parts per billion (ppb), the AflaCONTROL project found that aflatoxin levels above 10ppb were common in both the East and West of the country. Furthermore, AflaCONTROL demonstrated that the grain was already contaminated in the field, and that contamination levels continued to increase once the grain was harvested and placed in storage. In fact, in Makueni, AflaCONTROL showed that while 43 percent of households had aflatoxin levels above 10ppb at harvest, another 44 percent of farmers were effected after only one - two months of storage – meaning that 87 percent of households were effected with levels above 10ppb. Details on the aflatoxin problem in food and feed in Kenya, with references are given in expert review report in Annex 7.

Despite these risks, many farmers and consumers of maize based products:

- Are unaware of the link between aflatoxin and health;
- Lack knowledge of aflatoxin and how aflatoxin proliferates in their foods on and off the field; and
- Lack knowledge of or access to technologies or skills that could reduce the incidence of aflatoxin in their crops.

Assessing Current Technology

AflaSTOP will investigate whether current small-scale storage technologies (hermetic bags, plastic silos, metal silos, etc.) can prevent the *Aspergillus* fungi from continuing to produce aflatoxins during storage. It will do this through a thorough testing of storage technologies currently available and suitable for smallholder farmers from private sector companies operating or intending to operate in East Africa. The project aims to identify devices that will prevent and control aflatoxin contamination during storage, as well as pest infestation.

If the technologies appear to work in the off-farm testing phase, AflaSTOP will continue to test them with smallholder farmers (on-farm testing), while also working with the private sector to establish more widespread, commercial distribution. Through on-farm testing, AflaSTOP will observe whether post-harvest practices by smallholder farmers influence the effectiveness of the storage devices to help control and prevent aflatoxin contamination. In this scenario, smallholder farmers will use their own grain in the storage devices and AflaSTOP will simply monitor the ongoing quality of the grain and insect infestation, as well as how well suited the storage device is to the smallholder farmer's needs and requirements.

Device Effectiveness:

In order to test the actual effectiveness of storage devices currently available, AflaSTOP will source contaminated grain available on the market or through farmers at harvest from both Makueni and Meru counties in Eastern Kenya. To improve the project's ability to get statistically significant results with limited volumes of contaminated grain, the project will incubate the contaminated grain so that the aflatoxin levels rise to around 50ppb. Each batch of grain will be mixed thoroughly to ensure it as homogenous as possible, and then half the grain will be dried to a moisture level below 13.5 percent (this will be done in specialized facilities within the premises of Lesiolo Grain Handlers Ltd, Nakuru) while the other half of the grain will be dried (if required) to around 15% moisture level. The grain will then be placed in the different storage devices in 12 small stores in Makueni and Meru counties in Eastern Kenya. The grain within each storage device will be sampled and tested every month for 6 months, after which the grain will be collected and destroyed. All equipment and storage spaces will be thoroughly cleaned after project use. Any storage devices found effective will then be tested with the farmers using their own harvested grain (no incubation will take place at this stage) to see whether it works under farm conditions.

Environmental Safeguards:

AflaSTOP will implement a number of protocols to safeguard the Kenyan environment and people from contamination from the grain procured for the testing phase of the project. All protocols and safe handling instructions have been developed with the following environmental and personnel considerations of the AflaSTOP project in mind. In terms of human safety the first consideration is the safety of the employed personnel who come in contact with the contaminated grain. The secondary consideration is exposure of the general public.

To mitigate the risk of exposure, the project has developed a safety plan for exposure to workers, the general community, transporters, and possible theft. The Aflatoxin Safe Handling Action Plan

(A-SHAP) Annex 8 will reduce exposure and the plan outlines the equipment personnel will need to wear and the precautions to be taken when handling contaminated grain. All personnel will also be trained prior to handling contaminated grain. The second consideration is general exposure of the population which other than for theft the risk is very low - the contaminated grain will be brought to the stores in bags, and decanted carefully into the storage devices. The grain will remain in the storage devices for approximately 6 months, and then removed. The bags will simply be carried back into the trucks. The bulk devices will have to be unloaded but the risk to the general population at this point is very low since they will not be allowed into the stores while the operation is undertaken . The third area is the loss of contaminated grain through theft from any of the storage points or during transportation. In response to this, each storage point will be securely locked and will be monitored externally by an askari. Inside the store, there will be clear warnings in Swahili stating that the goods are dangerous to human health and should not be consumed under any circumstances. Each storage device will have a standard danger warning sticker on it. In addition, AlfaSTOP staff will carefully monitor the stores on bi monthly basis. In regards to transportation of the contaminated grain, AflaSTOP staff will accompany all trucks transporting contaminated grain. If for some reason the grain needs to remain in a truck overnight, the truck will be locked into a secure compound and be guarded by an askari. There is always the possibility of a road accident. Simple road accidents will be dealt with by transferring the bags of grain to an alternative truck; AflaSTOP staff would remain with the grain and bring in askaris to guard it at night if it had not been transferred within daylight hours and the local police force would be immediately informed. If the accident was more severe and the truck over turned and burst open with bags being burst and spreading the grain onto the ground - again AflaSTOP staff would be in attendance, the local police force would be called to attend the scene, labourers would be immediately hired to gather up the grain from the ground, and to transfer the grain into an alternative truck. The final consideration is the cleaning of equipment, trucks and stores after they have come into contact with contaminated grain. In this regard, small equipment such as grain probes will be cleaned using a mixture of ethanol and water. Larger equipment and surfaces such as mechanized dryers, trucks, and stores will be cleaned using a solution of sodium hypochlorite (bleach) and water. This A-SHAP has been peer reviewed by both Kenyan and international aflatoxin expert (Annex 7).

The use of sodium hypochlorite breaks open the aflatoxin ring structure and results in the deactivation of the toxin. The solution will also kill any *Aspergillus* fungi remaining in the equipment to avoid any subsequent contamination.

The final consideration is the disposal of contaminated grain and any other equipment which cannot be properly cleaned. In this scenario, unless an alternative approved by the Government of Kenya is found, the project intends to incinerate the grain and any additional equipment at an accredited facility that has the technical capacity to handle and manage hazardous wastes, plus monitor all airborne chemical releases.

1.2 Project and EIA Justification

Maize is an important food crop in Kenya, consumed by all communities. It is planted in one out of every two acres of land under crop production. Efforts to increase production such as use of fertilizers, weed control, insect and disease control have continued to increase yields, but post-harvest handling of the produced grain remains rudimentary.

During storage, the poorly prepared grain is vulnerable to further contamination by mycotoxigenic fungi which include *Aspergillus, Fusarium* and *Penicilum*. Such fungi activity leads to mycotoxin production. Mycotoxins cause significant economic loses associated to human health, animal production and trade. Aflatoxins B1, B2, G1 and G2 are produced by strains of *Aspergillus flavus, Aspergillus parasiticus* and *Aspergillus nomius* with aflatoxin B1 being the most common.

In Kenya aflatoxin poisoning has been occasionally reported causing both disease and death in animals and humans. The first reported outbreak of aflatoxicosis in Kenya was reported in 1978; many outbreaks have since been reported with the worst in 2004 in which 317 cases were reported with 125 deaths in Eastern Province, Kenya. Maize from the affected area contained as much as 4,400 ng/g aflatoxin B1, which is >400 times the 10ng/g tolerance level set by KEBS.

Aflatoxin contamination in maize has been associated with drought and stress to growing plants combined with high temperatures as well as insect injury, poor harvesting practices and improper storage.

This project will provide data on the small scale storage technologies best suited for agro climatic zones of Meru and Makueni counties that will prevent further aflatoxin contamination of maize. These areas have been reported to have most outbreaks of aflatoxicosis in Kenya, the most virulent strain of *aspergillus* is found in Makueni and therefore devices found to work here can be rolled out throughout the country.

1.3 The Study Approach

1.3.1 Overview

In accordance to the Kenyan EIA regulations (Kenya Gazette Notice No. 56 of 13 June 2003), the following are the key issues that have been covered in the environmental impact assessment study;

(i) A comprehensive description of the proposed project including its objectives, preliminary designs (as availed by the Client), proposed project implementation and anticipated by-products among others,
(ii) Description of the project areas such as to cover the location, environmental setting, social and economic issues, as well as national development plans, etc. linkages have been established between the information so gained and the role of the proposed project,
(iii) Key social linkages including business (associated costs, employments and working schedules) and social disruptions in terms of accessibility of common resources and amenities and travelling schedules,
(iv) Policy, legal and institutional framework within which the proposed project will operate, that will also include the corporate policy and strategic planning,
(v) An overview of the anticipated impacts from the project to physical environment, social status and general benefits to the national economy. Appropriate mitigation measures and action plans have also been suggested for incorporation into the project implementation and facilities operations thereafter.

Following on the above, emphasis on the environmental and social assessment for the project have been laid on the following key areas;

(i) Environmental baseline conditions within Makueni and Meru Counties,

(ii) Anticipated environmental impacts with particular focus on human health risk from exposure, physical environment, social and economic issues as well as natural resources aspects within the project region,
(iii) Social implications of the project gathered through structured public participation and interviews with the stakeholders, etc.,
(iv) Mitigation measures and an environmental management plan outline have also been developed,

The ultimate goal of the EIA Study is to identify the potential impacts resulting from the proposed project and develop mitigation measures to reduce or eliminate negative effects, which is determined on the basis of the baseline conditions established during the field work and information obtained from the documents reviewed.

1.3.2 Preliminary Consultations

Preliminary meetings with the Client took place followed by an immediate mobilization of the Consultant Team. A reconnaissance tour of the town centers was carried out during the project report stage, followed by a review of the available project documents and the development of the TOR (TOR document). A copy of the TOR and its approval leading to the approval by NEMA to undertake the full study is attached in Annex 10.

1.3.3 Document and Literature Review

Various relevant documents were reviewed in accordance with the terms of reference, environmental status data, social and economic characteristics of the two counties in general. In summary, the following documents were reviewed;

(i) The Terms of Reference,
(ii) Latest state of environment report for Makueni and Meru area,
(iii) Policy documents and legal statutes,
(iv) Kenyan environmental legislation and standards.
(v) Aflatoxin in Kenya back ground document which researched human and ecological exposure (Annex 12)

1.3.4 Environmental and Social Assessments

The various stores have been selected within the two counties, selection criteria are laid out in the store protocol Annex 2. A comprehensive physical evaluation of the project area has been undertaken taking into consideration physical and biological environmental conditions and socio-economic activities within and around the counties.

Field visits also involved interviews of key stakeholders within the counties. The project brief was presented to the respective NEMA, Agriculture, Water and Irrigation, Public Health and other stakeholder offices, Kenya Red Cross, Drought Management and World Vision offices. Interviews with focused groups were also undertaken for the surrounding communities in collaboration with the Local Administration at pre-determined locations in Makueni County (Muumandu, Katuaa, Kivani and Chabalasi town centers) and in Meru County (Marima, Giampampo, Kariene, Mwichiune town centers). Information collection tools for this purpose were prepared, distributed and completed by the participating stakeholders. Among the objectives of the detailed fieldwork were to:

(i) Obtain available information on the importance of safe maize storage issues and views and opinion on the proposed project in relation to health and safety, and environmental issues. The meetings were arranged prior to the visits by the consultants in collaboration with the Local Administration and AlfaSTOP
(ii) Assessment of the store locations with respect to land use, proximity to human settlements, potential health and safety of the residents, size and ownership among other issues.

1.3.5 Reporting

The process of report writing involved participation of the team members through analysis of respective data and information obtained. This was translated into findings and anticipated impacts. It also provided a basis for development of mitigation measures and an Environment Management Plan for incorporation in the project implementation and other investigation.

1.4 EIA Outputs

The EIA process generated the following output documents;

(i) Project Report
(ii) Terms of Reference for NEMA approval (Submitted and approved by NEMA)
(iii) EIA Full Study Report for submission to NEMA for review and approval process

1.5 Study Team

The EIA exercise was undertaken by a multidisciplinary team of experts including the following;

1. Prof. Anthony Gachanja — Lead EIA Expert (Team Leader)
2. Mr. Muriuki Gitau — Environmental Engineer
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Chapter 2: Project Background Description

Aspergillus fungi prefer warm moist conditions to develop whether inside the plant or inside the store. Bother western Kenya and Eastern Kenya appear to have suitable conditions since in the AflaCONTROL project over 43% of field level samples had aflatoxin levels above 10ppb. Furthermore when plants become stressed for since due to insufficient water for optimum growth, they are more susceptible to *aspergillus* growth and subsequently aflatoxin contamination - which again relates to the high occurrence found in Eastern Districts.

In terms of the scientific approach of the project there is a balance to be made between the number of test sites, the influence of random factors and the statistical reliability of the data collected. To reduce a number of random factors, the stores all follow a basic design (for instance they all have metal roofs rather than a mixture of concrete and metal). In each testing area, the stores are all in the same agro climatic zone - there may be slight changes of temperature, humidity, and altitude, but these are slight variations enough to show that these slight changes do not make a difference to the outcome.

Makueni currently hosts the most virulent strain of aflatoxin producing *aspergillus*, therefore if the devices are found to work with the Makueni and Meru strains, there is a strong to definite assurance (depending on the statistical analysis) that they will work with less robust *aspergillus* strains elsewhere in the country.

2.1 Geographical Location of Makueni County

2.1.1 Location and size

The County covers an area of 8,034.7 Km^2. The County borders several counties which include Kajiado to the West, Taita Taveta to the South, Kitui to the East and Machakos to the North. It lies between Latitude 1º 35´ and 30 00 South and Longitude 37º10´ and 38º 30´East.

2.1.2 Climate

The County experiences two rainy seasons, the long rains occurring in March /April while the short rains occur in November/December. The hilly parts of Mbooni and Kilungu receive 800-1200mm of rainfall per year. High temperatures of 35.8^{0}C are experienced in the low-lying areas causing high evaporation which worsens the dry conditions. Climate variations and extreme differences in temperatures can be explained by change in altitude.

The areas to the north such as Kilungu and Mbooni hills are usually cool with temperatures ranging from 20.2^{0}C to 24.6^{0}C, while the low-lying areas of the south such as Kitise are usually hot. Generally, the County experiences high temperatures during the day and low temperatures at night. During the dry periods between May and October the lower parts of the County experience severe heat. The northern part of the County is hilly with medium rainfall ranging from 800mm to 1200mm and has high potential for food crop production. This part of the County, covering mainly in Kilungu and Kaiti has few natural and planted forests, the area is therefore suitable for horticulture and dairy farming. Over time, the County has experienced climate change and variability, which includes insufficient rain and prolonged dry spells among others.

2.1.3 Topography

The County lies in the arid and semi-arid zones of the eastern region of the country. The major physical features in Makueni County include the volcanic Chyulu hills which lie along the southwest border of the County in Kibwezi West Constituency, Mbooni Hills in Mbooni constituency and Kilungu Hills in Kaiti constituency which rise to 1,900m above sea level. The County terrain is generally low-lying from 600m above sea level in Tsavo at the southern end of the County.

2.1.4 Geology and soils

The area is under laid with basement rock system. They are represented in the area by stratified succession of originally sedimentary rocks all of which have metamorphosed and granitized. Other rock types are derived from lavas and volcanic fragment rocks. This type of rock is porous in nature and percolation of pollutants to ground water is potential. There three distinct soil types in the County. Red clay soils which occur in the hills and some parts of the lowlands, the sandy soils which mainly occur in the central parts of the County. Black cotton soils found mainly in southern parts of the County

2.1.5 Water resources

The County is largely arid and semi arid and usually prone to frequent droughts. The lower side which is very dry receives little rainfall ranging from 300mm to 400mm. The southern part of the district is low lying grassland, which receives little rainfall but has an enormous potential for ranching. The northern part of the district is hilly with medium rainfall and has potential for food crop production

Surface water

The main river in the County is Athi River, which is perennial and fed by tributaries such as Kambu, Kiboko, Kaiti, Thwake and Mtito Andei, which drain from various parts of the County. A few other streams flow from the Mbooni and Kilungu Hills but their flow becomes irregular as they move to the low-lying areas. These rivers provide a high potential for both large and small-scale irrigation.

Water resources, quality and supply schemes

The County has two permanent rivers; Athi and Kibwezi. There are four protected springs and 117 boreholes. Households with piped water are 12671 while 27752 households have access to potable water. There are 289 water pans and 159 surface dams.

The water demand in the County is 22,113 M^3/day and developed sources have an average production of 13,607 M^3/day.

There are two major rivers: Athi which is permanent and Thwake which is semi-permanent. Other big rivers include Kaiti, Muooni and Kikuu all of which are seasonal. There are 278 earth dams with a storage capacity of 3,265,543 M^3 while the sand dams are four protected springs and 117 boreholes.

Water Supply schemes

Households with piped water are 12,671 while 27,752 households have access to potable water while here are 289 water pans. There are 159 water supply schemes with a production capacity of 1360.7 M^3/hour.

The average distance to nearest water source is eight Kilometres indicating that there is need for initiating more water projects. Athi River which is perennial passes through the County and can be used for development of major water supply schemes. Sand and earth dams are used in water harvesting. Due to perennial water shortages, the local community has picked up the practice of roof catchments and installation of and storage tanks to harvest rain water.

Sanitation

All the major towns lack sewerage facilities and the sanitation condition is worsened by water shortage. The local community has however embraced the use of toilets and currently about 80 per cent of the households have access pit latrines.

2.1.6 Population

According to the national census exercise that was carried out in 2009 the population of the County is approximated to be 884,527 comprising of male – 49% and female – 51%. The total number of households is 320,616 as per the 2009 National Census. This gives a population density of 110.4 people per Km2. In reference to the age pyramid, 43.7% fall under the 0-14 year bracket, 5.2% above the 65+ years and 51.1% between the 15-64 year bracket which is considered the most productive age group in the pyramid. 12% of the total population lives in the urban areas while the rest of the population is projected to be living in the rural areas (Kenya Bureau of Statistics).

2.1.7 Infrastructure and Access

Modern and well maintained infrastructure is the key catalyst to socio- economic growth and development. Production costs remain high if the physical infrastructure is undeveloped or poorly maintained. Competitiveness and access to markets therefore depend to a large extent on efficiency and effectiveness of the physical infrastructure.

Road, Rail Network and Airstrip

The County has a total road network of 3,203.5 Km of which 453.8Kms is bitumen, 555.2Kms gravel, and 2,198.6Kms surface roads. The main roads in the County are Katumani-Wote-Makindu road, Masii-Mbumbuni road Salama-Kikoko and Mombasa road. The bitumen roads are in fairly good condition but most of the gravel and surface roads are in poor state which makes them impassable during rain seasons. The County is traversed by a railway line which covers 140 kms. Major railway stations are Makindu, Kibwezi, Mtito-Andei and Emali. It also have has one airstrip situated in Makindu and it is operational.

2.1.8 Administrative Units

The County is currently divided into nine sub-counties and twenty five divisions as shown in Table Six. The sub counties are Makueni, Kilungu, Mukaa, Kibwezi, Kathonzweni, Makindu, Mbooni East, Mbooni West and Nzaui. Among the Divisions, Mtito Andei, Makindu and Kibwezi are the largest and are situated in the low potential areas of the County while, Kee, Mbitini, Kalamba, Kilome and Kasikeu are the smallest in that order.

Source: Kenya National Bureau of Statistics

2.1.9 Ecological Conditions

The County is largely arid and semi-arid and usually prone to frequent droughts. The lower side which is very dry receives little rainfall ranging from 300mm to 400mm. The depressed rains in the lower part of the County hardly sustain the major staple food of maize and beans. Unfortunately, the traditional crops which are more drought tolerant have largely been abandoned. Outbreaks of aflatoxin in maize occur when maize is stressed through lack of sufficient water, or insect infestation during the growing period. The ecological conditions in Makueni and the diversification into maize have allowed toxigenic strains of *aspergillus* to flourish.

2.1.10 Land and land use

The County has a total arable land of 5042.69Km^2 which is 74 percent of the total area. A total of 1,762.71Km^2 is non-arable accounting for 21.9 percent of the total area. Part of the 2,023 Ha of land that Konza Technology City lies in the County. There are no water masses or industrial area in the County while the urban area accounts for only 7.4 percent of the total area. Most of the land is used for agricultural purposes since most people depend on agriculture and livestock for their livelihood. The County has potential in horticulture and dairy farming especially the hilly parts of Kilungu and Mbooni west sub counties. The lowlands are used for livestock, cotton and fruit production. Fruits grown are mainly mangoes, pawpaw and oranges. These areas include; Kathonzweni, Mbooni East, Nzaui and Makueni sub counties. There is an upcoming fruit processing plant at Wote town to process the fruits as well as a ginnery for cotton processing. This will go a long way in value addition for these products.

2.1.11 Environment and Climate Change

The reduced agricultural production due to drought being experienced in the County has significantly contributed to environmental degradation as residents seek an alternative source of livelihood. These include sand harvesting and charcoal burning which have reduced the vegetation and forest cover. Industrial effluent and plastic materials released into Athi River at the upstream locations and poor farming methods has also contributed to environmental degradation.

There is reduced forest cover in the County due to charcoal burning which has resulted to soil erosion affecting soil fertility and the crop production. Sand harvesting has also contributed to soil erosion of river banks and further vegetation loss. The County continues to experience dry spells which appear to be worsening; a situation where environmental degradation may have contributed.

To protect the environment the County has embarked on protection of hill tops, regulating sand harvesting and charcoal burning by increasing surveillance. Due to the high poverty level and limited range of economic activities, there is a need to initiate alternative economic activities to mitigate against the environmental degradation of current activities.

2.1.12 Health

The health sector has played a major role in ensuring that most of the County‘s population can access affordable healthcare services. There is Makueni level five hospital, six level four hospitals at Kilungu, Makindu, Mbooni, Kibwezi, Mukaa and Nzaui. The County also has 21 level three, 113 dispensaries and eleven private clinics. Most of the public health institutions lack sufficient drugs, equipment, transport and health personnel. The bed capacity in the County stands at 616 and doctor population ratio is 1:22,712 which is below the accepted standards. There are nine VCTs and 138 counselors in the County which need to be increased to accommodate the population. The average household distance to health facility is six Kilometers which is way below the national recommended distance of four Kilometers.

The current average Morbidity rate in the County is 33.3 percent which higher than the national average of 24.7 percent. Malaria is the most common disease in the County with a

prevalence rate of 51.1 percent followed by flu (12.7 percent) and stomach-ache (5 percent) Other common disease include upper and lower respiratory diseases (3.3 percent) and diarrhea (2.5 percent).

The immunization rate in the County is 62.26 per cent while contraceptive acceptance rate is 30.75 per cent.

HIV/AIDS

The Kenya HIV/AIDS Indicator Survey (KAIS-2009) indicated that the HIV/AIDS incidence was 7.4 per cent of Kenyans aged 15-64 years as compared to 6.3 per cent in 2003. Women were more likely to be infected (8.4 per cent) than men (5.4 per cent). In particular, young women aged 15-24 years were four times more likely to be infected (5.6 per cent) than young men of the same age group (1.4 per cent). Makueni County has registered a decline in HIV prevalence from a high of approximately 10.30 per cent in 2006 to a low of approximately four per cent in 2012. Cases related to HIV/Aids are still the leading killer among the productive segment (ages 15-45 years) majority of whom are women. HIV and AIDs remain a big challenge due to its devastating effect. In Agriculture, where 70 per cent of the rural population derive their livelihood, the pandemic has reduced productivity through loss of manpower and productive time. Generally HIV and AIDS has affected all sectors of the economy in the County as a result of absenteeism, sick days and deaths. The caring for the sick leaves less time for work while high costs of treatment means resources are diverted from productive use.

Persons with HIV are immune compromised and are thought to be more adversely effected when exposed to aflatoxin compared to healthier individuals.

2.1.13 Education and Literacy

Pre-School Education

The County has 1,510 Early Childhood Development (ECD) Centres with a total enrolment of 41,820 composed of 21,922 boys and 19,898 girls. There is a high retention rate of 94.4 per cent and average of two years of attendance. There are 1315 teachers translating into a teacher pupil ratio is 1:25.

Primary Education

The County has 982 primary schools out of which 914 are government owned while 68 are privately owned. The total enrolment is 269,752 pupils and 7,242 teachers which translate into a teacher pupil ratio of 1:37. The retention rate is 93 per cent. On average most of the pupils (70 per cent) cover a long distance of 5 km to the nearest school. The Gross Enrolment rate in primary school stands at 120 per cent meaning there are many children who are above age 6-13 age group who are still in primary school.

The illiteracy rate in the County is 22.41 per cent against the national level of 28.59 per cent.

In 2012 there were 339 secondary schools with a total enrolment of 75,985 and a retention rate of 86 per cent. With a total of 2300 teachers, the County has a teacher pupil ratio of 1:33. The transition rate from primary to secondary school is 60 per cent while Gross Enrolment rate stands at 76.6 per cent

The County has 12 tertiary institutions and two university satellite campuses. Shortage of University and National Polytechnics to accommodate the high numbers of students from secondary schools impacts negatively in career development.

2.1.14 Economy

The major economic sectors of the Makueni County's economy are tourism, industry, mining, agriculture and commerce.

2.1.15 Tourism

The County shares a small part of the famous Tsavo National Park which is considered as one of the world's biodiversity strongholds. Tourism activities are mainly confined within the park which is rich in diverse wildlife which include the famous 'big five' consisting of lion, black rhino, cape buffalo, elephant and leopard. The park also is also home to a great variety of bird life such as the black kite, crowned crane, lovebird and the sacred Ibis. To support tourism there are three one star hotels situated in Wote and Mtito Andei. There is a need to invest in more tourism class hotels as establishment of Konza ICT Park is in addition expected to enhance the potential of tourism in the County.

Tsavo National park which lies in the southern part of the County, in Kibwezi West Constituency is considered as one of the world's biodiversity strongholds. It is home to diverse wildlife species which include the famous 'big five' consisting of lion, black rhino, cape, elephant and leopard. The park also has a great variety of bird life such as the black Kite, crowned crane, lovebird and the sacred Ibis among others.

Viewing point at rocks at Kilungu hills

2.1.16 Industry

The County has limited industries mainly due to limited natural resources, location from major urban centres and low level of investment. The two main industries include cotton ginnery and a bakery. However, there are light industries especially in the jua kali sector which produce for the local market.

This includes dye making from tree barks & roots, ciondo, mats, baskets and wooden carvings. The County has seven jua kali associations employing 1,000 artisans. The light industries are mainly operated by self-help groups. In total there are five industries which includes; Makueni Ginnery, Makindu- cycle Assembly, Makueni dairy Farmers co-operative society, Kibwezi Honey Refineries and Mash bakers inn.

2.1.17 Mining

Sand is the major natural resource available in almost all the rivers and streams. Sand harvesting however, remains illegal in the County and this makes it hard to get the data on amount harvested and personnel employed this informal sector. Other resources include limestone, granite, gypsum, and quartz in Kibwezi West Constituency though their commercial viability has not been established.

2.1.18 Agriculture and Fish Production

The main crops produced in the County are maize, green grams, pigeon peas and sorghum. Mangoes, pawpaw and oranges are also being produced. Grafted mangoes are rapidly gaining momentum due to the high demand and favourable conditions.

The total area under cash and food crop is 23,356 Ha and 65,453 Ha respectively which is 2.9 per cent and 8.1 per cent respectively of the total County area.

The average farm size is 3.44 Ha for smallholder farmers and 30.4 Ha for large scale farmers. The majority of farmers are smallholders. There are no ranches in the County.

Small wooden stores are the main storage facility used in the County mostly for the cereals harvested. There is a National Cereals and Produce Board store at Wote which provides supplies of cereals, seeds and fertilizer at reduced cost. The organic farming performance is marginal with about 16.83Ha being under certified organic production.

Livestock and Ranches

Livestock production is a major economic activity in the County. The main breeds reared include livestock (dairy and beef cattle, sheep, goats and donkeys, poultry farming, pig farming, bee keeping and fish).

The County has 12 ranches covering a total area of 45,916 Hectares. Kima estate and Kiu ranches are owned by cooperatives while Aimi ma Kilungu and Malili ranches are owned by companies. There are eight ranches owned by individuals that include Stanley & sons, Sultan Estates, Uathimo Farm, Mwaani, Muiu farm, Nzai farm, Kalima and New Ashtra.

2.1.19 Commerce

The commercial capital of the County is Wote Town which is connected to Machakos Town by a Tarmac Road. Wote town is served by 3 commercial banks, 4 microfinance institutions and a village bank. In addition there are numerous mobile banking facilities e.g. MPESA outlets with the County.

Agriculture is the main source of income in the County. It accounts for seventy eight per cent of the total household income followed by wage employment at ten percentage while rural and urban self employment contribute eight and four per cent respectively. Commercial agriculture mainly cotton and fruit farming is done in the lower parts of the County. Other crops grown are maize, beans, peas, millet, sorghum, sweet potatoes and cassava. Dairy farming is also undertaken both for subsistence and commercial purposes

Due to the arid nature of the County, agriculture which is the main economic activity has been performing poorly. This situation has limited the sector‘s capacity to create much needed job opportunities. A dozen of water management community projects that include dams, irrigation schemes and boreholes have improved the County’s overall water supply resulting in a boost in both agricultural and horticultural production.

The Mombasa-Nairobi highway has positively enhanced the income from trade. However, trade among other sources of income are limited which have led to overreliance on the poor performing agriculture. As a result the poverty rates in the County have risen.

The world famous Chyulu Hills National Park is home to the longest lava tube in the world. The park, its lava tube along with the caves and wildlife, are major tourist attractions of tourists to the area. There are a number of tourist hotels and lodges however opportunities exist in developing more of such facilities to tap into the growing tourist market.

2.2 Geographical Location of Meru County

2.2.1 Location and size

Meru County is located in the eastern part of Kenya and borders Isiolo County to the North and north east, Tharaka County to the south west, Nyeri County to the south west and Laikipia County to the west. Meru County comprises of the following 7 constituencies: Igembe, Ntonyiri, Tigania West, Tigania East, North Imenti, Central Imenti and South Imenti. It is approximately 6936 Km^2 in size.

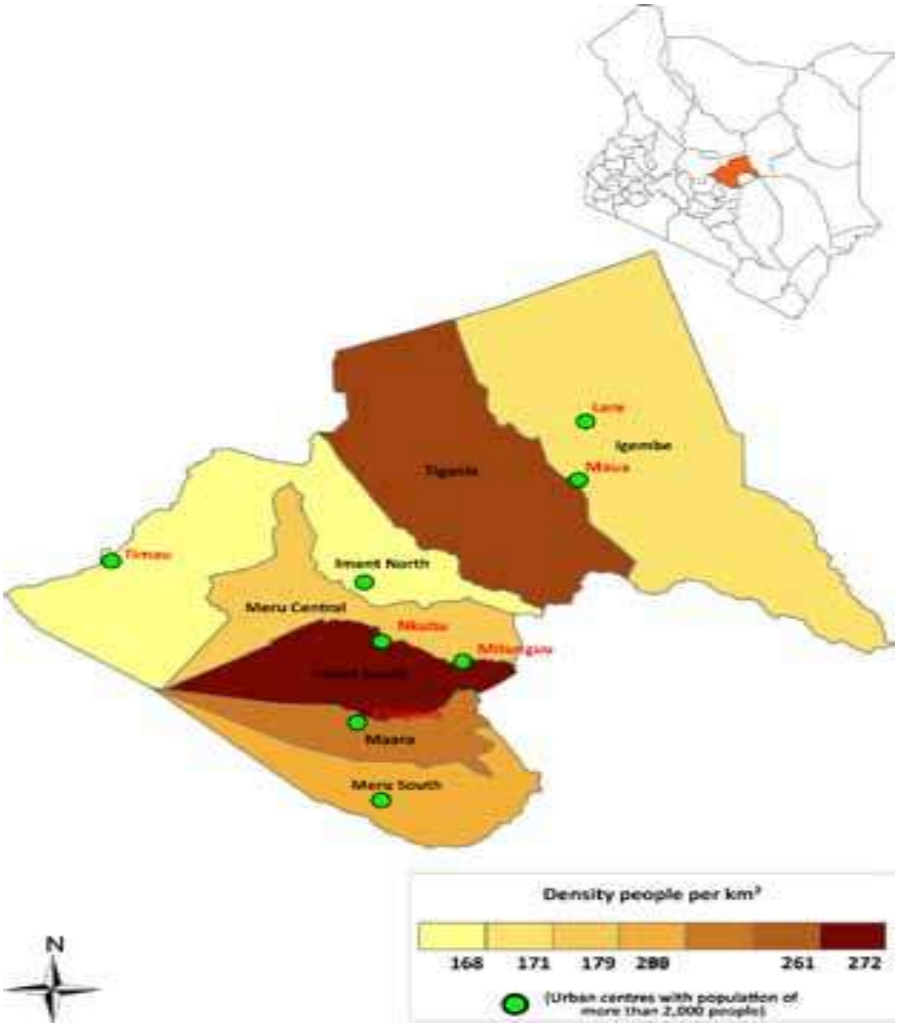


Figure 1: Location, Administrative Areas and Population Density Pattern for Meru County
Source: Kenya County Fact Sheets 2010

Meru town in particular is 226 km north east of Nairobi and is the sixth largest urban centre in Kenya after Nairobi, Mombasa, Kisumu, Nakuru and Eldoret. It is situated at an altitude of approximately 1662m above sea level and located at; 0.047035 degrees north 37.649803

degrees east on the north eastern slopes of Mount Kenya. The town is about five miles (8 kilometres) north of the equator and the Kathita River passes adjacent to the town. The main administrative part of the town is on the northern side of the Kathita River while the southern side of the river is where residential areas are sited.

2.2.2 Climate

Meru County is characterized by Equatorial Mountain Climate and has bi-modal rainfall pattern with two wet seasons and two dry seasons. From mid-March to June the heavy rainy season, known as the long rains, brings approximately half of the annual rainfall in the region. This is followed by the wetter of the two dry seasons which lasts until September. During October to December the area experiences the short rains, which is approximately a third of its total annual rainfall. Finally from December to mid-March is the dry season when the area experiences the least rain. The upper areas of the County experience reliable rainfall and lower regions unreliable and poorly distributed rainfall. The short rains October to December are more reliable than long rains. Temperatures in the highlands range between 140°C to 17°C while those of lowlands between 22°C to 27°C. Large daily temperature fluctuations occur, which means that day temperatures are very high while the nights are very cold. However, there is variation in daily minimum and maximum temperatures but the standard deviation of the mean hourly pattern is small.

Vegetation

The variety of the natural vegetation in Meru County attests to the diverse environment. It ranges from forests on the mountain massifs to desert thorn-shrub grassland in the north. The basic control of this diversity is altitude. Higher altitudes, on the whole mean more moisture, denser, higher and diverse plant cover. Lower altitudes, generally have less rain, plant cover and varied vegetation. There are however, significant aberrations brought about by such factors as the rain shadow effect and soil fertility. The vegetation in the County include: grassland and dwarf shrub-grassland, forest, woodland.

2.2.3 Topography

Meru County is dominated by the great massifs of Mt. Kenya and the Nyambeni range both of which lend striking diversity to the physical landscape. These two elevations affect the physiography of the County to a greater level. At its highest point on Mt. Kenya which is also the highest point in the country, the County rises to 5199 metres. The land then slopes gently from west to east, finally reaching an altitude of 335 metres, near the Tana River. This tremendous range of altitude gives the Meru County a more diverse climate as well as a variety of agro-ecological zones.

2.2.4 Soils

The soils of Meru County are closely related to the landforms and are therefore as diverse as the physiography. A clear dichotomy exists between soils that have evolved in the highlands from recent volcanic events and those that are derivative of the ancient basement rocks. Mt. Kenya and Nyambeni basalts give rise to clay soils whereas the basement system granites and gnesis, usually of high quartz content and yield sandy soils. This difference has been intensified by climatic diversity. Not only are the eastern lowlands endowed with less fertile bedrock, but they also receive little rainfall which does not adequately decompose this parent material. Of the volcanic regions, the upper altitudes on the eastern and south eastern slopes have the most infertile soils. Heavy rainfall rapidly leaches out minerals in these soils, most are over-acidic,

structureless and weak. In lower altitudes and in areas with lower rainfall, dark friable clays are predominant. Here soils are not uniformly fertile most probably because of erosion. For example a belt which is very infertile exists between Chuka and Meru and has soils that are mineral deficient and of acid reaction. The basement complex yields very sandy soils. Tharaka on the eastern side of the County is covered red sandy loams. Neither the feral soils nor the luvisols are particularly fertile. In the northern foothills of MT. Kenya are in the lava plains to the north, dark brown loams are found. These soils overlay hard volcanic lavas but are believed to have originated from volcanic ash. Where drainage is impeded, black cotton soils develop. Hardly any of this northern region is cultivated because of aridity, the lava blocks and stoney outcrops and the poor development of these soils.

2.2.5 Geology

The geology of Meru County comprises of two natural sub-divisions; the volcanic rocks of Pleistocene to recent and tertiary eras and the pre-Cambrian basement systems. There are a few intrusives in the southern parts of Tharaka and a small part of North Nithi but these are insignificant. The basement system, which is in a state of maturity, forms the floor on which all the remaining rocks of the County lie. It is on the southern flanks in the low lying areas (below 914m) mainly in Tharaka and the Meru Game Park. Other basement systems found in the County are due to post-volcanic erosion. The basement system rocks are mainly sediments-grits, sandstones, shale and limestone that have been metamorphised by heat and pressure or impregnation by pervading fluids. Other types include heterogeneous gneisses, granulites and schists of varied and complex origin.

The rest of the County is made up of volcanic rock, Tertiary volcanic on the uppermost reaches of Mt. Kenya and on the Southern slopes and Quaternary volcanic in the Mount Kenya forest, North Imenti, Igembe and the Northern grazing area.

2.2.6 Water Resources

Surface water

Surface water sources in Meru County are plenty on Mt. Kenya and the eastern and south-eastern Nyambeni. The Mt. Kenya forest acts as a catchment area thus orographic precipitation is high and most of it is well retained by the volcanic rocks in the region. Here, the rivers are permanent and large enough to keep the dry eastern lowlands well-watered. These surface waters are replenished by the runoff of precipitation from land, sub- surface storm flow of the water that percolates and infiltrates underground aided by the indigenous trees up in Mt. Kenya forest and are therefore considered a renewable resource although finite in nature. Some of these indigenous trees include; Moringa oleifera, Casuarina cunn (Whispering pine), Croton megalocarpus (Mukinduri), Brachyleana (Muhugu), Croton macrostachus (Mutundu), Cupressus lusitanica (Cypress), Markhamia lutea (Muu), Grevelia robusta (Mukima). However, the agricultural practice of the indigenous people is slowly depreciating the potential of the resources since they cultivate even at the edges of the rivers causing siltation, the agricultural chemicals are swept into the rivers during erosion. Wetlands were evident in most parts around in the area.

On the other, in the north there is a critical shortage of surface water. Rainfall is low in the rain shadow areas and the northern lowlands and the basement systems soils drain too easily. In the dry season, there is water shortage in Tigania, Igembe and northern Nyambeni. Porous bedrock allows much of the drainage to flow beneath the surface. The County has potential for hydro-electricity with all the waterfalls and swift flowing rivers but it is largely untapped.

Ground water

Ground water sources include boreholes, springs and shallow wells mostly found on the lower part of the County. The average borehole depth is 108 meter though this varies from as shallow as 21 meters in Nkabune to 213 in Meru town. Nearly half of the boreholes are in Timau. This is probably because the large-scale farming that has been practiced for many years making the digging of the boreholes economical. Examples of the boreholes include Muthambe and Kanyakine which were drilled to serve Muthambe Girls School and Kanyakine Catholic Mission.

2.2.7 Water services

Water services in the County are provided by Meru Water and Sewerage Company (MEWASS) which is registered on 25th July 2001 as a body corporate under the Trustees (Perpetual Succession) Act, Cap 164 of the Laws of Kenya. The two main supply sources of water are Gatobora springs and Kathita River.

Figure 4*:* Gatobora springs and Kathita River:

Source: http://www.mewass.or.ke/infrastructure.

Kathita River and Gatobora Spring has its source in Mount Kenya, hence the protection of Mount Kenya forest is crucial to the source. In both cases, water is abstracted using mass concrete weir and steel pipes of twelve by eight inches diameter respectively. The two raw water mains deliver water to the Treatment Works at Milimani. On water treatment, there are six composite, two filtration units of capacity 262 meter cubed and four filtration units of capacity 960 meter cubed per day. The direct filtration unit treats the Gatobora Spring water which is fairly clean and requires filtration. The rest of the units treats Kathita water which is normally dosed with aluminium sulphate, settled and filtered to remove turbidity which can be as high as 400 NTU in the rainy season. All the water is then chlorinated to kill germs after which it is stored in receiving tanks.

Figure 5: Part of the Water treatment plant at MEWASS:
Source: http://www.mewass.or.ke/infrastructure.

From there the water is transmitted to seven zonal distributing tanks, from where it is distributed to the customers. The current supply is 400 cubic meters per day. The treatment system has a capacity of 6,730 cubic meters. The area covered is 38 square kilometer and the estimated population in the supply area is 61,000 people but only about 34,044 people are served due to the existence of community water supply which do not charge anything. There are 10 staff members who are involved with the treatment process and 14 are involved with the distribution and customer connections. Water is distributed through customer meters. All customers are metered and charged on a usage rate. .

Figure 5: Water tanks at MEWAS
Source: http://www.mewass.or.ke/infrastructure.

Sewerage

Sewage collection and treatment is vital for the protection of public health and the environment. Sewerage services in the County are provided by Meru Water and Sewerage Company (MEWASS) which is registered on 25th July 2001 as a body corporate under the Trustees (Perpetual Succession) Act, Cap 164 of the Laws of Kenya. If an individual is connected to the sewerage system, he/she is supplied with sewerage services and MEWASS takes all reasonable care in operating their sewerage system to avoid blockages, spills and odours.

2.2.8 Population

According to the national census exercise that was carried out in 2009 the population of the County is approximated to be 1,356,301 comprising of male – 49.4 % and female – 50.6 %. The total number of households is 320,616 as per the 2009 National Census. This gives a population density of 195.5 people per Km^2. In reference to the age pyramid, 39.9% fall under the 0-14 year bracket, 4.4% above the 65+ years and 55.6% within the 15-64 year bracket which is considered the most productive age group in the pyramid. Estimated12% of the total population lives in the urban areas while the rest of the population is projected to be living in the rural areas (Kenya Bureau of Statistics).

2.2.9 Infrastructure, Amenities and Services

The infrastructure, amenities and services currently available in Meru County include road transport, communication, water, sewerage, solid waste management, electricity, housing, health care and education.

2.2.10 Transport

Road Transport

Meru town is linked to Nairobi by a paved road, whether from the south around the east side of Mount Kenya, via Embu, or from the northwest around the west and north side of Mount Kenya, via Nanyuki and Timau. Within the town, the roads have seen a lot of improvement after the maintenance of urban roads was transferred to the Kenya Urban Roads Authority, which in turn set up its Upper Eastern Regional Headquarters in Meru. In the wake of seeing vision 2030 be a reality, the World Bank will spend Sh2 billion in the construction of the Meru Eastern and Western by-passes before the end of the year. The project includes the tarmacing of 30-

kilometre of road which will create a ring around Meru town. An international airport is being built in Isiolo County, 35 Kilometres away, via a new tarmac road through Ruiri.

Rail Transport

Currently, there is no railway network in Meru County. In reference to achieving Kenya's Vision 2030, the Government has taken the initiative of establishing a railway network through the Lamu and New Transport Corridor Development to Southern Sudan and Ethopia (LAPSSET) project. The proposed railway network is to run from Lamu to Nakodok totaling 1500 KM. The stretch will link Lamu to Isiolo (530 KM), Isiolo to Moyale (450KM) and Isiolo to Nakodok (420 KM). The railway network will run past Meru County.

Air Transport

The County does not have any air transport infrastructure and thus is serviced by the currently available Isiolo Airstrip when need be. Isiolo Airstrip is a small civilian airport, serving Isiolo County and surrounding communities. It is situated at 1,067 metres (3,501 ft) above sea level and has a single asphalt runway that measure 5,000 feet (1,500 m) long. The airstrip's location is approximately 200 kilometres, by air, north of Jomo Kenyatta International Airport (JKIA), the country's largest civilian airport. The geographic coordinates of this airport are: 0° 20' 37.00"N, 37° 35' 16.00"S (Latitude:0.343610; Longitude:37.587778). On February 8, 2013 there was a groundbreaking ceremony for the upgrade of Isiolo Airstrip into a fully-fledged international airport officiated by Retired President Mwai Kibaki who also officially presided over the official opening of the new 1.4 KM long runway at Isiolo Airstrip.

Figure 2: Isiolo airstrip currently:
Source: Construction Business Review

The upgrade of the airport includes the construction of a Passenger Terminal Building with throughput capacity of 600,000 passengers annually, an administration block with a floor area of 1025 m2 and a passenger terminal car park to accommodate 200 cars. The airport is intended to facilitate fast and efficient movement of people, goods and services and thus open up the region to investment opportunities. After completion of the project, livestock farming, tourism and agriculture in the region will benefit from the upgraded airport as it will make it easy to export livestock products to key markets in Asia and the Middle East. The airport will enable farmers and traders in the region access international markets without having to transport their goods all the way to and from Nairobi or Eldoret as is the case currently. In addition, Isiolo International Airport will also facilitate transport within the Horn of Africa region due to its strategic location.

2.2.11 Health

The Ministry of Health is the major provider of health in Meru County and works hand in hand with the Public Health Department. It seeks to promote and improve the status of health services in order to be more effective, accessible and affordable. The County has a total of about 311 health facilities. These facilities range from District Hospitals (5), Sub-District Hospitals (6), Dispensaries (102), Health Centres (23), Medical Clinics (158), Nursing Homes

(5), Maternity Homes (3), Others (9). The doctor/population ratio is about 1:49,438 showing an large shortage of doctors.

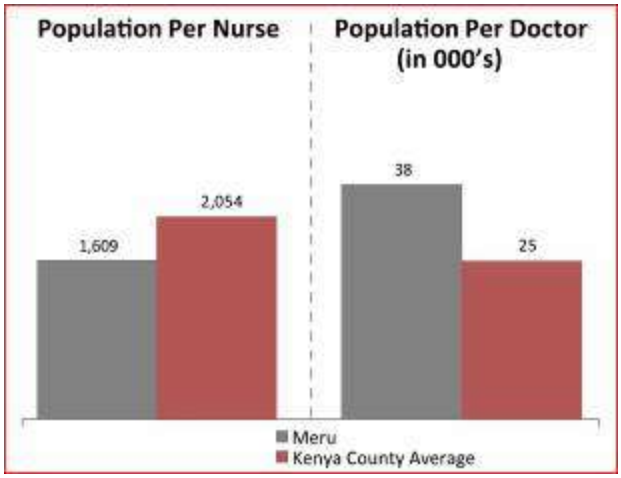


Figure 6: Medical practioners to patient ratio:
Source: Kenya County Fact Sheets (http://kenya.usaid.gov)

In the provision of health care services, the Social Services Department in the County works with National Authority for Campaign Against Drug Abuse (NACADA), National Education of Peer Educators (NOPE) and the Ministry of Health to reach the community.

Health indicators for Meru County are as follows:

Health Indicator	Ratio or percentage
Crude birth rate	241/1000
Crude death rate	9.6/1000
Infant mortality rate	76.4/1000
Maternal mortality rate	124/1000
Under 5 mortality rate	87/1000
Neonatal mortality rate	143/1000
Population growth rate	3%
Immunization coverage	70%
Life expectancy	male 62 Female 68
Fertility rate	3.6%

Figure 6: Health indicators for Meru County: Source: Kenya County Fact Sheets (http://kenya.usaid.gov)

2.2.12 Education

The Ministry of Education is the major provider of education services and all its related activities in the County. Meru County boasts of institutions of learning in the eastern part of Kenya and

they comprise of pre-school, primary, secondary, tertiary institutions, colleges and universities. Meru County has 712 notable and renowned primary schools that operate either as boarding or day schools. Of these, 486 are public schools while 226 are privately owned. The teacher to pupil ratio in the public primary schools is 1:29 and the enrollment is 105,537. Examples include: such as Freds Academy, Kanyakine Boys Boarding, Consolata primary School, Meru Junior Academy, Meru Primary school, Lions Primary School etc.

As for secondary schools, the County has a total of 190 schools; 112 public schools and 78 privately owned. The teacher to pupil ratio in the public secondary schools is 1:30 and the enrollment is 27,729. Examples include: Chogoria Girls High School, Meru School, Nkubu High School, Kanyakine High School, Abothuguchi High School, Katheri High School, St. Mary's Girls High School, Kaaga Girls High School, Kaaga Boys High School, Ndunyu Barikui School just but to mention a few.

The County has more than 20 training colleges and Meru Technical Institute is the major technical school. Other institutions of Higher learning in Meru include: Meru Technical Training Institute, Nkabune Technical Institute, Kenya Institute of Management - Alexander House, Bugema University, Meru town Campus located within Angaine Plaza etc. The campuses of various universities including Egerton University, University of Nairobi, Kenyatta University, African Nazarene University, among others are also found in Meru County. The main Universities are Meru University College of Science and Technology (MUCST) and Kenya Methodist University both of which have their main campus within and near Meru town.

2.2.13 Economy

The major economic sectors of the Meru County's urban economy are tourism, industry, commerce and agriculture.

2.2.14 Tourism

Meru County has several tourist attraction sites that attract very many local and international tourists. One of the main tourist attraction sites is Meru National Park that has a wide variety of animals and birds. The park is wild and beautiful. Straddling the equator and bisected by 13 rivers and numerous mountain-fed streams, it is an especially beautiful area of Kenya. It has diverse scenery from woodlands at 3,400ft (1,036m) on the slopes of Nyambeni Mountain Range, north east of Mt. Kenya, to wide open plains with meandering riverbanks dotted with drum palms. Game to view includes: lion, elephant, cheetah, leopard black rhino, zebra, gazelle, oryx and some of the rarer antelope, Lesser Kudu and duiker, also the more common Dik Dik, one of Africa's smallest antelope. Large prides of lion can be seen and some of Kenya's largest herds of buffalo. The rivers abound with hippo and crocodile, fishing for barbus and catfish is permitted at camp sites and along the Tana River. Lodges have been built in and around this area and provides quality and affordable accommodation and catering services.

Figure 6: Some of the Animals in Meru National Park
Source: http://dumaafrikatreks.com/meru-national-park-2/

The Meru side of Mt. Kenya National Park has tourist attractions which include Vivien Falls, Semwe Salt lick, Lake Alice, Lake Ellis and Sacred Lake. The Meru National Museum displays include an explanation of evolution, mounted wildlife, as well as clothing, weapons and initiation practices of the Meru people.

2.2.15 Industry

In Meru County, most industries are agro based due to the dominance of agricultural practices in the area. These industries include:

- Tea factories
- Coffee factories
- Vineyard camps
- Processing of miraa
- Processing of dairy and livestock products
- Small scale informal sector (Jua Kali) which includes trade such as carpentry and metal workshops, automobile garages etc

In line with making vision 2030 a reality, other forms of industrial activities that are developing include fruit processing, processing of herbal products, processing of nuts, wood and forest products and alternative energy provision.

2.2.16 Agriculture

In Meru County, agriculture sector the main source of employment and is provides 80 per cent of food requirements and contributes 45 per cent of household incomes. It employs approximately 64,000 workers. The kind of crops grown varies depending on the ecological zones which vary in terms of precipitation, temperature and soils. Some of the crops grown in the highlands include maize, sugarcane, bananas, sorghum, millet, yams and cassavas. Cash crops in the region include Miraa (khat), coffee, tea and tobacco. Khat is usually exported to the Middle East, and Ethiopia and this in turn promotes economic growth in the area and country as a whole. Other cash crops include coffee, tea, sisal, wheat, sugar and pyrethrum.

Livestock reared include cattle, sheep, rabbits, chicken and goats. In the lowland the major agricultural activity is livestock rearing where farmers have established ranches that provide the residents with animal products such as milk and meat. The different types of livestock production systems include:

- **Intensive**

It is common with dairy cows, dairy goats and exotic poultry- common in upper and middle zones of the County. Many are fed and housed in sheds (store feeding).

- **Semi intensive**

The animals are left to graze, with limited area and time. This is common in middle coffee zones.

- **Extensive (free range)**

Animals are left to loam extensively in search of fodder/pastures and water. It is common in lower parts of the County. As for livestock production patterns in Meru County, dairy production is on the increase both in terms of animals and milk production. However, the population of cattle solely kept for meat is slowly declining due to land subdivision and competition with other agricultural practices e.g. sheep and goats. Poultry are kept in each homestead, a few exotic layers and broilers are available in areas near market centers. Pork production follows availability of food for humans as most are fed on swill. There is limited external market i.e. most are slaughtered for local consumption in various market centers. The number has reduced drastically over the last two years.

2.2.17 Commerce

Within the County, retail, wholesale and informal sector enterprises occupy all the commercial activity space. Commercial activities associated with servicing the agricultural economy are an important of the County's commerce, and there is a significant network of financial institutions providing banking, insurance and credit services to the business community.

Meru town is the commercial capital of northern and eastern Kenya. It hosts a Central Bank of Kenya's Currency Centre serving the north eastern half of Kenya. Meru has 22 banks branches of Kenya's Banks; Equity, Barclays, Standard Chartered Co-Operative, Diamond Trust, National Bank and Family Bank have branches in the town while several micro-finance institutions are also available. It is the business and agricultural center for north eastern Kenya. The County also has a dozen of small scale SACCOS that serve farmers engaged in agriculture, livestock and dairy production as well as members involved in other economic activities and businesses such as transport, trade, housing, real estate, etc. Meru town is well served by branches of national co-operatives societies such as Afya Sacco and the Kenya Police Sacco, and MPESA among others.

Chapter 3: Policy, Legal and Institutional Framework

3.1 Policy Review

Application of national statues and regulations on environmental conservation requires that the proponent of any project has a legal duty and social responsibility to ensure that the proposed project is implemented without compromising the status of environment, public health, and safety. The following section highlights legal provisions and safeguards which should be considered in reviewing this proposed activity and checks the project is in compliance with such legal provisions and safeguards.

Provision of health and food security is major component of vision 2030. In the course of achieving this vision, environmental sustainability will be achieved through appropriate strategies for promoting environmental conservation.

3.1.1 The Constitution of Kenya

Article 42 of the Bill of Rights of the Kenyan Constitution provides that 'every Kenyan has the right to a clean and healthy environment, which includes the right to have the environment protected for the benefit of present and future generations through legislative and other measures'.

Part 2 of Chapter 5 of the constitution is dedicated to Environment and Natural Resources. Article 69 in Part 2 provides that the state shall;

(i) Ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits
(ii) Work to achieve and maintain tree cover of at least ten per cent of the land area of Kenya
(iii) Encourage public participation in the management of, protection and conservation of the environment
(iv) Protect genetic resources and biological diversity
(v) Establish systems of environmental impact assessment, environmental audit and monitoring of the environment
(vi) Eliminate processes and activities that are likely to endanger the environment
(vii) Utilize the environment and natural resources for the benefit of the people of Kenya

Further, Article 70 states that if a person alleges that a right to a clean and healthy environment recognized and protected under Article 42 has been, is being or is likely to be, denied, violated, infringed or threatened, the person may apply to a court for redress. Development projects should ensure compliance with the constitution in so far as equitable sharing of the resources, between the stakeholders. Further, the projects should ensure the sustainability of livelihoods and biological resources within the project areas are protected. Any development proposals should also be cognizant of the increased powers under the Constitution given to communities and individuals to enforce their rights through legal redress.

3.1.2 Kenya Vision 2030

Kenya Vision 2030 is the current national development blueprint for period 2008 to 2030 and was developed following on the successful implementation of the Economic Recovery Strategy for Wealth and Employment Creation which saw the country's economy back on the path to rapid growth since 2002. GDP growth rose from 0.6% to 7% in 2007, but dropped to between 1.7% and 1.8% in 2008 and 2009 respectively. The objective of the vision 2030 is to transform Kenya into a middle income country with a consistent annual growth of 10 % by the year 2030".

One of the aims of the Kenya Vision 2030 is designed to make Kenya to be a nation that has a clean, secure and sustainable environment by 2030. This will be achieved through promoting environmental conservation to better support the economic pillar. Improving pollution and waste management through the application of the right economic incentives in development initiatives is critical.

3.1.3 The Land Policy

Environmental management principles: to restore the environmental integrity the government shall introduce incentives and encourage use of technology and scientific methods for soil conservation. Fragile ecosystems shall be managed and protected by developing a comprehensive land use policy bearing in mind the needs of the surrounding communities..

The sustainable management of land based natural resources depends largely on the governance system that defines the relationships between people, and between people and resources. To achieve an integrated approach to management of land based natural resources, all policies, regulations and laws dealing with these resources shall be harmonized with the framework established by the Environmental Management and Coordination Act (EMCA),1999.

3.1.4 Agriculture Policy

Agriculture remains the backbone of the Kenyan economy. It is the single most important sector in the economy, contributing approximately 25% of the GDP, and employing 75% of the national labour force (Republic of Kenya 2005). Over 80% of the Kenyan population live in the rural areas and derive their livelihoods, directly or indirectly from agriculture. Given its importance, the performance of the sector is therefore reflected in the performance of the whole economy. The development of agriculture is also important for poverty reduction since most of the vulnerable groups like pastoralists, the landless, and subsistence farmers, also depend on agriculture as their main source of livelihoods. Growth in the sector is therefore expected to have a greater impact on a larger section of the population than any other sector. The development of the sector is therefore important for the development of the economy as a whole.

Policies for agriculture consist of government decisions that influence the level and stability of input and output prices, public investments affecting agricultural production, costs and revenues and allocation of resources. These policies affect agriculture either directly or indirectly. Improved agricultural production has been seen as one of the overall objectives for poverty reduction in the country. The objectives of agricultural sector strategy have been increasing agricultural growth, seen as important for increasing rural incomes and ensuring equitable distribution. Due to limited availability of high potential land, it has been envisaged that

increasing agricultural production will have to come from intensification of production through increased use of improved inputs, diversification especially from low to high value crops, commercialization of smallholder agriculture, and increased value addition through stronger linkages with other sectors.

3.1.5 National Environnemental Action Plan (NEAP)

The NEAP for Kenya was prepared in mid 1990s. It was a deliberate policy effort aimed at integrating environmental considerations into the country's economic and social development. The integration process was to be achieved through a multi-sectoral approach to develop a comprehensive framework to ensure that environmental management and conservation of natural resources are integral part of societal decision-making. The NEAP also established the process of identifying environmental problems and issues, raising awareness, building national consensus, defining policies, legislation and institutional needs, and planning environmental projects.

3.1.6 National Policy on Water Resources Management and Development

While the National Policy on Water Resources Management and Development (1999) enhances a systematic development of water facilities in all sectors for promotion of the country's socio-economic progress, it also recognizes the by-products of this process as wastewater. It therefore calls for development of appropriate sanitation systems to protect people's health and water resources from institutional pollution. Economic activities therefore should be accompanied by corresponding waste management systems to handle liquid effluents and other wastes emanating from the activity. Waste management systems should also include appropriate measures to ensure environmental resources and people's health in the immediate neighbourhood are not negatively impacted by the wastes produced.

In addition, the policy provides for charging levies on wastewater on quantity and quality (similar to polluter-pays-principle) in which those contaminating water are required to meet the appropriate cost on remediation, though the necessary mechanisms for the implementation of this principle are still being formulated.

3.1.7 Sessional Paper on Environment and Development

The paper, now being developed into a full policy on environment, presents broad categories of development issues that require sustainable approach. The paper harmonizes environmental and developmental objectives so as to ensure sustainability. The paper provides comprehensive guidelines and strategies for government action regarding environment and development. Under this paper, broad categories of development issues have been covered that require sustainable approach.

3.1.8 Environmental Management and Coordination Act (1999)

Section 72 of the EMCA, 1999 prohibits discharging or applying poisonous, toxic, noxious or obstructing matter, radioactive or any other pollutants into the environment. Section 73 require that operators of activities which discharges effluent or other pollutants to submit to NEMA accurate information about the quantity and quality of the effluent. Section 74 demands that all

effluent generated from point sources are discharged only into the existing sewerage system upon issuance of prescribed permit from the local authorities.

Section 87 sub-section 1 states that no person shall discharge or dispose of any wastes, whether generated within or outside Kenya, in such a manner as to cause pollution to the environment or ill health to any person, while section 88 provides for acquiring of a license for generation, transporting or operating waste disposal facility. According to section 89, any person who owns or operates a waste disposal site or plant or generate hazardous waste, shall apply to the NEMA for a license. Sections 90 through 100 outline more regulations on management of hazardous and toxic substances including oils, chemicals and pesticides.

Under EMCA, 1999, a set of regulations have been developed to address management and compliance in special aspects of the environmental. Among the regulations are listed here below;

Water Quality Management Regulations, 2006 (Legal Notice No. 120)

These regulations were drawn under section 147 of the Environmental Management and Coordination Act 1999. In accordance with the regulations, every person shall refrain from acts that could directly or indirectly cause immediate or subsequent water pollution and no one should throw or cause to flow into water resources any materials such as to contaminate the water. The regulation also provides for protection of springs, streams and other water sources from pollution.

Waste Management Regulations, 2006 (Legal Notice No. 121)

The regulations are formed under sections 92 and 147 of the Environmental Management and Coordination Act, 1999. Under the regulations, a waste generator is defined as any person whose activities produces waste while waste management is the administration or operation used in handling, packaging, treatment, conditioning, storage and disposal of waste. The regulations requires a waste generator to collect, segregate and dispose each category of waste in such manners and facilities as provided by relevant local authorities. Regarding transportation, licensed persons shall operate transportation vehicles approved by NEMA and will collect waste from designated areas and deliver to designated disposal sites.

Noise and Excessive Vibration Pollution Control Regulations, 2009

Part II section 3(I) of these Regulations states that: no person shall make or cause to be made any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment and section 3(2) states that in determining whether noise is loud, unreasonable, unnecessary or unusual. Part II Section 4 states that: except as otherwise provided in these Regulations, no person shall;

(i) Make or cause to be made excessive vibrations which annoy, disturb, injure or endanger the comfort, repose, health or safety of others and the environment;
(ii) Cause to be made excessive vibrations which exceed 0.5cm per second beyond any source property boundary or 30m from any moving source.

Part III, Section 11(1) states that any person wishing to;

(i) Operate or repair any machinery, motor vehicle, construction equipment or other equipment, pump, fan, air-conditioning apparatus or similar mechanical device;
(ii) Engage in any commercial or industrial activity, which is likely to emit noise or excessive vibrations shall carry out the activity or activities within the relevant levels

prescribed in the First Schedule to these Regulations. Any person who contravenes this Regulation commits an offence.

Section 13(1) states that except for the purposes specified in sub-Regulation (2) hereunder, no person shall operate construction equipment (including but not limited to any pile driver, steam shovel, pneumatic hammer, derrick or steam or electric hoist) or perform any outside construction or repair work so as to emit noise in excess of the permissible levels as set out in the Second Schedule to these Regulations. These purposes include emergencies, those of a domestic nature and /or public utility construction. Section 14 relates to noise, excessive vibrations from construction, demolition, mining or quarrying sites, and states that: where defined work of construction, demolition, mining or quarrying is to be carried out in an area, the Authority may impose requirements on how the work is to be carried out including but not limited to requirements regarding machinery that may be used and the permitted levels of noise as stipulated in the Second and Third Schedules to these Regulations.

Environmental Management and Co-Ordination Act, 1999; Environment Co-Ordination (Air Quality) Regulations, 2008

The government has developed the air quality regulations standards The Environmental Management and Co-ordination (air quality Regulations). The regulation has provisions with prohibitions of Priority air pollutants associated with machine operations and burning activities (general sources, mobile sources and greenhouse gasses) outlined under the second schedule of the regulations. Tolerable air quality limits are provided under the first schedule of the regulation while lists specific limited for emissions from controlled and non-controlled facilities by sector. An operator of a site or equipment is required to obtain a license under the regulations and stipulated regulations. A compliance is also required as part of the emission license.

EMCA (Controlled Substances) Regulation, 2007

This regulation controls the production, consumption and exports and imports of controlled substances.

EMCA (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit Sharing) Regulations, 2006

The regulation requires proponents to conduct ESIA if their activities may have adverse impacts on ecosystems or lead to unsustainable use of natural resources or/and lead to introduction of exotic species. The regulation aims at increasing the coverage of protected areas and establishing new special status sites by providing guidelines for protecting endangered species.

EMCA (Fossil Fuel Emission Control) Regulations, 2006

This Regulation aims at eliminating or reducing emissions generated by internal combustion engines to acceptable standards. The regulation provides guidelines on use of clean fuels, use of catalysts and inspection procedures for engines and generators. This regulation is triggered as the proponent would use vehicles and equipments that depend on fossil fuel as their source of energy. It is recommended the requirements of the regulation be implemented in order to eliminate or reduce negative air quality impacts. This would be relevant for construction equipment and vehicles and operations within the airport thereafter, and particularly with respect to utilization of the pavements (aviation activities)

3.1.9 Occupational Safety and Health Act No. 15 of 2007

This act provides for safety, health and welfare of workers and all persons who are lawfully present at work places. Part VI provides for general health provisions while Part X provides for

the general welfare of the workers with respect to supply of drinking water, washing facilities and first aid among other aspects. Section 53 of this Act requires that for workers employed in a process involving exposure to any injurious or offensive substances, suitable protective clothing and appliances (gloves, footwear, goggles, and head coverage) shall be provided.

3.1.10 Work Injury Compensation Benefit Act 2007

This act provides for compensation for employees on work related injuries and diseases contacted in the course of employment and for connected purposes. The act includes compulsory insurance for employees. The act defines an employee as any worker on contract of service with employer

3.1.11 The Water Act 2002

Section 73 of the Act of the Act allows a person with licensee to supply water to make regulations for purposes of protecting against degradation of water sources. Section 75 and sub-section 1 allows the licensee to construct and maintain drains, sewers and other works for intercepting, treating or disposing of any foul water arising or flowing upon land for preventing pollution of water sources within his/her jurisdiction. Section 76 states that no person shall discharge any trade effluent from any trade premises into sewers of a licensee without the consent of the licensee upon application indicating the nature and composition of the effluent, maximum quantity anticipated, flow rate of the effluent and any other information deemed necessary. Under the Water Act 2002, Water Rules were development to ensure sustainable and harmonized utilization of water resources throughout all sectors. The rules are summarized in the statement below;

3.1.12 Water Rules

One of the outcomes of the water sector reforms has been improved regulatory framework for water resource management and use. In addition to the Water Act 2002, the main document outlining the regulations is the Water Resource Management Rules 2007. The rules set out the procedures for obtaining water use permits and the conditions placed on permit holders. Sections 54 to 69 of the Water Resources Management Rules 2007 impose certain statutory requirements on dam owners and users in regard. These provisions address:

(i) Technical design report in respect of the water use permit;
(ii) Operational information to be lodged with WRMA;
(iii) Dam safety measures and requirements for inspections;
(iv) Requirements for procedures to notify downstream communities in the event of unexpected releases.

Other sections within the rules imply that WRMA can impose water quality sampling requirements on Athi Water Services Board from the dam and impacts to the water sources downstream the project locations. Section 16 of the Water Rules requires approval from the Water Resources Management Authority (WRMA) for a variety of activities that affect the water resources, including the storage of water in dams and pans. Approval by WRMA is conferred through a Water Permit. A permit is valid for five years and must be renewed.

Section 104 of the Water Resource Management Rules requires certain water permit holders to pay water use charges. The intention of the water use charges was to raise revenue for water

resource management, raise revenue for catchment conservation activities, improve efficiency of water resource abstraction and provide a system of data collection on water resource usage.

3.1.13 Public Health Act (Cap. 242)

Section 115 of the Act states that no person/institution shall cause nuisance or condition liable to be injurious or dangerous to human health. Section 116 requires Local Authorities to take all lawful, necessary and reasonably practicable measures to maintain their jurisdiction clean and sanitary to prevent occurrence of nuisance or condition liable for injurious or dangerous to human health. Such nuisance or conditions are defined under section 118 as waste pipes, sewers, drains or refuse pits in such a state, situated or constructed as in the opinion of the medical officer of health to be offensive or injurious to health. Any noxious matter or wastewater flowing or discharged from any premises into a public street or into the gutter or side channel or watercourse.

Other nuisances are accumulation of materials or refuse which in the opinion of the medical officer of health is likely to harbour rats or other vermin. On the responsibility of local authorities, Section 129 of the Act states in part "It shall be the duty of every local authority to take all lawful, necessary and reasonably practicable measures for preventing any pollution dangerous to health of any supply of water which the public within its district has a right to use and does use for drinking or domestic purposes…". Section 136 states that all collections of water, sewage, rubbish, refuse and other fluids which permits or facilitate the breeding or multiplication of pests shall be deemed nuisances and are liable to be dealt with in the manner provided by this Act.

3.1.14 Physical Planning Act (Cap 286)

Section 24 of the Physical Planning Act gives provision for the development of local physical development plan for guiding and coordinating development of infrastructure facilities and services within the area of authority of County, municipal and town council and for specific control of the use and development of land. The plan shows the manner in which the land in the area may be used. Section 29 of the physical Planning Act gives the County councils power to prohibit and control the use of land, building, and subdivision of land, in the interest of proper and orderly development of its area. The same section also allows them to approve all development applications and grant development permissions as well as to ensure the proper execution and implications of approved physical development plans. On zoning, the act empowers them to formulate by-laws in respect of use and density of development.

Section 30 states that any person who carries out development within an area of a local authority without development permission shall be guilty of an offence and the development shall be invalid. The act also gives the local authority power to compel the developer to restore the land on which such development has taken place to its original conditions within a period of ninety days. If no action is taken, then the council will restore the land and recover the cost incurred thereto from the developer. In addition, the same section also states that no person shall carry out development within the area of a local authority without development permission granted by the local authority. At the same time, sub-section 5, re-enforce it further that, no licensing authority shall grant under any written law, a license for commercial use for which no development permission had been granted by the respective local authority.

Section 36 states that if in connection with development application a local authority is of the opinion that, the proposed activity will have injurious impact on the environment, the applicant shall be required to submit together with the application an Environmental Impact Assessment

report. The environmental impact assessment report must be approved by the National Environmental Management Authority (NEMA) and followed by annual environmental audits as spelled out by EMCA 1999. Section 38 states that if the local authority finds out that the development activity is not complying to all laid down regulations, the local authority may serve an enforcement notice specifying the conditions of the development permissions alleged to have been contravened and compel the developer to restore the land to it's original conditions.

Conclusion

Having reviewed all the relevant policy positions it is the consultants consideration that the AflaSTOP project does not contravene any policy position and in fact has the potential to provide significant positive impact to the health and food security of the people of Kenya and the East African region in line with the vision 2030.

Chapter 4: Project Description

4.1 Nature of the Project

The project is an evaluation of small scale grain storage technologies that prevent further aflatoxin contamination of maize in the eastern region (Meru and Makueni counties) of Kenya. The storage will be on leased premises. The range of storage containers will be plastic, metal, and different types of bag. Grain samples will be periodically analyzed using Neogen equipment for testing levels of aflatoxin contamination. At the end of the project (~6 months), the contaminated maize will be destroyed.

4.2 Project Design

The experimental design to be used in the project will be randomized complete block design and repeat measure design. The stores to be used will have concrete floors, stone or concrete wall with metal or concrete roofs. The lockable door will be metal and windows will have metal grates for security purposes. The size of store should be a minimum area of 5 meters by 4.5 meters.

The maize to be tested in a given area will be purchased from the farmers in the County. This maize will be tested, mixed thoroughly to give a homogeneous sample and then dried into two lots (~15% moisture and 13.5% max). The maize will then be put in the different containers, kept in each store and periodically sampled and tested for aflatoxin. Protective measures for personnel handing the maize are provided in Chapter 6 and in the EM&MP in Chapter 7.

Sample of Storage containers to be used during the AflaStop Program

At the end of the experimental period, all the contaminated maize will be collected from all the testing storage sites, put into one store awaiting destruction. The stores will then be cleaned and decontaminated and their use reverted to their owners.

4.3 Site Location

The storage sites will be located in Meru and Makueni Counties.

MAKUENI COUNTY		
No	**TRADING CENTRE**	**COORDINATES OF THE SITE and Elevation**
1.	Muumandu Trading Centre	S 01^0 39' 42 .1'' E 037^0 17' 07 .8'' Elevation : 1840.9 M
2.	Katuaa Trading Centre	S 01^0 41' 01 . 1'' E 037^0 19' 03 .3'' Elevation: 1687.1 M
3.	Kola Trading Centre	S 01^0 42' 26 .6'' E 037^0 20' 53.3'' Elevation: 1595.4 M
4.	Kivani Trading Centre	S 01^0 43' 21 .3'' E 037^0 22' 34 .1'' Elevation: 1635 M
5.	Chabalasi Trading Centre	S 01^0 43' 57 .2'' E 037^0 25' 35 .5'' Elevation: 1382.8M
6.	Mukuyuni	S 01^0 45' 20 .9'' E 037^0 28' 13 .0'' Elevation: 1320.6M

MERU COUNTY		
	TRADING CENTRE	**COORDINATES OF THE SITE and Elevation**
1.	Kariene Trading Centre	S 00^0 02' 26 .1'' E 037^0 39' 52 .6'' Elevation: 1544.9 M
2.	Mwichiune Trading Centre	S 00^0 5' 37.2'' E 037^0 33' 43.9'' Elevation: 1491.1 M
3.	Pole Pole Trading Centre	S 00^0 13' 45.0'' E 037^0 33' 57 .5'' Elevation : 1488.6 M
4.	Marima Trading Centre	S 00^0 16' 22. 7'' E 037^0 39' 17 .6'' Elevation: 1450.8 M
5.	Mitheru Trading Centre	S 00^0 17' 43 .9'' E 037^0 33' 34.3'' Elevation: 1406.8 M
6.	Giampapo Trading Centre	S 00^0 18' 12.5'' E 037^0 39' 34 .0''

Elevation: 1387.7 M

4.4 Site Ownership

The storage facilities will be leased to the proponent for a given period. The sample of the contract document is given in Annex 1.

4.5 Project Activities

The project activities will include preparations of the storage facility before the main activity which is to be used for storage testing of the maize up to the stage where the storage facility use reverts to the owner of the facility. A listing of the activities is given below:

a) Selection of testing site / stores
b) Selection of storage devices
c) Purchase of the maize, and its transportation
d) Preparation of the maize used for the experiment
e) Setting up of stores, storage devices, filling them with maize
f) Sampling and analysis of the samples for aflatoxin
g) Disposal of the contaminated maize after expiry of the study period
h) Decontamination of the stores

Maize used in this study shall be locally procured. This will ensure that the maize is locally adapted and contains aflatoxin-producing fungi native to the area of interest, therefore reducing the possibility of introducing different strains from other areas. Maize should be bought directly from farmers or small traders in small market places supplying local maize again to ensure that the maize is actually local.
If after initial mixing the aflatoxin levels are significantly lower than 50ppb, the grain will need to be incubated to increase the amount of spores (indicated by the presence of aflatoxin) throughout the grain. This will improve quality of experimental results.

Maize kernels have to be mixed thoroughly before the experiment is set-up since they will have come from multiple sources within the area. Therefore, all grain should be mixed in a big grain mixer (e.g. Cement mixer, V-mixer, ribbon mixer, double cone mixer) for a period of 12 to 24h or multiple times. This elongated mixing period will ensure that the grain is homogenous and reduce the variance among replicates. One batch of maize will remain moist around 15% moisture; the other batch has to be dried to 13.5% moisture (to obtain dry maize). Once the drying process is completed, moisture contents are assessed from multiple samples throughout the batches. The mixing and drying of the grain will be done in the premises of Lesiolo Grain Handlers Ltd, located in Nakuru. The Proponent has entered into an agreement with Lesiolo Grain Handlers for them to undertake this activity for them in their premises. Protective measures for personnel incubating and mixing the maize are provided in Chapter 6 and in the EM&MP in Chapter 7. A copy of the agreement and photographs of the facility are attached in Annex 9.

Maize from Meru County must not be mixed with maize from Makueni County.

The potential storage devices to be tested are:

Device name	**Approx. Kg by volume**
Metal silo	350
Plastic silo	350
Bulk bag	800

Hermetic bag	90
Purdue Univ. bag	90
Univ. of Leeds bag	90
Control bag (normal polypropylene)	90

In each of the 6 stores per County, 13,890 kg of grain will be used for these experiments.

Both wet maize (moisture content ≥15%) and dry maize (moisture content ≤13.5%) will be tested. Maize samples will be periodically analyzed for aflatoxin content during the six months study period. Protocols to be followed during project operation phase have been developed and are included in Annex 8. These protocols have been endorsed by a Kenyan aflatoxin expert (See Annex 11).

There will be six stores in each of the counties, treated as a block with replicate treatment. The temperature and humidity in each of the stores will be continually recorded using calibrated data loggers.

4.6 Project Decommissioning

At the end of the testing period (~6 Months storage period), the remaining stored maize will be removed and disposed through incineration.

At completion of the experiments, the bad grain will be disposed of by incineration using a NEMA licensed facility in Kenya. The chemical formula for aflatoxin is $C_{17}H_{12}O_6$. This compound melts at around 300 degrees Celsius where it breaks down into CO, CO_2, NO and NO_2. The fungus that is responsible for the aflatoxin production is destroyed at much lower temperatures.

Environmental Combustion and Consultants Limited (ECC Ltd) was founded in 1995 to provide local industry and the public sector with the technical capacity to handle and mange hazardous waste. ECC Ltd is the only facility in the region that specializes in the management of hazardous waste. The facility is equipped with a rotary Kiln whose primary chamber burns at 800 degrees Celsius and a secondary chamber that burns at 1100 degrees Celsius. The facility is also equipped with cyclonic separators for particulate scrubbing. The ECC Ltd facility holds current licenses from National Environmental Management Authority (NEMA) allowing them to dispose of hazardous materials.

Decontamination of the stores will procedure as follows; the grain will be removed from the large storage devices and loaded onto a truck. The grain in the large storage devices will be emptied out, bagged and placed in the trucks. Any grains which have dropped will be collected up on the previously laid down tarpaulins (as the store was set up), bagged and placed in the truck. The tarpaulins will be folded up and placed in the truck. All the inner surfaces of the store will be sprayed down with a bleach solution twice. The stores will then be returned to their owners.

4.7 Budget

The estimated cost of the project, for activities of storage of grain in the two (2) counties is:

Total cost = Ksh.43,500,000 /=

The proponent has paid 0.05% of the project cost to NEMA as shown in the attached payment receipt. (Annex 3).

0.05% of project cost = Ksh 21,750 /=

Chapter 5: Project Alternatives

5.1 No Action Alternative

The no action alternative will mean that the status quo will be maintained and no project will be done. This will mean that:

- Maize contamination by aflatoxin during storage will continue to be a major contributor to postharvest losses. (AflaCONTROL results showed that the proportion of farmers with aflatoxin levels above 10ppb increased from 43% to 87% within one to two months from harvest. In 2010 NCPB bought quantities of contaminated grain in Eastern Kenya at discounted prices after the government estimated that over 30% of the grain was contaminated - this grain remains stuck in NCPB stores unable to be destroyed.)
- Severe outbreaks of aflatoxicosis will continue in Kenya unabated.
- Children will continue to be stunted probably due to consumption of aflatoxin contaminated meals.
- Families will continue to suffer long term detrimental health effects (consumption of aflatoxin contaminated foods has been linked to stomach problems, poor nutrient absorption, stunting, liver and other cancers).
- Maize from these regions will trade at a discounted price compared to other less affected areas. (In 2010 when the Government of Kenya announced a widespread presence of aflatoxin levels above 10ppb, maize in Mere and Makueni traded at Ksh 1,000 per 90 kg bag compared to the national average of Ksh 2,300 per 90 kg bag).

The no action alternative is best in instances when significant and severe environmental impacts are envisaged. In the proposed action, there will be insignificant environmental impacts during all the three phases of this project cycle. The no action alternative would result in losses to the people of Kenya and continued ignorance on the link between storage, moisture level and increasing aflatoxin levels. Health and economic benefits that would result from the project would not be realized.

5.2 Alternative 2

Other technical approach(es) to address the issue under investigation

The following section inserts a report which assessed the different options considered to test the hypothesis that storage devices might be able to prevent further contamination with aflatoxin.

5.2.1 Storage Testing Options:

Initial option:

In order to accurately test whether storage devices effectively control the spread of the Aspergillus fungus and limit or stop aflatoxin contamination, grain used for testing must be infected with native Aspergillus. Two options available to AflaSTOP for ensuring Aspergillus presence in grains used for testing of smallholder farmer storage technologies are:

1. Inoculate the grain with native *Aspergillus* spores, or
2. Buy contaminated grain from farmers or markets. If the grain is contaminated with high levels of aflatoxin, the assumption that highly aflatoxigenic *Aspergillus* strains are present is met.

Given the political sensitivity in Kenya of tampering with grain, USAID and BMGF determined that it was not in the project's best interest to inoculate grain at this time. Use of naturally infected grain, however poses additional preparation difficulties because the project must use grain with contamination levels at or above 50ppb[1]. Consulted research scientists state that this level of contamination represents the minimum threshold to safely assume relevant toxigenic fungi are present and active.

Current Options:

To use naturally affected grain purchased from farmers or directly from markets, AflaSTOP is proposing the following options;

1. Purchase contaminated grain from farmers or markets in Kenya
2. Buy old contaminated grain held that is currently being stored by the government of Kenya
3. Test storage devices in collaboration with a US University using inoculation with a native Kenyan *Aspergillus* isolate (or isolate mixture), followed by Kenyan off- and on-farm testing of the identified most effective storage technologies; or
4. Carry out the storage testing in alternative countries in Africa

Metrics for Consideration:

To ensure that international and Kenyan stakeholders as well as private sector storage companies trust and accept the findings of the AflaSTOP project, it is important to consider the scientific rigor of each option and that the results from off farm testing (first phase testing) will be scientifically valid. To ensure this acceptance the project must make certain results are replicable, the methodology used complies with scientific research standards and that extraneous factors that can bias results are minimalized or absent. In addition to scientific rigor, AflaSTOP must also carefully considered the following factors:

[1] Please see AflaSTOP's Research and Methodology document for more information.

- Ethical issues: Confidence levels of the results should be high. AflaSTOP should be confident that it only introduces highly effective storage devices to smallholder farmers. Over 40% of grain in Eastern Province will be contaminated and the project must have confidence that storage devices introduced to smallholder farmers do not worsen the situation.
- Political issues: the perceptions of tampering with maize can raise many questions and raise political sensitivities, especially in a country like Kenya where many people are still food insecure and aflatoxin is a known problem.
- Implementation and Budget: AflaSTOP must operate within the approved period of performance and budgetary parameters of the project

Margin of Error

The AflaSTOP Global Development Alliance (GDA) Advisory Group asked the AflaSTOP Implementation Partners to determine a margin of error between the inoculation approach and the incubation approach. After consultation with AflaSTOP's scientific advisor, we think that it is impossible to calculate a figure to quantify the margin of error between the inoculation approach and the incubation approach. To do this would require a series of scientific experiments to quantify the variations between the two approaches. The option of inoculation while mixing the grain allows for a relatively uniform spreading of live strain specific Aspergillus spores throughout the maize and gives the highest certainty of statistically significant results in a relatively short period of time quantified by the two experimental approaches (randomized complete block design and the repeated measure design). Buying contaminated grain brings in a number of variables that may affect the outcome of the experiment. Even with incubation and more than twice the mixing that was envisioned in the original plan, considerable variation in aflatoxin levels is likely between storage devices; however, as presented in the original methodology, the inclusion of a repeated measure experiment alongside the randomized complete block design increases the amount of samples taken at the beginning and end of the experiment. When analyzed, the findings will help to produce results showing how aflatoxin levels changed from the start compared to the end, as well as over time.

In both approaches - inoculation and incubation - the project is working with a 'live' organism and live organisms increase random results since they do not work in the same way as chemical reactions. Chemical reactions affect the whole process the same way time after time. As yet, there is no tested explanation as to why aspergillus grows in some spots and not in others in the same grain in experiments. Inoculation is the simplest and easiest way to achieve the project goals. Incubation adds a layer of complexity, but if the stages are carried out thoroughly, the results should still demonstrate (potentially over a longer period of time) which storage devices are effective in preventing further aflatoxin contamination during the storage period.

5.2.2 Recommendation:

Based upon internal analysis, which are summarized in the attached annexes, AflaSTOP prime implementers, ACDI/VOCA and ASI, in consultation with scientific consultant Dr. Claudia Probst, recommend Option 1 as the best option. The AflaSTOP team have the information used to assess the multiple options available to the project at this time. We took into consideration advantages and disadvantages in scientific rigor and technical implementation. We also assessed the implications on the timeline and budget for the project. Upon this assessment exercise, we found that Option 1 has the following key advantages:

- Recently harvested grain will closely match conditions farmers confront for storage.
- Uniform contamination of local of *Aspergilli* strains,
- Storage devices will be tested against newly characterized strains of Aspergilli which are highly aggressive and predominate in Eastern
- Off farm testing results using local contaminated grain will provide the highest level of confidence that effective storage devices can be tested with farmer's personnel grain surplus during the on farm testing phase
- Removal of contaminated grain from the Kenyan consumption market

Ultimately, buying contaminated maize from the market ensures scientific rigor as well as meets ethical, political and contractual considerations. Should USAID and Gates be in agreement, we propose to purchase contaminated grain in Kenya from farmers or directly in markets in Eastern Kenya and North Rift and then incubate the grain to ensure aflatoxin levels of 50ppb.

The AflaSTOP team advises to use the Nakuru site for mixing and incubating the grain. While this means that the contaminated grain will be transported over a larger distance (the grain will have to be transported from where it is procured to the Nakuru site), the Nakuru site is set up to handle grain, understands AlfaSTOP's program, and is willing to accommodate AflaSTOP’s requirements. The AflaSTOP team feels that it is important to have mechanisms that will help mitigate aflatoxin contamination. Using the Nakuru site provides the best mechanisms to do so. Locating suitable sites in both of the identified regions will be difficult and will incur additional expenses to the project.

Summary of Advantages and Disadvantage of the 5 options considered
Option 1: Purchase contaminated grain from farmers or markets in Eastern, Kenya

Advantages	Disadvantages
Scientific vigor	
• Grain will be the same as farmers use in Kenya • Off farm testing will be in 6 geographically diverse storage sites in each testing area (statistically important to discount climatic effects) • Grain will be infected with live Aspergillus which will grow and create further contamination unless the storage devices prevents its growth • Newly described Aspergillus strains native to Eastern are very aggressive, responsible for the acute aflatoxicosis outbreaks if the storage devices work on these strains and N Rift strains they should work on other strains not just in Kenya • Provides highest level of confidence that storage devices work before taking to smallholder farmers for on farm testing	• Time taken to incubate grain may affect the general quality of the grain • If *Aspergillus* is not spread homogeneously through the grain storage results may be invalid
Technical Implementation	
• Significantly more likely to be able to purchase grain with aflatoxin levels above 50ppb and potentially less need of incubation (only 20% of grain procured) • AflaSTOP has identified a facility capable of handling the mixing and drying of the grain in Kenya	• Increase in aflatoxin testing costs • Significant increase likelihood of having grain between 10 - 50ppb and need of incubation
Timeline Considerations	
• NA	• Suitable grain will be available March 2014 • On farm testing in N Rift should start Dec 2014 • On farm testing in Eastern should start March 2015

Option 2: Purchase contaminated grain from farmers or markets in Western, Kenya

Advantages	Disadvantages
Scientific vigor	
• Grain will be the same as farmers use in Kenya • Off farm testing will be in 6 geographically diverse storage sites in each testing area (statistically important to discount climatic effects) • Grain will be infected with live *Aspergillus* which will grow and create further contamination unless the storage devices prevents its growth	• Time taken to incubate grain may affect the general quality of the grain • If *Aspergillus* is not spread homogeneously through the grain storage results may be invalid • *Aspergillus* strains from Western will be introduced to Eastern and N Rift • Results from storing maize produced and infected with Aspergillus isolates from Western cannot be applied to Eastern (This newly described fungus is very aggressive, responsible for the acute aflatoxicosis outbreaks and its characteristics have not been studied in great depth)
Technical Implementation	
• Of farm storage testing can be carried out in Kenya first time around • Over 30% of grain sampled may have aflatoxin above 10ppb • AflaSTOP has identified a facility capable of handling the mixing and drying of the grain in Kenya •	• Increase in aflatoxin testing costs • Significant increase likelihood of having grain between 10 - 50ppb and need of incubation (80% will below the 50ppb level) • Incubation of grain will be time consuming • Will require more field staff • Mixing grain will be more time consuming • Large scale mixers are not readily available (need to buy a commercial cement mixing truck)
Timeline Considerations	
• Subject to crop production and weather grain will be available to buy late July/August • On farm testing in N Rift should start Dec 2013 • On farm testing in Eastern should start March 2014	• NA

Option 3: Test storage devices in US University, replicate off farm testing in Kenya

Advantages	Disadvantages
Scientific vigor	
• Homogenize grain readily available • Use of inoculation ensures reliable results in off farm testing in US.	• Grain tested will be significantly different from Kenyan smallholder farmer quality grain • Likely to be very difficult to have 6 geographically diverse storage sites • Off farm testing of successful devices in US will have to be repeated in Kenya to ensure climatic conditions are not a factor • Few sites in US where storage conditions in Kenyan can be mimicked
Technical Implementation	
• Potential reduction in volume of contaminate grain required for off farm testing in Kenya	• Significant increase in costs • Buying 'wet' maize in America will require purchasing direct from the farmer or at the dryers • University facility will require drying facility
Timeline Considerations	
	• Off farm testing will have to be repeated in Kenya March 2014 • On farm testing in N Rift should start Dec 2014 • On farm testing in Eastern should start March 2015

Option 4: Buy old contaminated grain from the Government of Kenya

Advantages	Disadvantages
Scientific vigor	
• N/A	• Grain is old, insect damaged and not representative of smallholder farmer stored grain • No way of knowing until after extensive testing whether live Aspergillus spores are still present • Effects of tempering the grain may have unforeseen affects on the grain and may negate storage findings • No knowledge of where any of the grain will have come from and therefore which strains of Aspergillus may be present • Aspergillus strains from Eastern may be introduced to N Rift • Since the grain is not characteristic of smallholder farmers stored grain it would be advised that the effective storage devices be re tested with farmer quality grain
Technical Implementation	
• No transportation of contaminated grain prior to mixing	• Significant increase in testing costs
Timeline Considerations	
• Grain is available immediately • On farm testing in N Rift should start Dec 2013 • On farm testing in Eastern should start March 2014	• NA

Option 5: Carry out storage testing in alternative country in Africa which allows inoculation

Advantages	Disadvantages
Scientific vigor	
• Guaranteed suitable grain providing statistically relevant results	• Climatic conditions may vary from Kenya
Technical Implementation	
• Simple procurement of wet grain, introduce inoculate, and start testing phase • Quick implementation of project • Minimum level of AflaSTOP staff	• Facilities in other African countries with ability to produce inoculums with relevant strains unknown • Prevalent levels of aflatoxin unknown therefore hard to understand successful on farm testing • Moving on farm testing to Kenya requires off farm testing to be done in climatically similar areas to the on farm testing in Kenya • Kenya has the largest proportion of commercially orientated smallholder farmers, and commercial services (input dealers, financing, manufacturing sector etc)essential for building the commercial networks to deliver storage devices to smallholder farmers
Timeline Considerations	
• Depends upon alternative country and harvest.	• Same.

Initial Option: Inoculation

Advantages	Disadvantages
Scientific vigor	
• Guaranteed to have the same strains of active toxigenic *Aspergillus* relatively homogenously spread throughout the maize • Guaranteed statistically relevant results	• None
Technical Implementation	
• Simple procurement of wet grain, introduce inoculate, dry and start testing phase • Quick implementation of project • Minimum level of AflaSTOP staff	• None
Timeline Considerations	
• Start in March 2013	• NA

5.3 Evaluation of All Options

This section describes each option:

1. Purchase contaminated grain, increase aflatoxin levels, and test in relevant sites in Kenya;
2. Buy old contaminated grain held by the government of Kenya
3. Test storage devices in collaboration with a US University using inoculation with a native Kenyan *Aspergillus* isolate (or isolate mixture), followed by in country and on-farm testing of the identified most effective storage technologies; or
4. Carry out the storage testing in alternative countries in Africa

It is important to consider the scientific rigor of each option and that the results from the off farm testing (first phase testing) are scientifically valid. As such, the project needs to ensure that the results are replicable, that the methodology used stands up to scrutiny, and that confounding factors that may have affected the results or minimal or absent. In addition to scientific rigor, AflaSTOP will also carefully consider the following factors:

- Ethical issues: Confidence levels of the results should be high. AflaSTOP should be confident that it only introduces highly effective storage devices to smallholder farmers. Over 40% of grain in Eastern Province will be contaminated and it has to be ensured that storage devices introduced to smallholder farmers by AflaSTOP do not worsen the situation.
- Political issues: the perceptions of tampering with maize can raise many questions and could be politically sensitive, especially in a country like Kenya where many people are still food insecure and where aflatoxin is a known problem.
- Implementation time lines and costs

Options 1 & 2: Purchase contaminated grain in Kenya

Desription. This option would require the following steps:

1. Buy contaminated grain in the market in Kenya;
2. Increase aflatoxin contamination levels to 50ppb; and
3. Conduct the storage test as described in the Research Methodology.

This option raises a number of logistical challenges, but with the following likely solutions. Contamination levels in grain in Kenya are highly variable across regions. However, some generalities can be drawn from findings from the preliminary AflaCONTROL project. Contamination is more prevalent in the East and the West, as shown in table 1. In North Rift only 2% of samples were above 10ppb.

Table1; Percentage of samples with aflatoxin levels above 10+ppb and 50+ppb

Location Eastern	10ppb+	50ppb+	Location Western	10ppb+	50ppb+
Meru	43%	31%	Kisii	36%	11%
Makueni	43%	20%	Homa	38%	7%
Machokos	36%	14%	Nyamira	31%	4%

Based on the above information, purchasing grain in Meru has a 43% chance of being above 10ppb and approximately 75% of grain above 10ppb will be above 50ppb. Purchasing grain in Meru increases the likelihood of finding contaminated grain.

Maize produced in Western or N Rift is mainly infected by *A. flavus*, a very common aflatoxin-producer. *A. flavus* has been very well described. Results from storage testing in Western and N Rift could be used to extrapolate usefulness of the device in other countries. Therefore, it can be recommended to use locally produced grains for storage testing in all Provinces. Eastern grains to specifically address the unique aflatoxin problems in the Eastern Province, and N Rift grains to ensure the storage device works equally well for grain contaminated with common aflatoxin-producing fungi.

Due to legal and ethical issues AflaSTOP will have to purchase any grain with confirmed contamination levels above 10ppb. If aflatoxin levels are below 50 ppb, grains could be incubated under favorable conditions to increase aflatoxin values and jumpstart fungal growth post-harvest. For example, by providing the right conditions (warmth and humidity) growth of aflatoxin-producing fungi present and subsequent aflatoxin production can be stimulated. Grains would be incubated until tests confirm an aflatoxin contamination level of 50ppb or more indicating a widespread colonization and contamination by the fungi.[2]

Advantages	Disadvantages
• Include collaboration with local bodies (e.g., KARI) to increase acceptability of results by stakeholders in Kenya. • Uses local grain so that the project can move straight onto on-farm trials if any storage device is found effective. • Assess timing trade-offs: • Procure grain in Eastern to have a higher chance that the grain will have levels above 50ppb (approximately 75% (Meru) to 50% (Makueni) chance),	• Procuring grain will be more difficult and will require more AflaSTOP staff in the field to: identify possible contaminated grain (high moisture levels, previously found in that area etc), test the grain, buy and transport it to the central store. • Compared to inoculation it will be more expensive to manage and will take longer to set up. • Using grain from Western involves moving a strain of *Aspergillus* out of its

[2] This will involve mixing all the grain, then placing it in store, covering the stacks with plastic to increase the humidity and temperature, possibly splashing water on the floor, or having buckets or water around. After about one week we would check the aflatoxin levels. If they had increased sufficiently we would then mix all the grain once to see if the levels were still around 50ppb. If the levels were not high enough we would incubate it again for another week (and so on). If after mixing the aflatoxin levels were still above 50ppb we would proceed with the testing phase - but include 4 - 6 extra mixes to ensure that the *Aspergillus* spores were properly spread throughout all the grain.

but delays the project until early 2014 harvest. ○ Procure in Western to benefit from earlier harvest, but the likely hood of having to incubate the grain is about 60 - 80%. However, this would allow for on farm testing in Eastern Province to start March 2014.	natural area into a new area within Kenya. • If we want to maximize the chance to buy grain with 50ppb, the project will have to wait for the next harvest in Eastern Province in March 2014. This will delay the on farm testing in Eastern to March 2015 (N Rift would start Dec 2014 but unlikely to have aflatoxin results). • Testing Western strains of *Aspergillus* in Eastern will not provide the level of confidence testing Eastern grain in Eastern will provide

The two main options to buy contaminated grain in Kenya area;

1. Buy grain in Eastern Province and N Rift Province and test the same grain in those locations

2. Buy grain in Western Kenya and test in storage devices in Eastern and N Rift

The project can either buy contaminated grain from the same location as the testing occurs (ie buy grain in Eastern & N Rift and test in Eastern and N Rift), or the project could buy grain from Western, and test it in the storage devices in Eastern. While buying grain form an early harvest area (Western) would potentially allow the project to start up again in July 2013, results from storing maize produced and infected with Aspergillus isolates from Western cannot be applied to Eastern. In the Eastern Province, a novel species of aflatoxin producers, only distantly related to *A. flavus* (the major producer of aflatoxins in most of the World), is found to be dominant on the locally produced grain. This newly described fungus is very aggressive, responsible for the acute aflatoxicosis outbreaks and its characteristics have not been studied in great depth. For this reasons, storage devices tested in Eastern should contain grain produced in the respective area

Option 3: Test storage device in a US University and Replicate in Kenya
Description. This option would involve several steps:

1. Select an American academic institution with relevant expertise;
2. Test storage devices in the US with grain purchased in the US that would be inoculated with *Aspergillus* isolates native to Kenya but available in the US (Cotty lab has these isolates);
3. Replicate the off farm test with only the most promising technologies in Kenya, using locally purchased grain (as described in option 1).

The political risk of inoculating good grain in the US for a controlled test in a safe location should be significantly less than inoculating grain in Kenya. This would allow the project to eliminate storage devices which obviously did not work before off farm testing in Kenya however it will draw out the time lines even further since the project will still have to go through off farm testing in Kenya unless it is proven that .

Advantages	Disadvantages
• Using a US University may add legitimacy to the perceived scientific rigor of first testing phase of the project • Allows the project to eliminate storage devices that obviously did not work before off farm testing in Kenya reducing the volume of contaminated grain in Kenya requiring disposal. • Grain is likely to be cheaper in the US as prices return to nearer normal after this year's disastrous drought. • Could employ a Kenyan graduate student to undertake this project and do part of the study in the US (which would allow additional training of local new scientists in aflatoxin problematic) and transfer his knowledge to Kenya	• A number of factors will require that the tests are replicated in Kenya, including: ○ The climatic conditions in the U.S. are different than those in Kenya. ○ The grain in the US is very different from the grain in Kenya ○ Storage sites will be very different in the US ○ It will be difficult to buy wet grain characteristic of Kenyan grain which is placed in store. • Regulations surrounding such testing and disposal of grain after testing are unknown at this point • There may be limitations on availability of Kenyan strains of *Aspergillus* and regulations controlling the production of inoculums in large volumes • Shipping the storage devices to the US would incur additional unplanned expenses to the project and successful devices will have to be procured a second time for the Kenyan off farm storage (rather than shipping them back). • On farm testing in Eastern Province will not start until 2015

Time line;

Off farm testing in US buy grain Sept, mix, dry half, inoculate all, put in storage devices Oct/Nov, buy grain in March, incubate 4 weeks, mix 2 weeks, start off farm storage testing Eastern mid may, N Rift June, start on farm testing in N Rift Dec, and Eastern March 2015.

Option 4: Buy old contaminated grain from the Government of Kenya

Description; This option would involve the following steps:

1. Robustly ID, sample and test over 600 bags of contaminated grain stored at one of NCPB's sites
2. Work with the University of Nairobi to test whether *Aspergilli* on the grain are still active;
3. Select only those bags where the aflatoxin levels are above 50ppb and the spores are still active
4. Add moisture to 50% of the grain to get internal moisture readings of around 16%
5. Conduct the storage test as described in the Research Methodology (Annex 13).

The Kenyan National Cereals and Procurement Board is holding considerable stocks of contaminated grain from Eastern acquired a couple of years ago[3]. The size of the stocks has created problems concerning disposal as well as generating considerable expense. AflaSTOP could request approximately 55 mt for the off farm testing. However this grain is dry (13.5% or lower), has had significant insect infestation and cannot be considered representative of smallholder farmers harvested and stored grain. To replicate 'wet' maize, the project would have to temper the grain (i.e. add water). As grain dries down it enters into a dormancy period. Adding water to grain is like planting it in the soil and it then raining; the grain starts to germinate. Germination probably starts around 35% moisture levels; tempering the grain to 16% moisture level will be very experimental and may have consequences to the grain which will negate the test results. To be sure that tempered grain behaved in the same way as farmers recently harvested grain a second level of testing would need to be completed.

Advantages	Disadvantages
• Large stocks of contaminated grain are available, AflaSTOP would be able to sort through the piles to identify bags with levels above 50ppb. • It is possible that the GOK would lend or donate the contaminated grain, thereby reducing AflaSTOP's expense of procuring grain. May be able to hand the grain back to NCPB at the end of the testing phase and therefore reduce possibility of having to pay for disposal • Using the government's own grain would build additional linkages between government and the project	• Grain is old, insect damaged, and not representative of smallholder farmers stored grain • Each bag will have to be vigorously sampled and individually tested ($6/test)- • We will have to test whether the fungi are still active (UON) • Grain may have been treated with chemicals, including fungicide. • Grain will have to be tempered for the wet maize storage treatment - the effect of this on the grain is unknown and may negate the results of the storage testing • Tempering the grain is experimental and the project will have to work out the best ways of achieving uniform moisture levels of 16% requiring more grain • In trying to test for the effectiveness of the storage devices the aim is to remove variables which may affect the results but are not related to the storage devices - having to wet the old grain introduces a number of variables which may make the off farm testing non effective, or at least statistically questionable. • It will be impossible to tell whether the storage devices are effective on pests (a concern of smallholder farmers) since NCPB will have treated the grain.

[3] The NCPB has 210,000 bags of contaminated maize in the NCPB stores.

Time line; can start whenever - 2 months to test and ID bags, one month to temper grain, start storage tests in Eastern and N Rift, on farm testing Dec 2013 N Rift and March 2014 Eastern

Option 5: Carry out the storage testing in alternative countries in Africa

It might be possible to identify a country in Africa where there is less concern with the potential political perceptions of using inoculum to conduct the off-farm test. One option would be to explore which countries in Eastern Africa (to start with) have relevant *Aspergillus* strains and the capacity of producing the volumes the project would need. While Kenya has the greatest data available about prevalence other countries experience aflatoxin problems. WFP reports that maize in Uganda often has a problem, in both Rwanda and Tanzania the breweries test maize grits and in Rwanda there has been one occasion when the level was found to be higher than recommended. The results from these tests would not demonstrate whether the storage devices will be effective in Eastern Kenya with its unique strains of *Aspergilli.*

Advantages	Disadvantages
• Using inoculation would allow rapid re-start of the project • Inoculation provides the most scientifically robust start for testing • Given the regional focus of PACA, working in an African country may be viewed more positively than testing in the US. • Guarantee statistically relevant results under conditions tested and the ability to identify storage which effectively prevents further contamination by aflatoxin	• Availability of capacity to produce inoculums in other African countries unknown at this point • Significant in country research will need to be done to check feasibility of carrying out testing in different locations • On farm testing will be more difficult since areas which suffer from aflatoxin are unknown and therefore whether the storage devices prevent further contamination when farmers store will be extremely difficult to test in another country. • We would need to set up an office in a different country and would incur additional expense of the COP moving back and forward to supervise. • Unless we can do off-farm testing in areas with the same climatic conditions as the on farm testing in Kenya we cannot do on farm testing in Kenya until the storage devices have passed off farm testing in the same climatic conditions • Disposal of contaminated grain may be more difficult in other countries • Kenyan farmers are the most economically active in the region and therefore the easiest to build commercial models around, Kenya's manufacturing industry is the most advanced and therefore again most likely to respond to commercial opportunities around storage devices smallholder farmers value.

Initial Option: Inoculation

The following table summarizes the pros and cons of inoculation when compared to one of the other options that was discussed above.

Advantages and disadvantages of inoculation	
Advantages	Disadvantages
• Incubation of specific toxigenic strains of *Aspergillus* present in testing area • Guaranteed presence of sufficient levels of active *Aspergillus* spores throughout the grain stored which will be guaranteed to show whether or each storage device being tested works off farm • Purchase of exact volumes required by the project • Rapid mobilization of storage testing	• Potentially good grain is infected with toxigenic *Aspergillus* • USAID's concerns of potential bad publicity by politicians agitating in the current election climate
Advantages and disadvantages of buying contaminated grain	
Advantages	**Disadvantages**
• Purchasing contaminated grain removes it from the market and therefore prevents a significant number of people eating it • Politically USAID views this as a more favorable option • Could save money if grains are donated by the Government • Grains in stock by the Government are already highly contaminated, a second incubation would not be necessary • Buying grain from Eastern Kenya will likely to have the new aggressive stains of *Aspergilli.*	• While the project needs the grain to be at around 50ppb+, we will have to purchase all grain we find above the legal limit of 10ppb • Grain with levels less than 50ppb will need to be incubated (see explanation below) which is not an exact process and will take time • It will be incredibly difficult (time consuming and laborious) to find and incubate N Rift local strains of toxigenic Aspergillus (less than 2% of samples had aflatoxin levels above 10ppb in AflaCONTROL) • The best locations to buy grain with contamination levels above 50ppb are Meru (31% samples AflaCONTROL) and Makueni (20% samples AflaCONTROL) which harvest maize in March of each year - buying from these locations would delay the project start up until January 2014

5.4 Project Location

Having determined that purchase of contaminated grain was the best option for the project to implement this constrained the areas of implementation to areas where there is significant likelihood of high occurrence of aflatoxin levels above 10ppb at harvest. The area in Kenya which best fit this criteria is Eastern, in particular Meru and Makueni Counties.

For the purposes of this project, project alternatives analysis was done considering the various stores selected in the various towns within the two counties;

- The choice of the counties was done on the strength of previous records demonstrating high probability of sourcing contaminated grain at harvest and district agro climatic zone. The worst

recorded outbreak of aflatoxin poisoning was recorded in Eastern Province in 2004 in which 317 cases were reported with 125 reported deaths.

- The areas selected to test the storage devices are therefore most suited for the project. The location of the store will be in the identified trading centers to increase the security of the store. The selection of store and location will be as per the choosing parameters listed in Annex 2

- This project selection of the store was strategically done by the proponent considering areas with all weather road accessible trading / market centres. These are areas outside the residential area, close to the tarmac road and where ever possible close to security points such as chiefs camp.

- The stores are already constructed and are being rented from the owners for a period of 9 months only, so there are no design specifications to consider. The stores are also well secured with metal grill windows and metal doors.

- It is, therefore, not feasible to consider site alternatives.

Chapter 6: Public Consultations

6.1 Introduction

Public participation basically entails involving, informing and consulting the public in planning, management and other decision-making activities. It attempts to ensure that due consideration is given to public values, concerns and preferences when decisions are made, with the public actively sharing in the decisions that government and other agencies make in their search for solutions to issues of public interest. Effective public participation requires the availability of adequate information in public inputs. The latter involves various values, critiques, questions, information, suggestions and other inputs, which are expressed in a structured manner by individuals, groups or organizations among the general public in an attempt to influence decision-making.

Public consultation during this impacts assessment was carried out with the following aims:

- To seek views, concerns and opinions of people in the area concerning the activities to be carried out in the proposed storage facilities in both Makueni and Meru counties.
- To establish whether the neighbours are subject to existing/potential positive or negative environmental effects from the operations of the storage facilities and give proposals on their mitigation.
- To seek views, concerns and opinions of people in the area to establish whether they had any significant environmental effects concerns in relation this project.

6.2 Methodology

Public participation was achieved through consultation with government authorities, the neighbours to the sites of proposed storage facilities of both administrative locations (Makueni and Meru) counties and various other stakeholders. In addition, the agricultural and public health officers in the respective areas were contacted and briefed on the proposed project. This was done through direct interviews, observations and questionnaire administration. The EIA experts also made a tour of the area proposed for the project and its environs, taking records of observations and photographs. The following is a detailed discussion of public consultation methodology used by the team.

6.3 Questionnaire administration

Questionnaires were prepared and administered to the neighbours of the proposed project site. The experts held meetings with the agriculture County directors, public health County directors, administration officers and also with neighbours, with whom they spent considerable time, and held discussions on their opinions about the operations of the proposed storage facilities and impacts of the proposed project. Comments from 14 respondents were sought through the interviews. Copies of the questionnaires and briefs are attached in Annex 4.

6.4 Photography

Photographs of neighborhoods, facilities and installations related to the project were taken and have been affixed in various sections of this report. Selected photographs are given in Annex 5.

6.5 Local meetings / Barazas

Seven Barazas were held in the two counties, three in Makueni and four in Meru with 107 different participants; Minutes of the barazas and the signed attendance lists for the members present are attached in Annex 6.

Chapter 7: Impact Identification and Mitigation Measures

7.1 Introduction

The process of impact identification brings together both the environmental baseline and project characteristics in order to identify, evaluate and predict the positive and negative impacts of development for sustainable development (socio-economical and environmental). The environmental and socioeconomic impacts on this project are expected to arise from the operation and decommissioning phases of the project. This project doesn't have a construction phase since the stores where maize will be stored already exist, all the storage devices and other equipment will be procured from the market, maize will be procured locally.

Aflatoxin contamination of grain starts in the field and is exacerbated when the crops are damaged by drought or insect infection or when the grain comes into contact with soil and is not properly dried. Contamination levels continue to increase after the grain is harvested and stored. In Makueni County, AflaCONTROL showed that while 43 percent of households had aflatoxin levels above 10ppb at harvest, another 44 percent of farmers were affected after only one month of storage – meaning that 87 percent of households were affected with levels above 10ppb. Aflatoxin strains and spores will already be present in the areas where this project proposes to undertake its activities.

The chart below illustrates the key impact indicative parameters applied in the assessment associated with the project implementation and post-implementation phases

Impact Aspect	Significance	Human health	Potential project related Issues Investigated
Waste Management	Low	Low	▪ Spores of *aspergillus* in the air within the stores (n, r) ▪ Waste management capacity availability to handle the contaminated maize at end of the project (n)
Health and Safety	Medium	▪ medium	▪ Contamination of workers handling the contaminated maize (n) ▪ Decontamination of transportation trucks (n) ▪ Safety and security of the contaminated maize during storage and transportation (n) ▪ Safety and security of the contaminated maize during disposal (n) ▪ Potential improved health of the population due to use of storage that reduces the increase of aflatoxin levels in stored maize (p)
Social	Medium	▪ medium	▪ Improved food security (p) ▪ Employment creation as maize and other grain storage containers are locally produced and sold through local networks (p)
Economic Linkages	High	▪ Not applicable	▪ Generally positive implications to all stakeholders and the country ▪ Higher trade capacity
Drainage	Low	▪ Low	▪ Disposal of wash waters from washing of transportation trucks and grain dryer (n, r) ▪ Disposal of wash waters from decontamination of testing containers and the testing stores at the end of the project (n, r) ▪ Potential loading into the neighbouring areas and

Impact Aspect	Significance	Human health	Potential project related Issues Investigated
			receiving rivers (n, r)
Ecological	Medium	▪ Low	▪ Reduced presence of *aspergillus* spores due to reduced growth of *aspergillus* during storage (p)

p - positive: n-negative : r- reversible

7.2 Operation Phase

During the operation phase, the activities with issues associated with the project that may of environmental concern include:

- Handling of contaminated maize
- Transportation of contaminated maize
- Use of sodium hypochlorite in decontamination activities

From the activities of the project, although the magnitude of activities is small, it is evident that owing to its nature, the activities pose a potential negative risk to human health and to the environment in the absence of proper precautions. These risks are articulated below.

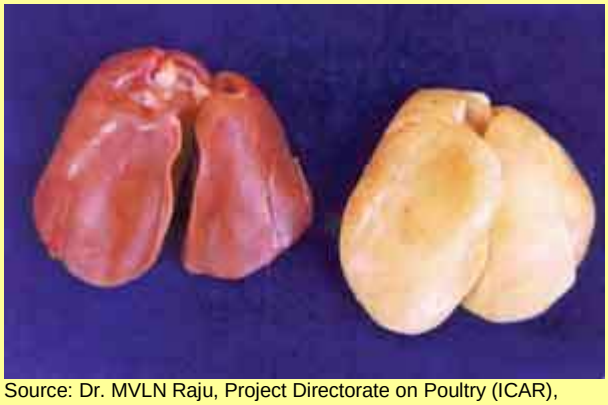
7.3 Human Health

The negative effects to human health in terms of inhalation have not been well investigated; there is an assumption that a person with a suppressed immune system (for instance suffering from untreated HIV/AIDs) may be effected if they inhaled dust containing fungal spores. However the is no documentary proof that this is the case. Healthy people should have no problems. People suffering from asthma may suffer asthmatic events when there is a lot of fine dust in the air and may be effected by the dust - but not the aspergillus spores of aflatoxin. Since the project cannot establish who has a suppressed immune system all personnel working with the grain will wear appropriate protective clothing, gloves and masks. However, the potential negative effects are less than the no action alternative.

Effects of aflatoxin B1 on Chicken

Source: Dr. MVLN Raju, Project Directorate on Poultry (ICAR), Rajendranagar 500 030

Chicken Liver



Source: Dr. MVLN Raju, Project Directorate on Poultry (ICAR), Rajendranagar 500 030

The negative effects to human health in terms of eating aflatoxin contaminated maize are also not well investigated (since it is unethical to feed poison to people) however it is clear in animal studies that eating maize contaminated with aflatoxin effects the digestive process resulting in lower absorption of essential nutrients and long term stunting. Ingestion of high levels of aflatoxin are lethal - and this is well documented in Kenya in humans and around the world (3,000ppb+). The project will remove over 50mt of contaminated food from smallholder farmer's stores. The project will destroy all the maize handled at the end of the project. The only potential negative risk is theft from the stores during the project. The project is mitigating this risk by communicating with the locals in each village so they understand the maize stored is not fit for human consumption, storing the maize in secure stores in secure areas with the presence of an askari and or a police / local authority security post, having a sign in the store saying the maize is not fit for

consumption and marking every storage device with a danger sticker approximately over 25 cm in length.

The potential benefit of the results (i.e., increased food security due to reduced post harvest loses through aflatoxin contamination and improved economic empowerment) when a scientifically proven protocol of drying and storage of maize that prevents further aflatoxin contamination is used by the small scale farmer cannot be overemphasized. The few environmental impacts and their mitigation measures are discussed below:

7.4 Impacts Triggering Issues

7.4.1 Air Pollution

Sources

Aspergillus flavus produces conidia (asexual spores) which can be dispersed / suspended in air. These spores are assumed capable of causing pulmonary infections in people specifically those that are immuno comprised. It is estimated that approximately 30 persons will be involved handling grain at different times during this study. Each person will be trained in health and safety precautions, issued protective clothing, gloves and face masks. Gloves and face masks will be replaced at least one a day. The risk of exposure to inhalation is considered low since for the most of the time (6 months) the maize will sit statically within storage devices and sampling procedures disturb the grain as little as possible. No indirect people are expected to be effected since the stores are contained and members of the public will not be allowed in them.

7.4.1.1 Mitigation Measures

- All staff and labourers handling the maize will be trained on the safety procedures laid out in the Safety Users Action Plan and use of the personnel protection equipment (goggles, mask, protective overalls and wellington boots).
- Other than transfer of the grain from polypropylene bags into the storage devices, and monthly sample collection the grain will remain static during the ~ 6 month storage period.
- Maize will be carefully loaded onto the trucks, which will be tightly closed and transported to the storage site with AflaSTOP staff in attendance. In the case of a truck having to stop over night the truck will be locked within a secure compound with the presence of askaris..
- Unloading will be supervised by AflaSTOP personnel.
- Personnel handling the grain will be strictly monitored to ensure compliance with safe handling procedures.
- Secured stores will be guarded, and monitored by AflaSTOP staff

In case of an incident during transportation of the contaminated maize;

- AflaSTOP staff will be in attendance of each truck. If an accident occurs AflaSTOP staff will not leave the truck unless adequate guards are present. In the case of a simple accident the grain will be transferred using the usual protocols from one truck to another. In the case where a truck has over turned and spillage has occurred AflaSTOP staff will clearly tell any local people that the maize is contaminated. They will immediately call the local police to come and help crowd control. They will immediately contact the COP who will send immediate back up and equipment. The maize will be gathered up, re-bagged and removed. The site will be thoroughly cleaned.

7.4.1.2 Disposal

- Disposal of maize shall be through incineration at a NEMA licensed incinerator only unless advised otherwise by NEMA
- Disposal of lab equipment (pipettes etc) shall be through incineration.
- Large equipment, stores and the dryer will be cleaned with a solution of sodium hypochlorite and water, this solution will be further diluted (5 times) with more water until it is allowed to enter into the drainage system.

Protocols for handling of aflotoxins have been developed by the proponent and are attached in the Annex 8.

7.4.2 Social – Economic

7.4.2.1 Employment

During implementation phase, the project will offer employment for casuals, consultants and permanent workers.

The estimated number of employees:

Category	Duration	Number
Casuals	30days	30
Consultants	15 days	3
Full time employees	As needed	4

7.4.2.2 Economic empowerment

The project will provide a small number of farmers with a market for maize and a small number of SMEs rental income to 12 storage sites. In addition the materials to be used, i.e. storage containers under testing, gloves, wellington boots etc will be purchased locally.

In areas where the effects of aflatoxin are known farmers show considerable interest in technologies which will prevent further contamination of aflatoxin. If any of these devices prevents further contamination of aflatoxin, AflaSTOP will work to build commercial manufacturing capacity, and distribution networks to supply farmer's needs. This will generate significant economic benefits as well as improve food security and reduce health risks. For instance a small agro dealer who starts stocking suitable storage devices may increase his income at say $0.10 per bag sold, each bag lasts 2 maybe three seasons, the market in Eastern produces between 3 - 5 million 90 kg bags in the short rain season.

Post-harvest losses are estimated in the AGRESULTS business plan at 13.5%; however, this includes losses through post-harvesting handling (as grains are dried, shelled, bagged re-bagged and stored) which aren't all addressed by proposed storage technologies. Unless there is a LGB or significant weevil infestation, storage losses as part of this percentage are more likely estimated at 5%. The proposed technologies may lower this storage loss to 1% representing a 4% savings (or 12KG per farm per year based on 300KG average production per household) – a potential monetary value of $2.00 per household for each season (or $0.60 per bag). (N.B. CIMMYT has found incidents of 25% losses from maize weevil and LGB using traditional bags.

Seasonal prices over the past year have changed from $14 farm-gate price at harvest to $18 price per 90KG bag. Assuming a farming family shifts from selling 100% of consumed food (est. 300KG) to simply storing 100% of this amount, this represents a $13.33 savings per season.

If the analysis of the data generated demonstrates that one or more of the storage devices work and prevent further contamination of the grain stores the project will then work to develop to commercialize these technologies small scale storage devices not just in Kenya but East Africa and beyond. This will increase food security, enhance business and also contribute to growth of the economy through:

- Reduced levels of aflatoxin in stored grain
- Reduced exposure to increasing aflatoxin levels while food is consumed out of poorly designed storage
- Increased trade of less contaminated maize which has been stored for longer periods
- Reduced incidences of aflatoxicosis in Kenya
- Gainful employment at firms with skills to fabricate and distribute the storage containers.

7.4.2.3 Accidents involving personnel employed by AflaSTOP

To prevent accidents, awareness creation for employees and laborers at the beginning of the project will be given priority while the operations manager will ensure the protocols and action plans and procedures are strictly followed throughout the project cycle.

Apart from protective clothing to prevent ingestion, skin contact and inhalation of harmful material, the workers will also be trained on standard operating procedures for health and safety

The following will be provided;

a) First aid kits
b) Protective clothing e.g. masks, aprons, gloves, safety boots / wellington boots etc.
c) Training on environmental health, safety and standards set for their observance
d) Workman's compensation for all workers in case of accidents

During operation phase, access and security rules and regulations will be adhered to while all precautions for fire prevention and fighting will be followed.

If a worker does expose his own clothes he will be instructed to wash them. Workers will be required to wash their faces, heads, and hands in water provided at the site.

7.5 Conclusion on the Severity of Impacts

In conclusion the environmental risks surrounding this project are low, the maize procured will come from the area it will be stored in for six months, and at the end of the project the maize will be transported to a NEMA licensed incinerator and disposed appropriate as per Kenyan regulations. The wash water from cleaning the large scale equipment could have negative impacts if not properly diluted, but it is the same treatment as most households use to clean sinks, toilets etc.. The health risks for workers undertaking activities for this project are low and the project has in place protective measures to protect those that might be at greatest risk. If contaminated maize was stolen by thieves breaking into the stores, or collecting grain from a truck which had spilled its load there are potential high health risks if this maize was then eaten, particular towards the end of the project when maize has been stored for up to 6 months and aflatoxin levels will have increased from around 50ppb to an unknown (at this point) level (while it is not acceptable it is common occurrence that people are eating maize with levels between 10 - 100ppb for everyday meals). The project has a number of security measures to prevent this happening but cannot guarantee it will not happen.

Risk	**Potential Occurrence**	**Suitable Mitigation Measure in place**
Inhalation of spores by workers with immune compromised systems	Low	Yes
Ingestion of contaminated maize	Low	Yes
Inappropriate disposal of maize	Low	Yes
Inappropriate treatment of wash water	Low	Yes

Arising from the project activities and formulated mitigation measures of the negative impacts, the impacts may not be severe to cause objection to the project going ahead. The volume of maize to be used for the project is relatively small. Maize from the particular area will be stored in the same district thus the *aspergillus* spores will already be present in the maize farms soil and ambient air.

This section needs a summary of pros and cons of each alternative and recommendation for the selected option.

CHAPTER 8

8.1 Environmental Mitigation and Monitoring Plan (EM&MP)

The EM&MP lists all the environmental aspects and potential impacts of the proposed new development. The mitigation and monitoring measures and means that must be implemented to manage the impacts within acceptable limits are also listed. The EM&MP also identifies the parties responsible for implementing the mitigation measures.

8.2 Pre-Project Phase

Activity	Potential adverse impact	Mitigation measure(s)	Cost in mitigation Ksh	Monitoring Indicator(s)	Monitoring and Reporting Frequency	Person(s) Responsible
	IDENTIFY COMMERCIALLY VIABLE SMALL SCALE STORAGE TECHNOLOGY THAT PREVENTS FURTHER AFLATOXIN CONTAMINATION					
	All project personnel must study and follow steps laid out in Safety Plan when handling contaminated grain.					
Store identification and cleaning	Generation of dust (resulting from brushing floors) Severity; negligible (this is prior to project activities)	• Training staff and laborers on safety procedures and use of Personal Protective Equipment (PPE); • Use of face masks, overalls, boots and appropriate gloves.	Ksh83,000	% staff trained % staff using PPE	Once	Operations Manager

8.3 Operation and Decommissioning Phases

Activity	Potential adverse impact	Mitigation measure(s)	Cost in mitigation Ksh	Monitoring Indicator(s)	Monitoring and Reporting Frequency	Person(s) Responsible
	All project personnel must study and follow steps laid out in Safety Plan when handling contaminated grain.					
Acquisition and handling of maize	Human exposure to aflatoxin from inhaling aflatoxin and spores present in contaminated maize Probability; low Severity; low	• Use of gloves, nose masks (PPE) and trucks for transportation to storage site	Ksh 127,000	% staff using PPE	Once	Operations Manager
Incubating and mixing grain with toxigenic strains of *Aspergillus flavus*	If inhaled potentially might adversely affect immuno compromised individuals, such as HIV + people Probability; low Severity; low	• Training staff and laborers on safety procedures and use of Personal Protective Equipment (PPE); • Use of face masks, overalls, boots and appropriate gloves when handling grain	Ksh 120,000	% staff trained % staff using PPE	Once	Operations Manager
Transporting contaminated grain from purchase point to incubation/mixing area and then back to storage sites	Grain is stolen from the truck Probability; low Severity; low Truck is contaminated Probability; low Severity; low	• Trucks will be accompanied by AflaSTOP staff to monitor; movement. Trucks will not be left unsupervised; • Grain will be placed in sacks, on tarpaulins; • After transport	Ksh 177,000	A-SHAP followed Grain truck movement records reconcile	Once per transportation	Operations Manager

Activity	Potential adverse impact	Mitigation measure(s)	Cost in mitigation Ksh	Monitoring Indicator(s)	Monitoring and Reporting Frequency	Person(s) Responsible
		trucks will be sprayed down with a decontaminating JIK (cleaning) solution, and then washed down. (Use household sodium hypochlorite; dilute wash waters with water by a factor of 5:1 and dispose of waste waters in safe locations.)				
Storing grain for 6 months	If contaminated grain is stolen from the store, sold and eaten it could potentially cause aflatoxicosis (depending on the grade of aflatoxin contamination present) Probability; low Severity; potentially high	• Warning signs inside the store in local language or recognizable symbol • Guards posted outside the store • Store locked	Ksh 2,300,000	% stores with warning signs	Daily monitoring by guards, weekly reports	Operations Manager
Drawing grain samples from storage devices	If spores from the grain are inhaled could potentially adversely affect persons exposed, especially HIV + affected people Probability; low	• Sign reminding staff to use PPE • Use of face masks, lab coats and appropriate gloves	Ksh 30,000	% staff using PPE	Six times per storage testing period	Operations Manager

Activity	Potential adverse impact	Mitigation measure(s)	Cost in mitigation Ksh	Monitoring Indicator(s)	Monitoring and Reporting Frequency	Person(s) Responsible
	Severity; low					
Analyzing grain samples	If contaminants from the grain are inhaled can adversely affect persons exposed, especially HIV + affected people Probability; low Severity; low	• Warning on inside of door restricting access • Sign reminding staff to use PPE • Use of face masks, lab coats and appropriate gloves • Disposable equipment to be bagged and taken to the University of Nairobi incinerator • Reusable equipment to be cleaned as laid out in Safety Users Action Plan	Ksh 360,000	% staff using PPE	Six times per storage testing period	Operations Manager
Cleaning and decontamination of the truck and stores	Generation of dust and use of soaps and detergents. Probability; low Severity; low Contaminated wash water from cleaning trucks and stores Probability; low Severity; low	• Provide masks, use environmental friendly detergents and workers observe discipline. Wear PPEs. • Decontaminate using household sodium hypochlorite. Use household sodium hypochlorite; dilute wash waters with water by a factor of 5:1 • Dispose of waste	Ksh 203,000	% staff using PPE Wash water testing records	once	Operations Manager

Activity	Potential adverse impact	Mitigation measure(s)	Cost in mitigation Ksh	Monitoring Indicator(s)	Monitoring and Reporting Frequency	Person(s) Responsible
		waters through drainage system UNLESS drainage system runs into a biologically controlled sewage works.				
Disposal of stored grain; • Incineration in NEMA certified incinerator within Kenya	Improper disposal can lead to exposure to aflatoxin and negative impact on human health and environment. Probability; low Severity; high	• Comprehensive recording of grain movement. Follow relevant regulations to incinerate in Kenya. Incinerate in a NEMA licensed facility in accordance with NEMA waste regulations. Use monitoring equipment to ensure controlled constant temperature and hazardous waste detection is done during incineration burns. Testing and proper disposal of ash solid waste after incineration.	Ksh 7,000,000	All grain is safely disposed of in accordance with GoK regulations	Once	Operations Manager

CHAPTER 9

9.1 Conclusion

The project will provide evidence to small scale maize farmers in Kenya if there are any storage technologies that prevent further aflatoxin contamination. During implementation phase, it will create jobs. After completion if there is a successful technology, artisans and local industry will fabricate and distribute the storage containers creating more jobs. The reduction of incidences of aflatoxin contamination in maize will increase available maize stock within the country improving food security. Improved quality of maize at the household consumption level will reduce long term detrimental health effects. This EIA study report has shown the positive attributes of the project.

However, there are potential significant health risks to workers handling the contaminated grain if safety procedures are not adhered to, and minor health and environmental effects during the acquisition, transportation and storage of the grain, and a possible negative air pollution effects from incineration of the contaminated grain and possible but minor negative effects from the disposal of waste water from cleaning the storage vessels. The project proponent must put in place measures that will reduce the potential negative impacts highlighted in this study report. The proponent shall also adopt the monitoring and evaluation plan suggested in the EM&MP to ensure that the project activities do not have significant long-term negative health or environmental effects. The proponent must properly dispose of the contaminated maize and decontaminate the storage facilities used during the decommissioning phase. The positive environmental and social impacts of the project outweigh the negative ones as indicated in the Environmental Mitigation and Monitoring Plan and therefore approval for its implementation is requested.

ANNEXES

ANNEX 1. Sample of contract document for lease of store

ANNEX 2. Details of selection of storage facility

ANNEX 3. Copy of receipt of NEMA payment

ANNEX 4. Copies of completed questionnaires and briefs

ANNEX 5. Photographs showing proposed project store location sites

ANNEX 6. Baraza attendance lists and minutes of the Barazas

ANNEX 7. Report of review of A-SHAP protocols

ANNEX 8. AflaSTOP A-SHAP protocols

ANNEX 9. Agreement with Lesiolo Grain Handlers and Photographs of site

ANNEX 10. NEMA Approved TOR and NEMA Letter to Undertake Full Study

ANNEX 11. Prof Shelia Okoth, University of Nairobi endorsement

ANNEX 12. Alfatoxin background document

ANNEX 13. Research Methodology

Annex 1: Lease Agreement

Mr. / Mrs. M/S _____ (ID No._____), Being the Proprietor of Plot No._____ Situated at _____)

And

AflaSTOP

This Lease, made and entered into this _____day of October in the year 2012 between_____) of P.O. Box _____Tel_____), hereinafter called, , the "lessor," inclusive of heirs, successors and assignees of _____, and, **ASI**, c/o ACDI/VOCA-Kenya, Muthangari Drive 209, off Waiyaki Way, P.O Box 1308, 00606 Sarit Centre, Westlands, Nairobi and funded by the United States Agency for International Development ("USAID") and Bill and Melinda Gates Foundation (BMGF) for the AflaSTOP (the "Program"), hereinafter called the "lessee."

WITNESSETH: The parties hereto, for the consideration hereinafter mentioned, covenant and agree as follows:

1. The lessor hereby leases to the lessee the following described premises, located at ……..……..

2. The lessor shall demonstrate that he is the owner or authorized agent of the owner of the property by providing proof of ownership or valid power of attorney, all in a form satisfactory to the lessee.

3. **TO HAVE AND TO HOLD** the said premises with their appurtenances for a period commencing on October _____and ending on _____ (the "Initial Term"). Should the Program be extended, the lessee, at its sole option, may renew this lease for successive _____ periods, on the same terms and conditions as contained herein. Prior to the commencement of each such successive renewal period, Lessee will give lessor at least one month prior written notice of lessee's intent to exercise its renewal option hereunder. The Initial Term and any and all successive renewal periods under this lease are referred to hereinafter, together, as the "Term" of this lease.

4. Throughout the Term of this lease, the lessor shall furnish the lessee the following:

i. The building and grounds located at the address in 1 above, which lessor shall maintain in a condition fit for commercial storage use.

ii. Charges for any utilities used during the Term of this lease will be borne by the lessor.

iii. The lessor accepts full and sole responsibility for the payment of all taxes including VAT and for any other charge of a public nature which may be assessed against the property including registration for which the premises covered by this lease form part; and

iv. The lessor shall provide adequate security to the premises for the time of lease and shall ensure safety of the goods stored therein.

5. It is further understood and agreed that in case the lessee decides to remove its establishment or change the grade or size thereof, or in the event that BMGF and or USAID either changes or terminates the Program or lessee's participation therein, or the property is no longer suitable (including for reasons of safety and security) in the lessee's judgment, or if the lessor fails to perform any of the obligations of this lease that lessor is required to fulfill, the lessee shall be at liberty to terminate this lease upon giving written notice to the lessor 30 days in advance, without the lessor having right to any payment other than for rental to the date the lessee surrenders the premises. In the event of such termination the lessor shall be required to refund to the lessee any unused portion of advance rental and rental tax payment within 14 days of vacating the premises. Any such refund will be paid to lessee by wire transfer in accordance with instructions to be provided by lessee in writing.

6. The lessor shall, unless hereinafter specified to the contrary, maintain all major structural items of the said premises in good repair and tenantable condition, unless conditions warrant earlier attention, during the continuance of this lease, except in case of damage arising from the act or negligence of the lessee, its agents or employees, the lessor being aware that the lessee intends to store irreplaceable material therein and that keeping of the premises in good repair and tenantable condition is particularly essential to make them appropriate for use by an agency and /or project of BMGF / USAID. For the purpose of so maintaining the premises, the lessor reserves the right at reasonable times to enter and inspect the premises and to make any necessary repairs to the premises leased. The lessor will notify the lessee in advance and initiate/complete necessary repairs without delay.

7. The lessee agrees that the building shall not be sublet (except with the prior written consent of lessor, which will not be unreasonably withheld or delayed), or use premises for illegal purposes or for gambling.

8. The lessee shall have the right, during the existence of this lease, to make alterations, attach fixtures, and erect additions, structures in or upon the premises hereby leased and office signs and insignia outside the building on such part of the premises leased (provided such alterations, additions, structures, or signs shall not be detrimental to premises and property inconsistent

with the rights granted to other tenants on the property or in the building in which said premises are located); which fixtures, additions, or structures so placed in or upon or attached to the said premises shall be and remain the property of the lessee and may be removed by the lessee prior to vacating the premises; and the lessee, if required by the lessor, shall restore the premises to the same condition as that existing at the time of entering upon the same under this lease, reasonable and ordinary wear and tear and damage by the elements or by circumstances over which the lessee has no control, excepted.

9. The lessee shall have the right to make the following specific alterations to the premises.
    a. Lock up system for added security

10. The lessee shall pay the lessor for the premises rented at the following rate: an amount of **Kes 7,500 (Seven thousand Five hundred only)** per month as rent and **Kes 200 (Two hundred only)** as security charges. All payments will be made in Kes (Kenya Shillings), Payments shall be as follows:
    a. Payments will be made quarterly, in advance, throughout the lease period, the first payment shall be made prior to occupation by check or bank wire transfer. Payment will be made within 2 working days of signing the lease or provision of proof of ownership or authorized agent.

11. It is understood and agreed that the lessor does not have the right to terminate this lease agreement during the Term; however, lessee may assign its interest herein upon written notice to lessor, and upon lessor's consent, which will not be unreasonably withheld or delayed. In the event of any such assignment, lessor will promptly refund any unused portion of lessee's advance rental payment as provided in section 5 above.

12. Whenever the said premises or any essential part thereof shall be destroyed by fire, earthquake, war, civil disturbance, or other casualty, this lease shall, in case of total destruction or on being rendered unfit for further tenancy, immediately terminate and in case of partial destruction or injury, shall terminate at the option of the lessee upon giving notice in writing to the lessor within 20 days after such fire or casualty, and no rent shall accrue to the lessor after such termination.

13. In the event the lessor fails to fulfill any of the conditions of this lease, and where this lease specifically provides no other remedy for such failure, the lessee is entitled either to terminate this lease after giving previous notice or at his option to take any measure which he may deem necessary to establish the conditions contemplated by this agreement at the entire expense of the lessor.

14. This signed, English version of the lease shall supersede any translations which are produced at any other time during the Term of this lease. This lease contains the entire agreement between the parties, and supersedes any prior oral or written agreements, commitments,

understandings, or communications with respect to the subject matter of this lease. No change, modification, alteration, or addition to the terms and conditions of this lease shall be binding unless in writing and signed by authorized representatives of both parties. Any notice, consent or other communication required or permitted to be given or made under this lease will be in writing and in the English language. Such communication will be deemed to be duly given or made when it has been delivered by hand, or by certified or registered mail, postage prepaid, to the party to whom it is directed, at such party's address as set forth above. If directed to lessee, any such communication will be sent to the attention of the Chief of Party.

IN WITNESS WHEREOF, the parties have hereunto subscribed their signatures as this day_____October 2012, first above written

LESSOR:

Name: _____

Signature _____

In the presence of:

LESSEE: AflaSTOP

Name: Sophie Walker, COP ASI AflaSTOP. Authorized Representative

Witness 1:

Details of Premises Rented:

Warehouse:

STORE	1
Location	Muumandu Market
Which road is it on?	Machakos /Wote
KM From machakos	23
Owner Name	Muange Kitethya
Owner contact details	0715064670
Store width	4.5 M
Store Length	6.2 M
Height of roof at highest point	3.7 M
Height of roof as it meets the walls	3.5 M
Wall material	Stone blocks
Are walls intact?	Yes
Floor material	Concrete
Roof material	Iron sheets
Is roof intact?	Yes
Details of door	Metal door, 2.2 M wide, 1.9 M left hand corner
Are there any windows, how many?	Yes, 2
Describe windows	Metal window with glasses
Is the store level with outside ground or above ground level?	Outside ground level
How much above ground level	N/A
Are walls intact?	Yes
How secure do you think the site is?	Very secure
Cost of renting the store per month.	Kes 7500 + 200 for security per month
Minimum rental period	6 Months
Describe trading centre	50 main shops, main business retail shops and presence of Administration Police lines

Annex 2.

AflaSTOP: Protocol for Store Choice

AflaSTOP will utilize 12 stores. We will initially employ a consultant to detail 10 - 20 stores, using the criteria below, while filling out the remaining information for each. Stores should have concrete floors, stone or concrete walls and metal roofs. It needs to be secure with a metal door with locking points and, if it has windows, with narrow metal frames/ grates. Guards will be required.

AflaSTOP staff will pick the most suitable stores in terms of suitability, via the consultant and visit them to verify the details. AlfaSTOP will select stores, which match each other as far as possible. Leases should be negotiated with the landlords for a minimum of 6 months, with potential to extend in 3-month periods.

Location	
Which road is it on	
Km from Makueni/Meru	
Owner name	
Owner contact details	
Store width	Min 4.5 m
Store length	Min 6 m
Height of roof at highest point	
Height of roof as it meets the walls	
Wall material	Stone or concrete blocks
Are walls intact	Intact
Floor material	Concrete
Roof material	Good condition metal sheets
Is roof intact	Roof intact
Details of door	Metal door with locking points
Are there any windows? How many?	
Describe windows	Should have metal frames - not big enough for a person to climb through
Is the store level with outside ground or above ground level	Above ground water level
How much above ground level	
How secure do you think the site is?	
Are guards present	Guards required
Describe the trading center	Should have a number of other businesses around

Annex 3:

Copy of Receipt of NEMA Payment

KCB

KCB SARIT CENTRE
CHEQUE DEPOSIT

Print Date: 10/09/2013

NAME NEMA REVENUE ACCOUNT
BENEFICIARY BRANCH: KICC
PAID IN BY: ACDI

A/C: 1102298158
REF: 091001641829

Drawer	Chq No.	TT No.	Bank		Amount
0104358034	000374	TT132530X278	CITIBANK N.A. HEAD OFFICE , NAIROBI	KES	21,869.80
			TOTAL	1	21,869.80

IMPORTANT:
CHEQUES WILL BE GIVEN VALUE WHEN PAID.
KINDLY CONFIRM THAT ALL THE CHEQUES HAVE BEEN CAPTURED CORRECTLY.

Customer Sign. : .....

Teller Sign. : .....

Transaction number. : 010910421414802488 at 16:40:40 on 10-Sep-2013

Thank you for banking with us. You have been served by Evans Kipkou Kaino

* * * Advice not valid unless Transaction Number shown * * *

KENYA COMMERCIAL BANK LTD.
TELLER No. 0268
10 SEP 2013
SARIT CENTRE, NAIROBI

ANNEX 4

Copies of Completed Questionnaires & Briefs

ANNEX 5: Photographs Showing Proposed Project Store Location Sites

ANNEX 6

Barazas Attendance Lists & Minutes of the Barazas

MINUTES OF THE BARAZA HELD AT MUUMANDU TOWN CENTRE ON THE PROPOSED EVALUATION OF MAIZE STORAGE TECHNOLOGIES ON DEVELOPMENT OF POSTHARVEST AFLATOXIN CONTAMINATION IN MAKUENI COUNTY, ON 1ST NOVEMBER 2013

List of Participants (See Attached List of Participants)

No.	NAME	IDENTITY NUMBER / CONTACT
1.	Stella Nduku Musyoka	20340852
2.	Mary Muli	21176432
3.	Miriam Kyama	2626104
4.	Mwikali David	Not given
5.	Benson Mwatu	0735140252
6.	Julian Mutuku Mutisya	2612178
7.	Raphael Mutomo	0988034
8.	Philip Mwinzi	2613423
9.	Samuel Kitetu	9225472
10.	Alex Ngunga	22035799
11.	Jackson Mutisya	2625654
12.	Parmwell Simitu	13591122
13.	Prof Anthony Gachanja	0756920
14.	Stanely Guantai	0566536
15.	Naomi Gitau	20680574
16.	Lizbancy Maundu	21980350

AGENDA

- Introduction by Proponent's Representative
- Presentation on the role of NEMA by the County NEMA representative
- Presentation by the EIA Expert and Invitation for participants to give comments / opinion
- Any Other Business (AOB)

Meeting started with a word of prayer

Min	Description
1.0	**Introduction by Proponent's Representative** After paying a courtesy call to the chief's office, who appointed members to attend the baraza, the baraza started at around 1030Hrs at the proposed storage site. The proponent's representative begun the baraza by a walkthrough of the proposed storage site. He later gave a description of the proposed project, by highlighting how maize will be bought from the farmers around and later stored in various storage containers that are already at the site. He informed members present that once every month maize will be sampled from the containers and taken to Nairobi for analysis of the level of aflatoxin for a period of six months. The maize remaining after expiry of the testing period will be transported to Nairobi and destroyed if contaminated with aflatoxin. The store will be cleaned and decontaminated before reverting to the owner.  Ongoing Baraza  A walk through of the storage site  Metal Storage container at the site  NEMA officer giving his Remarks

Min	Description
2.0	**Presentation on the role of NEMA by the County NEMA representative** He informed members present once the role of NEMA will begin once the EIA report is submitted to NEMA for licensing. He highlighted the EIA process will include up to advertising the project in the Daily paper so as to ensure proper wide consultations. Once NEMA is satisfied that the project meets the requirements on EMCA, 1999, it will issue an EIA license for the proponent to commence the project.
3.0 & 4.0	**Presentation by the EIA Expert and Invitation for participants to give comments / opinion** The consultants, M/S EcoServ Consultants were invited to facilitate collection of environmental comments/concerns from the members present. Positive impacts of the project were mentioned as follows; • The problem of rats destroying maize will reduce drastically • The project will improve food security • The project will improve the health of the local people • Profits will increase since farmers will be able to store maize up to until when the prices are good in the market There were No Negative impacts mentioned and so members present gave the project a strong approval
5.0	**AOB** The Expert thanked the community members for their contribution and urged them to share the information regarding the project with others. There being no other business the meeting ended with a word of prayer

Client Representative: *Date*:

Consultant Representative: *Date*:

MINUTES OF THE BARAZA HELD AT KIVANI TRADING CENTRE ON THE PROPOSED EVALUATION OF MAIZE STORAGE TECHNOLOGIES ON DEVELOPMENT OF POSTHARVEST AFLATOXIN CONTAMINATION IN MAKUENI COUNTY, ON 1ST NOVEMBER 2013

List of Participants from Kivani Trading center (See Attached List of Participants)

No.	NAME	IDENTITY NUMBER / CONTACT
1.	Margaret Muumbi	1319852
2.	Rose Nduleve	6268586
3.	Pius Kioko	0315058
4.	Anne Kinyati	1471478
5.	Rosina Mbindyo	1471478
6.	Stanely Mwololo	23193619
7.	Joyce Mutinda Mwololo	Not given
8.	Parmwell Simitu	13591122
9.	Prof Anthony Gachanja	0756920
10.	Stanely Guantai	0566536
11.	Naomi Gitau	20680574
12.	Lizbancy Maundu	21980350

List of Participants from Kola Trading centre

No.	NAME	IDENTITY NUMBER / CONTACT
1.	Catherine Ndinda	21211173
2.	Elizabeth Maweu	144226929
3.	Fransicah Nzomo	21165483
4.	Prof Anthony Gachanja	0756920
5.	Stanely Guantai	0566536
6.	Naomi Gitau	20680574
7.	Lizbancy Maundu	21980350

AGENDA

- Introduction by Proponent's Representative
- Presentation on the role of NEMA by the County NEMA representative
- Presentation by the EIA Expert and Invitation for participants to give comments / opinion
- AOB

Meeting started with a word of prayer

Min	Description
1.0	**Introduction by Proponent's Representative** The Baraza started with a walk through of the storage site. The proponent's representative gave a description of the proposed project, by highlighting how maize will be bought from the farmers around and later stored in various storage containers that are already at the site. He informed members present that once every month maize will be sampled from the containers and taken to Nairobi for analysis of the level of aflatoxin for a period of six months. The maize remaining after expiry of the testing period will be transported to Nairobi and destroyed if contaminated with aflatoxins. The store will be cleaned and decontaminated before reverting to the owner.  Completion of Questionaires  Ongoing Baraza
2.0	**Presentation on the role of NEMA by the County NEMA representative** He informed members present the role of NEMA will begin once the EIA report is submitted to NEMA for licensing. He highlighted the EIA process will include up to advertising the project in the Daily paper so as to ensure proper wide consultations. Once NEMA is satisfied that the project meets the requirements on EMCA, 1999, it will issue an EIA license

Min	Description
	for the proponent to commence the project.
3.0 & 4.0	**Presentation by the EIA Expert and Invitation for participants to give comments / opinion** The consultants, M/S Eco Serv Consultants were invited to facilitate collection of environmental comments/concerns from the members present. Positive impacts of the project were mentioned as follows; • The project will help us improve the harvest • The project will reduce death of local people after consumption of contaminated maize Negative Impacts were identified as follows: • Lorries delivering maize for storage should park safely near the storage site, since its next to the main road • Local People are not aware of effects of aflotoxins and so awareness should be carried out • If maize is found to be contaminated after the project it should be properly Incinerated to avoid consumption by people • The site should be properly secured to avoid breakage and stealing of maize • No chemicals should be brought to the site After highlight both positive and negative impacts of the project, members presents gave a go ahead to the project to be carried out at the site
5.0	**AOB** The Expert thanked the community members for their contribution and urged them to share the information regarding the project with others. There being no other business the meeting ended with a word of prayer

Client Representative: Date:

Consultant Representative: Date:

MINUTES OF THE BARAZA HELD AT MUKUYUNI TRADING CENTRE ON THE PROPOSED EVALUATION OF MAIZE STORAGE TECHNOLOGIES ON DEVELOPMENT OF POSTHARVEST AFLATOXIN CONTAMINATION IN MAKUENI COUNTY, ON 1ST NOVEMBER 2013

List of Participants (See Attached List of Participants)

No.	NAME	IDENTITY NUMBER / CONTACT
1.	Simon Musembi	11271509
2.	Peter Maluta	4938872
3.	Joseph Kimutu	23513873
4.	Wlliam Mauyu	0402902
5.	Thomas Nzioka	682223
6.	Makenga Masio	0965898
7.	Edward Kimeu	3035299
8.	Charles Nzioka	4418274
9.	Susan Kitusa	3030702
10.	Fedelis Mbithuka	2564051
11.	Philip Mauyu	2564051
12.	Parmwell Simitu	13591122
13.	Prof Anthony Gachanja	0756920
14.	Stanely Guantai	0566536
15.	Naomi Gitau	20680574
16.	Lizbancy Maundu	21980350

AGENDA

- Introduction by Proponent's Representative
- Presentation on the role of NEMA by the County NEMA representative
- Presentation by the EIA Expert and Invitation for participants to give comments / opinion
- AOB

Meeting started with a word of prayer

Min	Description
1.0	**Introduction by Proponent's Representative** The baraza begun with a welcome note from the Chief of the area. The proponent's representative gave a description of the proposed project, by highlighting how maize will be bought from the farmers around and later stored in various storage containers that are already at the site. He informed members present that once every month maize will be sampled from the containers and taken to Nairobi for analysis of the level of aflatoxin for a period of six months. The maize remaining after expiry of the testing period will be transported to Nairobi and destroyed if contaminated with aflatoxin. The store will be cleaned and decontaminated before reverting to the owner.  The proposed Storage site at Mukuyuni  The NEMA Representative giving his remarks
2.0	**Presentation on the role of NEMA by the County NEMA representative** He informed members present the role of NEMA will begin once the EIA report is submitted to NEMA for

Min	Description
	licensing. He highlighted the EIA process will include up to advertising the project in the Daily paper so as to ensure proper wider consultations. Once NEMA is satisfied that the project meets the requirements on EMCA, 1999, it will issue an EIA license for the proponent to commence the project.
3.0 & 4.0	**Presentation by the EIA Expert and Invitation for participants to give comments / opinion** The consultants, M/S Eco Serv Consultants were invited to facilitate collection of environmental comments/concerns from the members present. No Positive impacts of the project were mentioned Negative Impacts were identified as follows; • There might be a conflict of the project with the up coming Government drying centre located 200m from the proposed storage Site. The chief promised to carrying out awareness during his many barazas, to ensure that the proposed project is well understood by the local people • Disposal of maize after completion of the project should be done properly The project was given a strong approval by the local people. They also insisted that the aflotoxins problem in Ukambani should be seriously addressed by the government of Kenya
5.0	**AOB** The Expert thanked the community members for their contribution and urged them to share the information regarding the project with others. There being no other business the meeting ended with a word of prayer

Client Representative: Date:

Consultant Representative: Date:

MINUTES OF THE PUBLIC BARAZA HELD AT GIAMPAPO MARKET CENTRE, CHUKA, THARAKA NITHI COUNTY ON 25TH OCTOBER 2013

List of Participants (See Attached List of Participants)

No.	NAME	IDENTITY NUMBER / CONTACT
1.	Silas Mugambi	0713749082
2.	John B. Mwenda	0723467443
3.	Joseph Njagi	0712235358
4.	Silvano Mwiti	0718094837
5.	Samson Kithinji	0705740376
6.	Alex Mbabu	0704952076
7.	Franklin Kariuki	0713540824
8.	Domenic Mbabu	0726946876
9.	Justine Mutembei	0729154660
10.	John Nkomoi	0725824053
11.	Njue Mbabu	Not given
12.	Maurice Miriti	0711193303
13.	Ringera Joseph	0713956467
14.	Ramadhan Kinyua	0718419574
15.	Aileen Wangai	0712343276
16.	Erastus Miriti	4522319
17.	Purity Mbae	0718959707
18.	Ken Mburu	0711615027
19.	Jane Kaari	Not Given
20.	Marko Njagi	0711125595
21.	Prof Anthony Gachanja	
22.	Stanely Guantai	
23.	Gitau Muriuki	
24.	Sophie Kawira	

AGENDA

- Introduction by Proponent's Representative
- Presentation on the role of NEMA by the EIA Consultants
- Presentation by the EIA Expert and Invitation for participants to give comments / opinion
- AOB

The meeting opened at 10.30am with a word of prayer from one of the participants

Min	Description
1.0	**Introduction by Proponent's Representative** Mr. Stanley Guantai of ACDI VOCA explained the process of implementation of the project. Maize will be bought from farmers in various parts of the County and stored in the selected premises in various containers already in use in Kenya. No chemicals will be applied on the maize throughout the study and all the maize used in the study will be destroyed by incineration in Nairobi if found to be contaminated at the end of the project.  Proposed Site at Guampopo  Ongoing Baraza at Guampopo
2.0	**Environmental Issues** Consultants from Ecoserv firm explained the participants on their rights to healthy and clean environment as enshrined in the constitution of Kenya. The role of NEMA in environmental management was explained in relation to their involvement in project implementation; the community participation in formulation of mitigation measures for the potential negative impacts of project activities. Further the participants were again given details on the process of implementation of the study.
3.0 & 4.0	**Presentation by the EIA Expert and Invitation for participants to give comments / opinion** The consultants, M/S Eco Serv Consultants were invited to facilitate collection of environmental comments/concerns from the members present. • The participants welcomed the study and said that the results should be implemented within the area without delay so that they could benefit through increased profits from their produce. The participants were informed by the consultants that their request will be considered. • The participants requested that the locals be given priority for any available employment during the study. The consultants confirmed their concern will be a recommendation in their report. • The participants wanted to know if the stored maize will be available for sale. They were informed that it will only be study specimen and will not be for sale to the public. • The participants were further informed that the study will use maize dried at less than 13% and also maize with more than 15% moisture.
5.0	**AOB** The Expert thanked the community members for their contribution and urged them to share the information regarding the project with others. There being no other business, the meeting ended at 11.50 am with a word of prayer

Client Representative: Date:

Consultant Representative: Date:

MINUTES OF THE PUBLIC BARAZA HELD AT KARIENE CHIEF'S CAMP MERU COUNTY ON 26TH OCTOBER 2013

List of Participants (See Attached List of Participants)

No.	NAME	IDENTITY NUMBER / CONTACT
1.	Silas Munene	0720376605
2.	Silas Kinoti	0718404075
3.	Joseph Mugo	0722589810
4.	Jacob Ntomuari	0710334999
5.	Siripin Kiunge	0708398462
6.	Joseph Gatobu	0704677526
7.	Dominic Mugambi	0720657699
8.	Joseph Mburugu	0724240704
9.	Manku Kaithungu	0726212124
10.	Joseph Mwaja	0700337392
11.	Carnelius Mutwiri	0717384544
12.	Prof Anthony Gachanja	
13.	Stanely Guantai	
14.	Gitau Muriuki	
15.	Sophie Kawira	

AGENDA

- Introduction by Proponent's Representative
- Presentation on the role of NEMA by the EIA expert
- Presentation by the EIA Expert and Invitation for participants to give comments / opinion
- AOB

The meeting opened with a word of prayer led by one of the participants at 12.30 pm.

Min	Description
1.0	**Introduction by Proponent's Representative** The area chief welcomed the participants and thanked the conveners for organizing the meeting which was aimed at increasing the profitability of maize farmers in the area citing the case of the year 2009. In the year 2009 Aflatoxin fungus affected large quantities of maize in the area which resulted in massive campaign to collect the affected maize for destruction by the Ministry of Public Health. The chief then invited the consultants and the representative from the proponent to continue. Mr. Stanley Guantai explained the purpose of the meeting was to sensitize the public as stakeholders of the project in order to document their concerns regarding the impacts of the activities of the proposed project to their environment. This is a mandatory step as provided in the environmental law (EMCA 1999) and as regulated by NEMA through EIA & EA regulation of 2003. Mr. Stanley explained the project implementation process in detail to enhance the community understanding so that they could raise questions, comments or suggestion to be considered at an early stage before the project begins.  
2.0	**Environmental Issues** The Baraza was informed by the consultants from Ecoserv that, in accordance to NEMA regulations on Environmental Impact Assessment and Audit (EIA &EA), 2003, all projects under schedule 2 require an EIA study before implementation. The participants were also sensitized on their rights to healthy and clean environment as enshrined in the constitution of Kenya and as regulated by NEMA. Therefore the participants were requested to raise questions, make suggestions or comments regarding impacts of the project activities to their environment so that answers can be provided, or their suggestions / comments considered for recommendations in the EIA study report.
3.0 & 4.0	**Presentation by the EIA Expert and Invitation for participants to give comments / opinion** • The participants were informed that other Barazas have been held at various locations where the stores have been selected for the study. Further the neighboring community to the project study is considered most important as their environment will be most affected. They were also requested to share this information to any other interested persons. • Participants were informed that the source of the specimen maize will be the local community. All

Min	Description
	the maize to be used will be bought from the local farmers. • Participants enquired whether conveners will visit large dealers who store large quantities of maize. They were informed that the conveners of the meeting will not at this time involve large maize traders but can do so at a later stage during dissemination of results and training • Participants further wanted to know if using the existing forms of storage (e.g. metal /plastic drums, hematic bags) of maize assist in control of maize destruction by weevils and they were told Yes, if the existing drums or bags are closed and devoid of air, the weevils will finally die due to lack of oxygen, just like would happen to the aflatoxin fungus. • Participant asked how long it will take for the stored maize initially without aflatoxin to start being affected by the fungus. And they were informed that this will be better understood after the tests. Generally the participants had no objections on the project, though there is need for awareness on aflatoxins, especially on its effects and possible mitigations
5.0	**AOB** The participants agreed to support the project. There being no further business, the meeting ended at 2.15pm

Client Representative: Date:

Consultant Representative: Date:

MINUTES OF THE PUBLIC BARAZA HELD AT MWICHIUNE MARKET MERU COUNTY ON 26TH OCTOBER 2013

List of Participants (See Attached List of Participants)

No.	NAME	IDENTITY NUMBER / CONTACT
1.	Rosemary Mwirigi	0727554442
2.	Aileen Main	0713610585
3.	Benson Kimathi	Not given
4.	Catherine Gacheri	0702864134
5.	Fridah Kinano	0712438162
6.	Martin Mutugi	0724310885
7.	Douglas Mutugi	22961429
8.	Partick Mwenda	23941733
9.	Patrick Kithinji	0727554608
10.	Joses Mwiti	0717736539
11.	David Muhwiri	Not given
12.	Geofrey Mwiti	0725222080
13.	Japhet Mutua	0716456522
14.	Godfrey Ikunda	0710458810
15.	George Kauro	Not given
16.	Eric Mutwiri	0729016390
17.	Patrick Mwirigi	Not given
18.	Julius Riungu	Not given
19.	Edward Mugambi	0723347315
20.	Patrick Mwirigi	0724845418
21.	John Gitonga	0713454712
22.	Peter Kirimania	0714307504
23.	Prof Anthony Gachanja	
24.	Stanely Guantai	
25.	Gitau Muriuki	
26.	Sophie Kawira	

AGENDA

- Introduction by Proponent's Representative
- Presentation on the role of NEMA by the Consultants
- Presentation by the EIA Expert and Invitation for participants to give comments / opinion
- AOB

The meeting was opened with a word of prayer led by one of the participants at 10.00 am.

Min	Description
1.0	**Introduction by Proponent's Representative** The area chief who was present led the introduction of the conveners, the consultant from Ecoserv firm, and the proponent ACDI VOCA representative Mr. Stanley Guantai. The chief welcomed the team and informed the Baraza the importance of such meeting which was meant to make them aware of the projects being implemented in their county. He further told them to ensure they attend all such meetings where they could also provide new ideas and explore any exploitable opportunities. The chief then requested Mr. Stanley Guantai to take over and explain the purpose of the meeting and details of the project implementation process. Mr. Stanley explained the purpose of the meeting which was to sensitize the community on the planned study and before the study begins they should provide their inputs in terms of how any negative impacts arising from the study could be mitigated to ensure environmental sustainability.  Proposed storage site at Mwichunie  On Going Baraza
2.0	**Environmental Issues** The consultant from Ecoserv sensitized the Baraza on their rights to healthy and clean environment and how NEMA ensures the public is protected from any negative impacts associated with all projects implementation activities in the entire Kenya. The participants were requested to raise questions, make suggestions or comments regarding the project activities so that their inputs are included in the report, i.e. questions will be answered, suggestions considered and comments discussed and possible conclusions provided. These will be considered for recommendations in the EIA study report. Further their views regarding how to counter any negative measures to ensure healthy and clean environment will be considered at an early stage and included in the EIA study report.
3.0 & 4.0	**Presentation by the EIA Expert and Invitation for participants to give comments / opinion** During this session, the participants raised the following concerns, comments and questions. Participants did not mentioned any negative impacts but had the following issues that required clarification • Does the Aflatoxin fungus affect any other types of food produce? e.g sorghum, beans, groundnuts etc and the response was YES, They were also informed that Aflatoxin also affects other types of food produce but mostly it affects carbohydrates rich foods e.g. maize, groundnuts, macadamia nuts etc. There is also a type of fungus that affect coffee, called Ochratoxins. • The participants sought to know whether the project will create employment. They were informed that the study is unlikely to generate employment for the youth. Further the activities are limited to

Min	Description
	buying of maize specimens from farmers and delivery to the store. After storage a trained person from the proponent will carry out sampling of specimen from containers and deliver to Nairobi for analysis. However if any employment arises, the local youth will be given priority.
5.0	**Way Forward** The community agreed to support the project, There being no other business, the meeting ended at 11.45 am

Client Representative: Date:

Consultant Representative: Date:

MINUTES OF THE PUBLIC BARAZA HELD AT POLE POLE MARKET CENTRE THARAKA NITHI COUNTY ON 25TH OCTOBER 2013

List of Participants (See Attached List of Participants)

No.	NAME	IDENTITY NUMBER / CONTACT
1.	Fridah Muthoni	0726765222
2.	Caroline Nkatha	0710941639
3.	Lucy Murugi	0704068461
4.	Charity Gatwiri	0723782723
5.	Erastus Kiraithe	0706691939
6.	Stelah Kagweni	0710705226
7.	Felistas Makena	0720396104
8.	Nancy Kainyu	0716495091
9.	Pamela Keeru	0711844337
10.	Kenneth Munene	0724824793
11.	Purity Makena	0721908936
12.	Winoy Kawira	0700624408
13.	Chalus Mwandiki	0705949626
14.	John Kabere	0733539661
15.	Prof Anthony Gachanja	
16.	Stanely Guantai	
17.	Gitau Muriuki	
18.	Sophie Kawira	

AGENDA

- Introduction by Proponent's Representative
- Presentation on the role of NEMA by the Consultant
- Presentation by the EIA Expert and Invitation for participants to give comments / opinion
- AOB

The meeting opened at 2.30pm with a word of prayer led by one of the participants.

Min	Description
1.0	**Introduction by Proponent's Representative** The meeting started at 2.30pm with a word of prayer led by one of the participants. Mr. Stanley Quantai of ACDI VOCA the project proponent introduced the team of consultants from Ecoserv firm and also requested the attendants to carry out a quick self introduction. Further Mr. Stanley explained the process of the study that is planned in the near future and informed the baraza it will be done at selected stores in the county. He explained it will involve buying of maize from various farmers in the area and after various preparatory tests it will be stored in different containers as currently practiced. The stored maize will not be opened to the public to prevent interference. At regular intervals the maize will be sampled and taken to the laboratory  Ongoing Baraza at Pole Pole Trading Centre
2.0	**Environmental Issues** The consultants explained to the Baraza on their rights to healthy and clean environment as provided for in the constitution of Kenya. The process of the study was explained again citing the potential environment impacts from various types of projects that are normally implemented in the county. This was done in order to illustrate the type of inputs and comments that were required from them, but as is evident in the following minutes, the public did not strictly ask environmental related questions.
3.0 & 4.0	**Presentation by the EIA Expert and Invitation for participants to give comments / opinion** During this session, the participants raised the following concerns, comments and questions. Participants did not mentioned any negative impacts but had the following issues that required clarification • Participants requested for information of the activities of the project and they were informed that since it may not be possible to meet everyone, it would be necessary that the members of the community present pass information to any other person who would be interested to have details. • The participants requested that they be given priority for any jobs vacancies arising during the project
5.0	**Way Forward** The participants agreed to support the project and also inform other members of the community about it and its intended benefit to the farmers. There being no other business the meeting ended at 3.30pm

Client Representative: Date:

Consultant Representative: Date:

MINUTES OF THE PUBLIC BARAZA (GIAMPAPO) HELD AT MITHERU LOCATION CHIEF'S CAMP, THARAKA NITHI COUNTY ON 25TH OCTOBER 2013

List of Participants (See Attached List of Participants)

No.	NAME	IDENTITY NUMBER / CONTACT
1.	Basilio Kamundi	0728882739
2.	Samson Miriti	0707074043
3.	Charles Njagi	0720636928
4.	Philip Mburia	0723759994
5.	George Mukobwa	0720943241
6.	Paul Nyaga	0704188472
7.	Perminus Rucha	0719847606
8.	Jackson Silas	0720042209
9.	Salome Muthoni	0724830925
10.	Jane Muthoni	0725440332
11.	Julius Njeru	0728833678
12.	Festus Mbiuki	0728104292
13.	Boniface Gitonga	0723281673
14.	Dain Ukima	0721880943
15.	Gaudentious Mutegi	0726571708
16.	Harriet Muya	0727540392
17.	Josephine Igoki	0723939306
18.	Kaburu Njagi	
19.	Prof Anthony Gachanja	
20.	Stanely Guantai	
21.	Gitau Muriuki	
22.	Sophie Kawira	

AGENDA

- Introduction by Proponent's Representative
- Presentation on the role of NEMA by the Consultant
- Presentation by the EIA Expert and Invitation for participants to give comments / opinion
- AOB

The meeting opened at 10.30am with a word of prayer led by one of the participants.

Min	Description
1.0	**Introduction by Proponent's Representative** The chief was not present in the meeting but was represented by one of the elders in the area. We had earlier learnt that all the chiefs in the county had been called for a meeting by the county commissioner and could not postpone the planned Barazas. Lead by the representative of the proponent, ACDI / VOCA Mr. Stanley Guantai, the participants did self introduction. Mr. Stanley Guantai explained in details the process of implementation of the planned study in both Swahili and local language. After the explanation the participants confirmed they were aware of the problem especially from the experience of the year 2009
2.0	**Environmental Issues** From the explanation given by Mr. Stanley, the environmental consultants followed and informed the participants the need for being involved in projects implemented in their area to provide their views on mitigation of negative impacts where necessary as provided under EMCA 1999 and Kenya Constitution. Their right to healthy and clean environment as provided by the constitution and regulated by NEMA was highlighted. From the understanding of the of the planned project activities, the participants were then requested to provide any comments, questions and any other input regarding formulation of preventive measures of any potential negative impacts arising from the activities of the project
3.0 & 4.0	**Presentation by the EIA Expert and Invitation for participants to give comments / opinion** The following questions were asked by the participants and responses provided • Participants wanted to know if they will be allowed into the study stores and were informed that the study stores will not be opened to the public, but the results of the study will be disseminated to the public through the authorized government offices after completion of the study • Participants wanted to know if the recommended technology be availed in various size facilities to accommodate small and large farmers and the response was that various sizes of maize storage facilities will be available at an affordable cost to accommodate all categories of farmers (large and small) • Participants were informed that NO chemicals will be used during the project. Maize will be bought and stored by the farmers and tested for the required parameters before storage in the proposed stores at various locations. The project received an approval from the participants since no significant impacts were identified during the public consultation.
5.0	**Way Forward** After all the questions were answered, the members were satisfied and agreed to support the project. They also requested that the recommended technology be implemented in their area as quickly as possible. There being no other business the meeting ended at 12.30 Pm

Client Representative: Date:

Consultant Representative: Date:

MARIMA MARKET

PUBLIC AWARENESS ON AFLOTOXINS

Participants Present

No.	NAME	IDENTITY NUMBER / CONTACT
1.	Hellen Mukawanjiru	0700458036
2.	Annseta Nkinga	0706970854
3.	Frankline Mawira	0716746496
4.	Celia Mukanjeru	0725545168
5.	Nicholas Karimi	07066223
6.	Prof Anthony Gachanja	
7.	Stanely Guantai	
8.	Gitau Muriuki	
9.	Sophie Kawira	

Introduction

A baraza had been organized at the Chief Camp Marima Area. However since the chiefs were summoned to the county Headquarters, the participants to the baraza were not at the site. Neighbours to the stores assembled near the store when they saw the Consultancy team inspecting it. The consultant therefore engaged the neighbours on the proposed activities of the project. Five questionnaires were completed and are attached in this report, Annex 4.

Public Awareness Baraza at Marima

The store at Marima Trading Centre

All the five respondents who completed the questionnaire had no objection to the project since after the study, contaminated maize will be properly destroyed through incineration. This is one of the concerns that had been noted by the respondents. Also they looked forward to receiving the results which they hope will help solve the weevils problem in addition to the aflatoxin problem.

Client Representative: Date:

Consultant Representative: Date:

ANNEX 7:

Report of Review of A-SHAP Protocols

ANNEX 8: AflaSTOP A-SHAP Protocols

AFLASTOP PROTOCOLS

1. **Protocol for Store Choice**
2. **Protocol for Purchase of Contaminated Grain**
3. **Protocol for Mixing, Incubating and Drying Grain**
4. **Protocol for Setting Up Stores**
5. **Protocol for Transporting Grain to Stores and Filling Devices**
6. **Protocol for Monitoring Stores**
7. **Protocol for Grain Sampling**

1.) AflaSTOP: Protocol for Store Choice

AflaSTOP will utilize 12 stores. We will initially employ a consultant to detail 10 - 20 stores, using the criteria below, while filling out the remaining information for each. Stores should have concrete floors, stone or concrete walls and metal roofs. It needs to be secure- with a metal door with locking points and, if it has windows, with narrow metal frames/ grates. Guards will be required.

AflaSTOP staff will pick the most suitable stores in terms of suitability, via the consultant and visit them to verify the details. AlfaSTOP will select stores which match each other as far as possible. Leases should be negotiated with the landlords for a minimum of 6 months, with potential to extend in 3 month periods.

Location	
Which road is it on	
Km from Kitale/Makueni	
Owner name	
Owner contact details	
Store width	Min 4.5 m
Store length	Min 6 m
Height of roof at highest point	
Height of roof as it meets the walls	
Wall material	Stone or concrete blocks
Are walls intact	Intact
Floor material	concrete
Roof material	good condition metal sheets
Is roof intact	Roof intact
Details of door	Metal door with locking points
Are there any windows? How many?	
Describe windows	Should have metal frames - not big enough for a person to climb through
Is the store level with outside ground or above ground level	Above ground water level
How much above ground level	
How secure do you think the site is?	
Are guards present	Guards required
Describe the trading center	Should have a number of

	other businesses around

2.) AflaSTOP: Protocol for Purchase of Contaminated Grain

AflaCONTROL results showed that at the time of their investigation 43% of maize in Meru and Makueni had aflatoxin levels above 10pp and 31% and 20% of samples, respectively, were above 50ppb. In N Rift 2% of maize sampled had aflatoxin levels above 10ppb.

On average, a farmer has around 1,800 kg to sell over the next 6 months after harvesting and keeps back 500 kg for the household's consumption. Most farmers sell a significant amount immediately to pay back harvesting costs, loans to relatives and friends, and school fees which are due in April, a small balance they keep back to sell later on (July/August) when prices go up. Aflatoxin contamination levels will naturally vary among bags.

Based on crop assessments and interviews prior to harvest AflaSTOP staff will identify areas where it will be possible to acquire reasonable quantities of grain prior to being placed into long term storage. Acquisition of grain will depend on using the most acceptable scenario to the farmers and AflaSTOP logistics;

- Direct swap at harvest of bad bags for good - farmer goes on to sell through normal market channels
- Purchase of contaminated grain for going market price
- Mixture of swapping and purchasing of grain

Possible scenarios:

1. A farmer who only wanted to sell 10 bags, when finding these bags are contaminated may want to get rid of additional bad grain - but would be worried about having to pay a higher price when buying grain from the market and may worry about being able to buy sufficient volumes from local markets. Therefore, the farmer would probably prefer a swap.
2. A farmer who only sells 5 of his 10 bags to AflaSTOP - then has a lower volume when negotiating his sale which may affect his price.
3. Farmer may not be willing to receive maize from somewhere else.

Having determined the most acceptable way to buy contaminated grain from smallholder farmers, AflaSTOP will carry out the following activities to purchase approximately 26.45 mt of contaminated grain;

1. Test moisture level of maize - if grain has a moisture level of 15% or less move on to next farmer.
2. Observe grain - while it is impossible to see aflatoxin contamination, poorer conditioned grain is more likely to be effected.
3. Check how long it was placed in the sun, and whether it has been treated in anyway (e.g., pesticides).
4. Weigh bag, agree weight with farmer, take a 2 kg sample, grind the sample, and carry out the aflatoxin test.
    a. If the grain is not contaminated pay farmer for the 2 kg sample (or return it to the farmer) and move on;
    b. If the bags are contaminated mark the bags by their lot number, load bags onto truck, fill in truck manifest form.
5. Move onto next farmer/ village

Other transportation issues are handled in 5, Protocol for Transporting Grain.

3.) AflaSTOP: Protocol for Mixing, Incubating and Drying Grain

The following procedures lay out how the grain delivered to AflaSTOP at the wheat silos managed by Lesiolo Grain Handlers in Nakuru will be mixed and incubated. It is important to follow these instructions precisely. If for some reason issues arise, any change of process must be discussed with Sophie Walker before being carried out. Any change of process must be clearly noted at the time and fully written up at the end of the handling and treatment of the grain.

Receiving grain

Grain will be received at Lesiolo Grain Handlers Ltd, wheat silos in Nakuru. This site is surrounded by a strong perimeter fence/wall and a kai apple hedge (vicious thorns), the main gate is policed by guards day and night and there are a number of guards who walk around the facility. The different complexes are lockable. AflaSTOP's main operations will be in an area not used for grain handling.

The weight delivered will be established through the certified weighbridge.

The grain will be unloaded into one of the prepared storage areas, at the wheat silos in Nakuru where the feed mixer will be ready for mixing the grain.

Feed Mixer

The current feed mixer capacity is 1 mt (estimated) it takes approximately 15 - 20 mins to mix the grain thoroughly (estimated) and then a further 10 - 15 mins to bag the grain off the mixer. Cimbria will need to adjust the machine at the beginning to get a good calibration - this may require a number of loads to be used as test loads. Once the machine is properly calibrated all grain which has been used during the calibration should be mixed again as laid out in the directions below. If an alternative mixing solution is found this process will be adapted.

Gain Handlers

The grain handlers will be issued coveralls, masks, gloves and boots. They will receive safety training by an AflaSTOP staff member on the use of the PPE.

First mix of the grain

The aim of the mixing it is to ensure that the grain is of uniform quality.

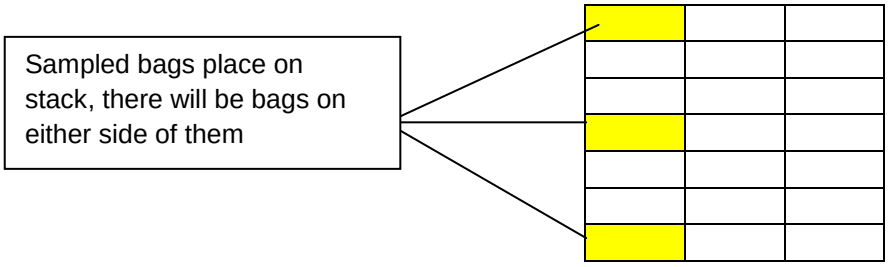
- The grain will be mixed in 1 mt lots. Each 1 mt mixed will be bagged into 11 bags, each bag will be placed on one of 11 different piles.
- After mixing 10 individual lots of 1mt, each of the 11 piles will have 11 bags. At this point the grain in each pile will be mixed again. All 11 bags will be placed in the mixer, and re mixed and re bagged.
- After the pile has been mixed the bagged grain is placed in one of two stores alternatively (i.e. all the grain bagged from the first pile goes into store one, all of the grain in pile two goes into store two, grain from pile three into room one and so on).
- When the second 10 mt is processed the first of the 11 piles will got into store 2 first.

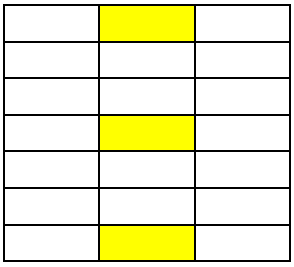
- Care needs to be taken to ensure that last piles are divided equally between the two stores.
- Repeat
- After repetition take a 4 kg sample from every third bag. Mark samples and bag carefully, test for moisture and aflatoxin levels.
- Send samples to University of Nairobi to establish which *aspergillus* strains are present
- Send results to scientific advisor who will advise whether the aflatoxin levels are high enough to move to second mixing or whether incubation is require.
- Scientific advisor will also advise on how successful mixing procedure is based on test results and whether the protocol needs adjusting.

Incubation

If the prevailing aflatoxin levels are below the recommended level of 50ppb, AflaSTOP staff will incubate the *aspergillus* fungi as follows;

- Prepare a number of sites outside of the stores (but within the perimeters of the facility) to pile grain for incubation
- Sample three bags, place these three bags on the outside of the stack in the middle - one on the bottom, one in the middle, one on the top. These bags should be marked and easily accessible to allow for ongoing testing.





- Place bags in piles on top of pallets outside in the sun.
- Place flat containers filled with water under the pallets
- Place buckets of water around the outside of the piles
- Set up hobos on top of stacks
- Cover pile and buckets with plastic sheeting – but make sure that air can flow in during the day – followed by dark tarpaulin.
- In the evening add a second tarpaulin and close off the spaces that allow airflow.

- In the morning, check the temperature and humidity levels recorded hourly by the hobo, add water to water containers and ensure airflow.
- If temperatures are too high (above 38 degree Celsius), remove dark covered tarpaulin and monitor temperatures.
- After 5 days, take samples from the three bags - if the aflatoxin level in these three bags is now above 50ppb move on to the next stage. If not - leave for another three days and re-test.

Second mixing

- Second mixing after incubation; take one bag from each of the incubation piles until there are 11 bags loaded into the mixer.
- Second mixing after first mixing; mix 5 bags from one store with 6 bags from the next store, (then 6 bags from the first store and 5 bags from the second and so on).
- The grain will be mixed in 1 mt lots. Each 1 mt mixed will be bagged into 11 bags, each bag will be placed on one of 11 different piles.
- After mixing 10 individual lots of 1mt, each of the 11 piles will have 11 bags. At this point the grain in each pile will be mixed again. All 11 bags will be placed in the mixer, and re mixed and re bagged.
- After the pile has been mixed the bagged grain is placed in one of two stores alternatively (i.e. all the grain bagged from the first pile goes into store one, all of the grain in pile two goes into store two, grain from pile three into room one and so on).
- When the second 10 mt is processed the first of the 11 piles will go into store 2 first.
- Care needs to be taken to ensure that last piles are divided equally between the two stores.
- **If following incubation** Repeat mixing process above again.
- Take a 4 kg sample from every third bag. Mark samples and bag carefully. Test for moisture and aflatoxin levels.
- Send results to scientific advisor who will advise whether the aflatoxin levels have changed enough to move on or whether more incubation is require - in which case repeat above steps.
- Whether the samples are uniform enough - if not grain will require further mixing

Drying the grain down to create the grain for treatment 1 and treatment 2

After completing all the mixing to the satisfaction of the scientific advisor; at the end of mixing the grain there will be two stores with the same number of bags in each store.

Creating grain for the two treatment arms

The following table lays out the amount of grain that is needed for each treatment arm (i.e., 'dry' and 'wet' grain). The additional 8 kg in the bagged devices is so that after first sampling which takes 4 samples of 2 kg each of the bags have 90 kg in them. One additional bag of approximately 90 kg is treated as a contingency - giving approximately 15 kg per store to cover miscalculations, split grain, etc.

Device	KG	Total KG loaded into devices per treatment	Total grain needed for one store
PP bag	90	196	1176
PICS	90	196	1176
Grain Pro bag	90	196	1176
Metal silo	350	358	2148
Plastic silo	350	358	2148
Grain pro bulk bag	800	800	4800
Extra grain			90
Total KG		2104	12,714

*Note that for the bag tests each storage devices has a bag opened monthly and a bag left to be tested only at the end of 6 months.

The aim of drying the grain is to get 12,714 kg (12.7mt) of well mixed 'dry' grain and 12,714 kg of well mixed 'wet' grain. In calculating the volume of grain required to be bought it has been assumed that the moisture level on the farm will be around 18%. Therefore the weight of grain needed for the 'dry' treatment arm prior to drying is ~ 13,420 kgs and the weight of grain needed for the 'wet' treatment arm prior to drying is 13,025. Once the grain is dried to the required moisture level each load should be around 12,714 kg.

Care needs to be taken to ensure as little as possible additional grain for remains after creating the two treatment arms - however the project has assumed that handling losses will occur (1%) and included an additional 265kg in the total to be bought to cover this. The project **does not have provision for storage of additional treated grain at the storage sites**- therefore there may well be grain left over at the end of mixing and drying the grain which will need to be stored at Lesiolo prior to disposal.

Drying the grain into the two treatment arms

- 13,025 kgs from one of the two stores will be placed onto a truck subsequently to be known as Load 1 WET and transported to Lanet for drying
- The balance of the grain in that store will be moved into the second store
- Load 1 WET will be dried down to approximately 16% and bagged.
- Load 1 WET grain will be moved back to the Nakuru site and placed in one store clearly identified Load 1 WET. The grain will be stored on a tarpaulin

- All the grain in the second store subsequently to be known as Load 2 DRY will be placed on the truck and transported to Lanet for drying
- Load 2 DRY be dried down to approximately 13.3% and bagged
- Load 2 DRY grain will be moved back to the Nakuru site and stored separately in a different store clearly identified Load 2 DRY grain. The grain will be stored on a tarpaulin

- Lock grain stores

- **Clean all equipment used using 10% bleach and 90% water to spray wash down equipment such as the feed mixer, dryer, boots, etc.**
- **Once the stores are emptied they need to be sprayed clean as well.**

The different consignments will be held separately ready for transportation and transported in separate trucks for eventual placement into the storage design containers when delivered to storage sites.

Load 2 dry grain will potentially include additional grain to that needed for the treatment arm, additional grain will be left at Lesiolo Grain Handing until disposal is arranged.

Note: that all personnel handling the grain particularly must wear protective clothing.

A tarpaulin will be placed on the ground where the operations are taking place to ensure no spillages are left on the ground, that similarly tarpaulins will be placed on the floor sheds where the grain will held during the conditioning process and

That tarpaulins will be used on the floor of the stores.

The feed mixer will be sanitized using bleach detergent after completing the operation to ensure any fungal presence is destroyed, the process should be repeated.

The dryer will be sanitized using bleach detergent after completing the operation to ensure any fungal presence is destroyed, the process should be repeated.

4.) AflaSTOP: Protocol for Setting up stores

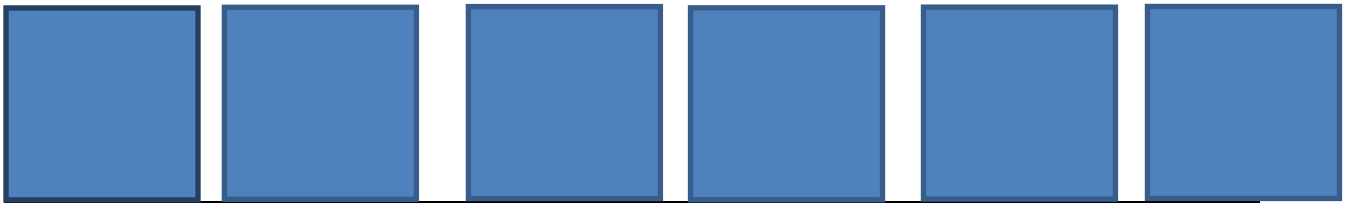
The following designs are being evaluated:

- Metal silos (350 kg)
- Plastic silos (350 kg)
- Hermetic bags (Grain Pro-00kg)
- Purdue triple layer bags (PIC 90 kg)
- Normal Polypropylene bag. (90 kg)
- Grain Pro bulk bag (800kg)

There are two treatments for each of the containers:

- Wet grains
- Dry grains

There will be a store in each selected market centre, all totaling six with closely matching dimensions.

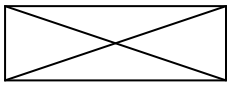


Remember, the bags from one treatment are all going on one pallet; the pallet will be marked into three stripes, the position of each of the type of bags will be randomly assigned

This means each store will have 8 spaces laid out in a grid pattern, the storage devices will be positioned exactly as per instructions provided - 6 spaces will have one technology each, and two spaces will have the bags.

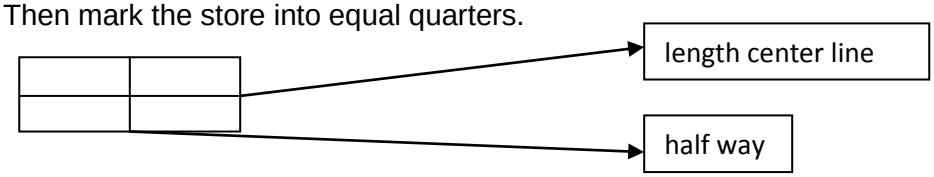
To mark up the grid in each of the store

1. Two diagonal lines will be made from one corner to the other, there they cross is the center of the store



2. On the tarpaulin two diagonal lines will be made from one corner to the other corner, where they meet is the center of the tarpaulin

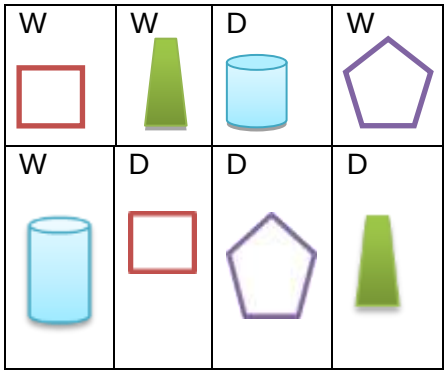
3. Then mark the store into equal quarters.



4. The tarpaulin should be marked into four equal stripes along its length (i.e. a 6m long tarpaulin will have 4 divisions each 1.5m from the previous one), and then the stripes divided by half down the center
5. The center of the tarpaulin will be placed over the center of the store (place a stone on the center so it can be felt - or mark the tarp underneath with the diagonals, fold it in half, place the fold and center over the center and then unfold over the other half of the store)
6. The division of the tarpaulin halving it along its length should then be placed over the center line of the store, and the line dividing the store in half should be matched with the half way point of the tarp (see extra sheet)
7. Each plot should then be given a marked number 1 through to 8 - about 1.5 m from the outer edge (in black marker pen)

1	2	3	4
5	6	7	8

Ultimately a store might look like the diagram below;



Legend:-

 Plastic silo

 Metal Silo

 Bulk bag

 Hermetic bag+PP bag+PICS bag

Prior to going to the field the positioning of the storage devices in the plots will be randomly assigned. The process to do this is as follows;

The following 8 slips will be placed in a bag (metal silo dry, metal silo wet, plastic silo dry, plastic silo wet, bulk bag dry, bulk bag wet, bags dry, bags wet). For each store the slips will be drawn the first being place in plot 1, etc. This will be repeated for each store.

The same process will be repeated for the bags; the pallet will be divided into three stripes labeled, 1, 2, 3 the three type of bags will be placed in a bag(GP, PP, PIC), the first drawn will be positioned in stripe 1, and so on. This will be repeated for the wet and dry treatments for each store. For each of the bag treatments there will be two bags. One bag will be filled at the beginning of the testing phase and left sealed until month 6; the other bag will be sampled from the second month onwards.

1	*2*	*3*	*4*
5	*6*	*7*	*8*

Setting up the devices

Each store must be set up exactly as laid out in the order provided.

According to the random pattern each store will have an order for the devices to be placed. Each device will be placed on a pallet or a frame. The shortest side of the pallet should be alongside the outer length. The center point alongside the shortest side of the pallet should be 75 cm from the beginning of the storage plot (i.e. the storage devices is centered in the middle of the plot)

There should be a corridor of between at least 1 - 2 meters between the devices down the middle of the narrowest store/ tarpaulin.

There may be small spaces between the pallets of each plot

In the center of the store a strong piece of string should be hung down from the ceiling - so that the end of it is at the same height in each store - for instance - if the string hangs down and touches the head of the same person in each store - it will be at the same height in all stores. (Later we will measure that person's height!). When we come to sample the maize we will attach a temperature and humidity monitor which will record during the storage period.

5.) AflaSTOP: Protocol for Transporting Grain

1. One or two trucks will be hired to purchase grain within Eastern and N Rift provinces
2. Two trucks will be hired to load grain at the Lesiolo facility and take it to Eastern and N Rift provinces; one truck will be clearly marked wet, the other dry.
3. Each truck will be lined with a tarpaulin ensuring that any potential grains seeping out of the bags are captured on the tarpaulins.
4. The loaders (Eastern, N Rift Provinces and Nakuru) will be issued coveralls, masks, gloves and boots. They will receive safety training by an AflaSTOP staff member explaining why they need to use the PPE.
5. The AflaSTOP staff member will supervise the loading of the trucks in Eastern, N Rift provinces and Nakuru, taking an exact count of bags loaded onto each truck and complete relevant paper work immediately. PPE equipment will travel with the trucks
6. If more than one truck, both trucks will travel as a convoy accompanied by the AflaSTOP member of staff. At all-time the trucks will remain together - if one truck stops, the other one must stop. At no point will the trucks be left unsupervised by an AflaSTOP member of staff -unless securely locked up at night at a site approved of by AflaSTOP staff member.
7. The truck/s will move from farmer to farmer, village to village to buy contaminated grain
8. When moving the treatment grain back to the storage sites the trucks will move from store to store 1 to 6 in the correct order as laid out on the store layout sheets,
9. Trucks will be reversed up as close as possible to the door of the store
10. Ensure loaders are wearing PPE correctly; carry the dry bags into the store
11. Moving from plot to plot, weigh each bag and note the weight on the storage sheet and the truck reconciliation excel sheet (carry computer), fill each of the dry grain technology; pour the grain from one PP bag to a clean PP bag (two bags)
12. All 90 kg bags should be loaded with an extra 8 kg – i.e. approximately 98 kg. Hermetic bags should NOT be sealed - including bulk bag, plastic and metal silos should not be closed.
13. Brush any loose grains from the floor and put into an empty bag marked waste.
14. Repeat 11 and 12 for wet grain.
15. Brush up any grains that have dropped between truck and store, place in bag marked waste with other brushed grain. Carry waste bag in truck to next store.
16. Repeat 9, 10, 11, 12 for all stores.
17. Reconcile bags weight into the trucks with weight measured into storage devices, less any bags still in trucks, and weight of grain in the waste bag.
18. Leave waste bag in last store.
19. Return to Nairobi or take truck to local cleaning station identified prior to transportation of the grain.
20. Remove tarpaulin from truck; spray truck floor and walls with 10% bleach and 90% tap water solution. Leave to dry - about 30 min. Repeat. Then spray with detergent and water. Allow to dry - brush out.

6.) AflaSTOP: Protocol for Monitoring Stores

- AflaSTOP will provide good quality padlock, the keys will only be held by AflaSTOP staff
- Store owners will provide guards to prevent theft
- AflaSTOP will contact the store owners by mobile phone once a week to check that in their opinion the stores are ok
- AflaSTOP staff will visit the stores at least twice a month to check that in their opinion no one has entered the stores, and all the grain is within the storage devices. Store check sheet must be completed
- Once a month for 6 months, on the same day each month, a Nairobi based member of AflaSTOP staff will visit the store and take samples from each storage device. The removable of the samples must be marked monthly on the store check sheet as well as reviewing store security

Any disturbance of the stores in any manner must IMMEDIATELY be reported to the COP (0722 510 757), and in her absence the Financial Manager (0722 869 550).

7.) AflaSTOP: Protocol for Grain Sampling

Goal: Sample stored maize with high precision and high accuracy to obtain a representative sub-sample that accurately reflects the lot aflatoxin concentration

The sampling step is usually the biggest source of variability associated with aflatoxin analyses. Aflatoxin contaminated kernels are not distributed uniformly throughout the lot (heterogeneous distribution). Therefore, the sample should be a composite of many small samples taken from many different locations throughout the lot. A smaller sub-sample will be drawn from the composite sample for aflatoxin analyses. The aflatoxin concentration in the treatment (storage device) is assumed to be equal to the aflatoxin concentration measured in the test sample.

Samples will be taken according to the sampling plan (see below).

More samples will be taken at the beginning and end of the experiment. These additional samples are used for the repeated measure design (to evaluate variances within the treatments).

For the three bags being tested, there will be two bags per treatment, at the beginning of the experiment for each bag treatment both bags will be tested. Then one will be sealed and marked 6 months, the other will be opened each month for sampling.

It is **VERY** important that the same process is used every time, and the process laid out below is used with **NO** variation.

The following are the designs being evaluated:

- Metal silos (350 kg)
- Plastic silos (350 kg)
- Hermetic bags (Grain Pro-90kg)
- Purdue triple layer bags (PIC 90 kg)
- Normal Polypropylene bag. (90 kg)
- Grain Pro bulk bag (800kg)

There are two treatments for each of the containers and that include:-

- Wet grains
- Dry grains

Assignment of treatments

1. Wet/ bad/ metal silo
2. Wet/ bad/ plastic silo
3. Wet/ bad/ bulk bag
4. Wet/ bad/ hermetic bag
5. Wet/bad/PICS bag
6. Wet/ bad/ control
7. Dry/ bad/ metal silo

8. Dry/ bad/ plastic silo
9. Dry/ bad/ bulk bag
10. Dry/ bad/ hermetic bag
11. Dry/bad/ PICs bag
12. Dry/ bad/ control

Sampling intervals

Time	Month	No. of samples/ treatment/ replicate	Total no. of samples
T_0 (start)	Month 1	4	288
T_1	Month 2	1	72
T_2	Month 3	1	72
T_3	Month 4	1	72
T_4	Month 5	1	72
T_5 (end)	Month 6	4	288

Process

Order of store visits;

The stores will be sampled in the following order;

Sampling order	Store order along road	Store location
1	3	Store Name
2	2	Store Name
3	6	Store Name
4	5	Store Name
5	1	Store Name
6	4	Store Name

This means the sampler will **have** to drive back and forth along the road driving past a store until its turn comes up. The reason for this relates to statistics and is very significant to the overall results.

Order of sampling once entering into the store;

Sampling in the store is in treatment order - not in plot number. Therefore every time the following order will be followed;

1. Wet/ bad/ metal silo
2. Wet/ bad/ plastic silo
3. Wet/ bad/ bulk bag
4. Wet/ bad/ hermetic bag
5. Wet/bad/PICS bag
6. Wet/ bad/ control
7. Dry/ bad/ metal silo
8. Dry/ bad/ plastic silo
9. Dry/ bad/ bulk bag
10. Dry/ bad/ hermetic bag
11. Dry/bad/ PICs bag
12. Dry/ bad/ control

Again this means you go back and forward through the store finding the right treatment. Each storage device will be marked with its relevant number.

Sampling equipment and use

Equipment

Grain Probe
Positioning card
150ml container
sealable plastic bags
disposable gloves
Squeeze bottle
Ethanol
Water

Sampling

The aim of sampling is to use the same position and same angle each time to ensure that as far as possible the sample is being taken from the same place.

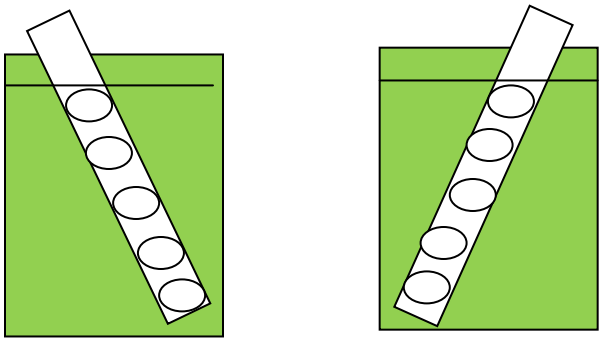
The grain probe collects approximately 300 gms per insertion of 5 holes (bag) and approximately 450 gms per insertion of 8 holes, and therefore the probe must be inserted seven times per bag and bulk container to collect the sample. However in the bulk containers it is also important to collect grain from the spouts.

Total sample size per storage device is approximately 2 kgs.

Sampling method for bags

Carefully open the bag, taking care not to disturb grain. Insert the probe vertically downwards at the 5 points indicated. The project may try to design a position card to facilitate this.

Insert probe twice diagonally across the middle of the bag; angle the probe from the top left hand side of the bag and towards the opposite corner on the floor, repeat other side

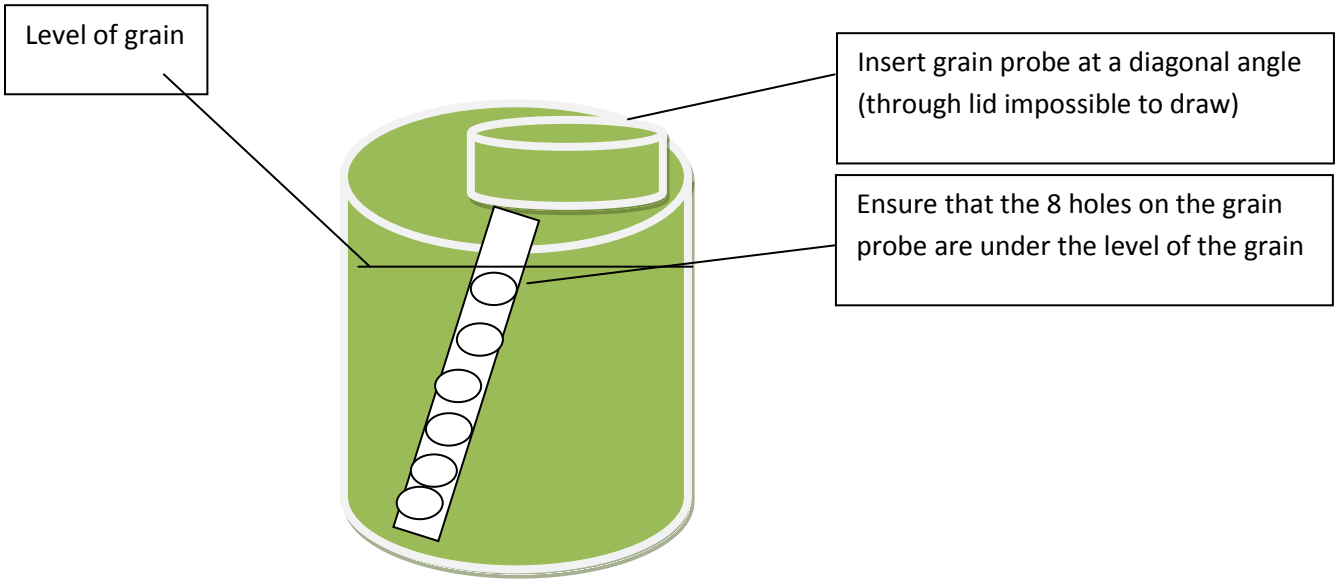


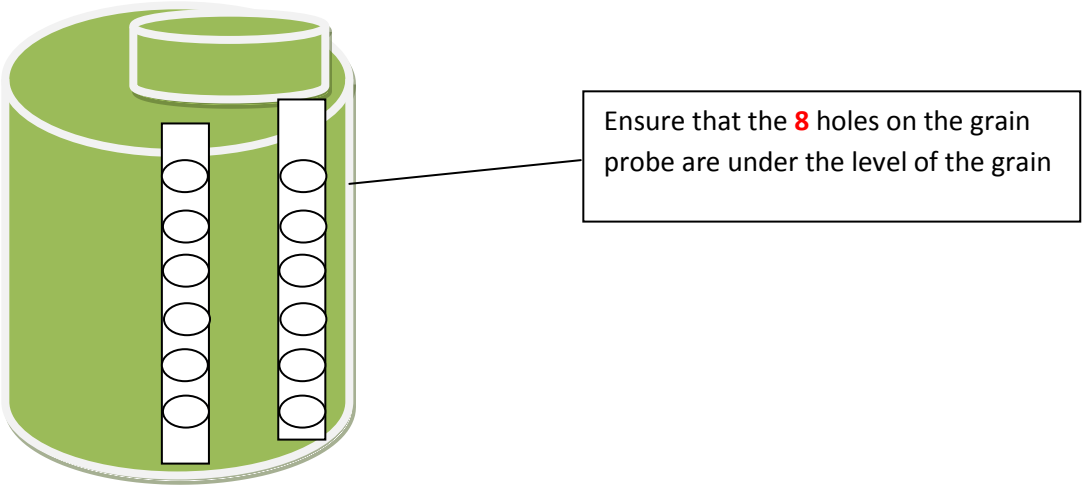
Seal the bag as instructed by manufacturer, or in case of PP bag fold the material over, and tape shut with packing tape.

Sampling method for bulk containers

Due to the height of the top of the bulk containers, and the size of the inlet - it will be harder to use a positioning card, therefore after taking the sample, place a large marble on each sample site where the sample was taken - pushing it slightly so it will not move. This will allow the sampler to go back to the same spot for each sample.

Depending on the length of the probe and the positioning of the opening it may not be possible to insert the probe vertically along the sides of the container, furthermore some containers may be deeper than the length of the probe. The probe needs to be inserted 7 times to collect an approximate 2kg sample. Three insertions should be vertically down - two of which should have the probe push down to touch the bottom of the container (even if it means pushing the end of the probe blow the level of the grain. 4 insertions should aim to sample the grain across the container towards the opposite side. Two of which should be pushed down to reach the bottom of the container if possible.





(The project may try and design a grid which simplifies this)

Ensure that the lid is firmly closed after sampling.

All the bulk containers have a spout for grain off take. Therefore a sample will be taken each time from the spout - releasing the 'tap" and filling a 150 ml yoghurt pot with grain which is added to the sample bag. To ensure no additional grain falls on the floor - place a bucket beneath the yoghurt pot and tap as the sample is collected. The tap must be firmly closed after the sample is taken.

Collecting Samples

1. Make up a solution of ethanol 70% and water 30% in the squeeze bottle.
2. The probe and the 150 ml container must be sprayed and allowed to dry before each sample is collected.
3. Spray the grain probe from the top - allow solution to run down inside - spraying in each of the 5 holes. Allow to dry
4. Spray the inside of the yoghurt pot - allow to dry
5. Change gloves between each device.

1. Take plastic bag and ensure it is labeled correctly;

1. Store number and name
2. Plot number and treatment
3. Date and time
4. Equipment clean

2. Collect sample

1. Start at treatment 1
2. Open the bag or the bulk container.
3. Using either the bag method or the bulk method collect the samples, dropping the sample into the bag.
4. Push out as much air as possible before sealing the bag.
5. Seal the bag, with the label place the bag within a second sealable bag. Seal second bag.
6. Clean sample equipment
7. Place sealed bags inside cool box

Repeat for each treatment area

All samples need to be delivered to Nairobi as quickly as possible and placed into refrigerated storage until each sample can be tested.

Additional input in the sampling protocol was provided by AflaSTOP Thomas Whitaker (PhD) Professor Emeritus, North Caroline State University, an acknowledged export on sampling procedures for aflatoxins.

ANNEX 9: Agreement with Lesiolo Grain Handlers and Photographs of Site

Lesiolo Grain Handlers & Photographs of Site

Proposed Site at Lesiolo Grain Handlers Ltd.

ANNEX 10: NEMA Approved TOR and NEMA Letter to Undertake Full Study

ANNEX 11: Prof. Sheila Okoth, University of Nairobi endorsement

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5th November 2013

TO WHOM IT MAY CONCERN

REF: REVIEW OF PROTOCOLS TO BE USED FOR EVALUATION OF STORAGE METHODS FOR CONTROL OF AFLATOXINS ACCUMULATION IN MAIZE

This is to confirm that I have reviewed the following documents and found them satisfactory in terms of scientific procedure and safety considerations:

The documents provided by ACDI-VOCA for review are:

1. Research and Methodology Approach for the Evaluation of Maize Storage and Drying Systems on the Development of Post -Harvest Aflatoxin Contamination
2. Initial Environmental Examination (IEE) and supporting documentation

Attached please find details review report.

Yours sincerely,

Sheila Okoth

Prof. Sheila Okoth
School of Biological Sciences

ANNEX 12: Aflatoxin Background Document

AFLATOXINS: A FOOD AND FEED SAFETY PROBLEM IN KENYA

What are aflatoxins?

Aflatoxins are naturally occurring mycotoxins that are produced by many species of *Aspergillus*, most notably *A. flavus* and *A. parasiticus*. These fungi produce the toxins on the substrate on which they grow and the most susceptible crops are grains and nuts including maize which is a staple food in Kenya. Aflatoxins have the capacity to cause devastating effects on humans and other animals upon consumption in the form of acute aflatoxicosis syndrome: acute liver damage, liver cirrhosis, tumor induction and teratogenesis. While ingestion of large amounts of the toxin results in aflatoxicosis and death, chronic exposure to low doses of the toxins results into cancer mutagenicity and nervous disorders (KEPHIS, 2006). Aflatoxin poisoning can also occur through inhalation and absorption through the skin (Park and Liang, 1995).

What conditions favor infection of maize by *Aspergillus flavus*?

Infection of maize by *A. flavus* and consequent disease development is favored by hot (>30^{0}C) dry conditions at pollination and during grain fill. Spores landing on the silks germinate, rapidly grow down the silk and colonize the surface of the developing kernels. Around physiological maturity, when moisture content (MC) drops to around 32%, the fungus starts to colonize the internal tissues of the kernels, and it continues to grow until MC is around 15%.

What conditions favor aflatoxin production?

Aflatoxin is a secondary metabolite that is produced by *A. flavus* under certain conditions. Drought and high temperatures (27 to 41^{0}C) during grain fill are the most common factors associated with pre-harvest aflatoxin production. Warm nights (>21^{0}C) may also increase risk of aflatoxin contamination. Toxin production depends on kernel moisture and temperature. As kernel moisture decreases, aflatoxin production increases. Toxin production is highest at 20 to 18% kernel moisture and stops at around 15% moisture. Aflatoxin production occurs between 11 to 40^{0}C with the optimum temperature range being 25 to 35^{0}C. Most parts of the country are therefore conducive for the growth and proliferation of the fungus in maize and toxin production. Most maize is harvested when already contaminated with the fungus and so post harvest handling is key in control of toxin production (Okoth *et al.,* 2012). Aflatoxin production can occur in the field, during harvest, transportation, storage or processing. Controlling storage temperature in rural Kenya is an uphill task for the smallholder farmers and so drying of the grains to the recommended moisture level (13.5%) effective in reducing aflatoxin production is the more practical option. However optimal conditions during transport and in storage must be maintained to

prevent moisture re-absorption by the grains. Genotype and insect activity are also important in influencing amount of toxin production and pre-harvest contamination respectively. The S strain existing in Eastern province is reported to produce more toxins compared to the L strains found in other parts of the country (Okoth *et al*., 2012).

Reported cases of aflatoxicosis and contaminated food and feed

Documented reports of aflatoxin exposure in Kenya are in the form of media release and scientific publications. Aflatoxin poisoning has continued to cause disease and death of many people in rural areas of Eastern and Central provinces of Kenya. The first outbreak of aflatoxicosis in Kenya was reported in 1978 and again in 1984-85 when a large number of dogs and poultry died due to aflatoxin poisoning (Manwiller, 1987). In 1978, aflatoxin contamination in dog meal exceeded 150ppb with the highest being 3000ppb. Other outbreaks affecting human beings occurred in 1981, 2001, 2004, 2005, 2006, 2007 and 2008 resulting in sickness, death and destruction of contaminated homegrown maize (Nagindu *et al*., 1982, Bennett and Klich, 2003; Lewis *et al*., 2005; KEPHIS, 2006; Probst *et al*., 2007; Reddy and Raghavender, 2007; MOA, 2008; Shephard, 2008). The largest outbreak reported in the world during the last 20 years was in 2004 when 317 cases were reported with 125 deaths (Lewis *et al*., 2005). Maize from the affected area contained as much as 4,400ppb aflatoxin B1, which is 440 times greater than the current 10ppb tolerance level set by the Kenya Bureau of Standards (at the time the limit was 20ppb) and the contamination was attributed to conditions of the homegrown maize. Most of the aflatoxin poisoning outbreaks occurred in remote villages and, therefore, the number of people affected could have been higher than reported. The outbreak covered more than seven districts encompassing an area approximately 40,149 km². Of the 317 case-patients, 89% resided in four districts (Makueni, Kitui, Machakos, and Thika). Of the four districts, Makueni and Kitui were most heavily affected (representing 47% and 32% of case-patients, respectively), followed by Machakos (6% of cases) and Thika (4% of cases). The existence of the S strain in Eastern Province explains the aflatoxicosis outbreak.

The semi arid and arid regions of North Eastern and Eastern Kenya receive relief foods and these have not been spared either from aflatoxin contamination beyond the country's acceptable limits (Table 1). Delay in clearing the relief consignment at the port and eventual handling and storage conditions; have been cited as possible causes of aflatoxin accumulation in the grains. This again confirms the importance of the role played by actors along the food and feed value chain in maintaining safety given that *Aspergillus* is a natural colonizer of most agricultural products.

Table 1: Reports of relief foods contaminated with aflatoxins

Commodity	Target ted recipients	Region	Reference
Unimix (pre-cooked, high protein food that comprises maize and soya) 3.62 tons worth >Ksh 500M	60,000 school pupils	North Eastern Province	Nation Media, Nov. 4th 2011
Maize, 6,350 tons worth 300M	Kenyans	North Eastern and Eastern Province	Nation Media, 18th March 2009
Maize and peas	School pupils	North Eastern and Eastern Province	Xinhua News, May 20th 2005
Maize	Kenyans	Kitui County	22nd August 2011
Maize, 19,000 tons	Kenyans	North Eastern and Eastern Province	Nation Media, 20th April 2011

Whereas aflatoxicosis has continued to be reported in semi-arid regions of Eastern Kenya, aflatoxin contamination of various food and feed is reported throughout the country from both household and market samples attesting to chronic exposure (Table 2). A cross sectional study involving analysis of aflatoxin levels in serum specimens in 2007 revealed that exposure levels were high and did not vary with sex, age group, marital status, religion or socioeconomic characteristics, meaning that all cohorts were exposed. However aflatoxin exposure varied by province; it was highest in Eastern and Coast provinces and lowest in Nyanza and Rift Valley provinces (Yard, 2007). Chronic exposure could be a more serious problem than the outbreaks of aflatoxicosis that attract attention at the time they occur. Table 2 also show that various food and feed are contaminated indicating that exposure is from varied sources. This situation is exacerbated by the fact that maize is consumed almost three times a day; an adult consumes 98kg of maize a year increasing the chance of exposure to contaminated maize. This is worsened in the rural areas where diets are less diversified. Children are also exposed to aflatoxins through milk and grains which form the basis of gruels used in early months of weaning (Okoth and Ohingo, 2004).

Table 2: Reports of food and feed contaminated with aflatoxins in Kenya

Commodity	Origin of samples	Aflatoxins (AF) content		Reference
		Total AF/AF B1 (ppb)	AF M1 (ppt)	
Animal feed Milk	Nairobi, Machakos, Nyeri, Nakuru, Eldoret (2006-2007)	600	680	Kangethe & Langa. Af. Health Sci 2009; 9(4): 218-226
Maize grains and flour	Eastern & North Rift Regions (Makueni, Machakos, Kitui, Uasin Gishu & Trans Nzoia district (2008-2009)	136.4		Muthomi *et al*., Int. Journ. AgriSci 2(1): 22-34
Groundnut and peanut butter	Nairobi & Nyanza Province	2,377.1		Ndungu *et al*., J. Appl. BioSci 2013; 65: 4922-4934
Maize grain Milled maize meal Milled cereal products Dairy cattle feed Oil seed cake	Market samples from Nairobi Province (2012)	>100		Okoth & Kola Afr. J Health Sci. 2012; 20: 56-61
Maize	Bura Irrigation Scheme, Garissa and Mwingi (2009)	3800		Nation Media, 2009
Maize	Coast, Embu and Ukambani (2010)	>10		Nation Media, 2010
Maize flour	Murang'a South district (2011)			Nation Media, December 9th 2011
Maize	Meru district Mbeere district (2010)	71000 89000		Nation Media , February 20th 2010

A study carried out by the AflaControl Project in 2010, to compare contamination levels in Western Kenya and Eastern Kenya revealed that there was not much variation between the two sites. In both regions the samples collected in the field and in storage had aflatoxins beyond the acceptable limits, Table 3. At harvest more samples in Western were unfit for human consumption than in Eastern. However in Makueni the increased accumulation of aflatoxin 2 months after harvest increased the number of samples unfit for human consumption from 43% to 87% .

Table 3: Aflatoxin contamination of maize in the field and in storage in Kenya

		Field samples Jan-Feb 2010		Stored samples April-May 2010	
Province	District	Mean aflatoxin content (ppb)	Max. aflatoxin content (ppb)	Mean aflatoxin content (ppb)	Max. aflatoxin content (ppb)
Eastern					
	Mbooni	44	1455	5	88
	Makueni	21		245	1777
	Mbeere	54		18	199
				5	12
Western					
	Homabay	37		45	268
	Rongo	54			
	Kisii Central			41	612
	Transmara			4	13

Aflatoxins are heat stable and most processing methods do not destroy the compound meaning that both the grains and the products are sources of exposure. This review points at aflatoxin as a serious health concern to the entire food chain, necessitating a multidisciplinary approach to analysis, action, and solution.

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ANNEX 13: Aflatoxin Background Document

Review of research methodology, protocols and safety plans outlined by ACDI/VOCA for the project titled: 'Evaluation of Maize Storage and Drying Systems on the Development of Post - Harvest Aflatoxin Contamination'

Reviewer:

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INTRODUCTION

Aflatoxins are secondary metabolites of fungi that are known to be carcinogenic. Fungi, notably Aspergillus flavus and A. parasiticus, produce them on the substrate on which they grow. Human beings and other animals can be poisoned by these compounds through ingestion of contaminated food and feed, and also inhalation of both the toxins and fungal parts and absorption through the skin. Observation of safety precautions is therefore mandatory while working with contaminated material, the toxins and the fungi.

The documents provided by ACEI for review are:

1. Research and Methodology Approach for the Evaluation of Maize Storage and Drying Systems on the Development of Post Harvest Aflatoxin Contamination
2. Initial Environmental Examination (IEE) and supporting documentation

Review comments are as below:

1. Research and Methodology

The methods described by the applicant (ACEI/WOCAT) are appropriate, relevant and uphold safety precautions at all steps. The choice of study sites is appropriate, Makueni and Meru being hot spots for aflatoxin exposure and outbreaks of aflatoxicosis. The experimental design is statistically acceptable and will answer the questions posed. Choosing to test storage technologies that are affordable and easy for farmers to handle is a desirable move by the project and will promote uptake.

The experiment intends to use already contaminated maize as their baseline. While this is a positive move to remove bad maize from circulation, it will also strengthen the authenticity of the results since quantification of toxins will be of larger values and not low quantities that would call for very sensitive measurement protocols and instruments.

Safety precautions for both the workers involved in the project and for the experiment itself are well covered. While solutions of sodium hypochlorite will be used for surfaces

and as a wash solution at all times, the workers will be physically protected by wearing overalls, boots, face masks and nitrile gloves.

3. Initial Environmental Examination (IEE) documents

Annexes

Environmental Mitigation and Monitoring Plan
The monitoring plan is comprehensive identifying potential hazardous steps within each activity and goes ahead to indicate mitigation measures.

Aflatoxin Safe Handling Action Plan (A-SHAP)
Operating safety precautions are all captured in this document.

Work Flow Chart
The chart is logical and contains all the details required to meet the objectives safely

Protocols

All the 8 operating manuals are clearly planned and written. All the processes are logically captured and laid down stepwise to ensure that the study procedure is followed in a scientific manner. The content of the protocols are easy to understand by those listed as actors, staff and study coordinators and so will ensure safety during the execution and exit of the project. All the protocols have taken into consideration operative safety precautions.