The effectiveness of Government programme on aflatoxin mitigation on maize in Tanzania:
A case study of Chemba district in Dodoma region.


A research project submitted to Van Hall Larenstein University of Applied Sciences in partial fulfillment of the requirements for the degree of Master in Management of Development, specialisation Rural Development and Food Security.

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Dedication

I dedicate this research report to my Mother and lovely wife Pelagia Mswata and our daughter Karen Abas Kambo, for allowing me to be away from home for the one year I was in the Netherlands.

Thanks for your prayers while I was abroad.

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List of abbreviations and acronyms

BO Better Off

CIAT International Centre for Tropical Agriculture

CIMMYT International Maize and Wheat Improvement Centre

EIU Economist Intelligence Unit

FAO Food and Agriculture Organization of the United Nations

IFAD International Fund for Agricultural Development

IFPRI International Food Policy Research Institute

IITA International Institute of Tropical Agriculture

M Middle

MoA Ministry of Agriculture

NBS National Bureau of Statistics

P Poor

PICS Purdue Improved Crop Storage

URT United Republic of Tanzania

VP Very Poor

WFP World Food Programme

Currencies

1 EURO 2600 Tanzania Shillings (TSH) in July 2018

ABSTRACT

Aflatoxin is the highly toxic, cancer causing poison that contaminates food. produced by the fungus which grows on crops. In Tanzania aflatoxin is a problem in maize and groundnuts, these crops are highly susceptible to fungal infestation and affects the health of consumers. Aflatoxin it causes liver cancer and makes stunts children growth. A project was introduced in Dodoma region by the Ministry of Agriculture has introduced a Technical Consultative Project (TCP) after the problem of aflatoxin in 2016 with the objective of aflatoxins mitigation through the dissemination of appropriate post-harvest management knowledge and raising awareness to communities on the emergence aflatoxin occurrence in Dodoma region. The main research problem was lacking the knowledge and practices of the awareness raised to farmers on aflatoxin mitigation by the Ministry of Agriculture, to disseminate this knowledge to other districts. The objective of the research was concerned with assessing the effectiveness of the project to farmers knowledge and practices on aflatoxin mitigation to provide recommendations on the Ministry of Agriculture to address the aflatoxin contamination of maize in Chemba district and disseminate the knowledge to other districts

The main research question in this research was to find out the effectiveness of the Government project on aflatoxin mitigation regarding on post-harvest knowledge to farmers in Chemba district after the project intervention. The researcher collected data through a qualitative approach to the farmers in three villages which were highly contaminated by aflatoxin. Farmers were selectively sampled based on their wealth group status of very poor (VP), poor (P), middle (M) and better off (BO). The reason for these categories of the group was to find out which group are adopting the recommended post-harvest knowledge. Based upon the facts collected through the tools such as Semi-structure interview (for respondent farmers and key informants), Observation and informal interaction information on drying, sorting and storage of maize were gathered. The total population of the respondents were 35 (7 female and 28 men) (nine (9) respondents for very poor, poor and middle respective and eight (8) respondents for better off) and 5 key informants in which 4 men and 1 female.

The findings of the research show that 85.7% of the respondents of the farmers reported being aware of the recommended post-harvest knowledge of proper drying and storage and for sorting was 97% as a way of mitigating aflatoxin in maize, the information of it was told from the village meeting after the problems of aflatoxin in their village. Although the awareness is high practising the knowledge was below 50% for drying was 47% and 40% for storage except for sorting was 97% practising. 14.3% of respondents lacked the knowledge of post-harvest because they were absent during the meeting. Before the project intervein into villages, farmers were not aware of the importance of post-harvest technologies for controlling the aflatoxin. After the project farmer has started to follow the recommended knowledge including the use of plastic sheet, increase sorting activities of their maize and dehulling to the machine, the use of PICS bags and pallet during storage. These have helped to reduce the health problems among the communities.

Majority of farmers in the study area found to be aware in the recommended post-harvest methods for aflatoxin mitigation, but they had a challenge of price in the of the facilities like plastic sheet and PICS bags. Therefore, if aflatoxin contamination is to be solved in Chemba District at the stage of post-harvest, it is recommended that the Ministry of Agriculture to continue with the awareness in farmers in groups and villages meeting, of post-harvest knowledge and subsidise the facilities of drying and storage as it is in fertiliser. Also, distributing the leaflets and broadcasting through local radio by emphasising harvesting, adequate drying, sorting and storage will enable to spread the knowledge.

1.0 CHAPTER ONE: INTRODUCTION

1.1 Background of the study

In Tanzania, the agriculture sector contributed approximately 32% to the country's National Gross Domestic Product (GDP) in 2015, mostly through food crop production, which accounted for approximately 65% of the agricultural (CIAT; World Bank, 2017). The country ranks 94th out of 113 countries in the Global Food Security Index (EIU,2017), indicating overall slow progress towards achieving food security targets (FAO, IFAD and WFP., 2015). Food insecurity is prevalent in low-income households, where there is a high reliance on agriculture for subsistence (CIAT; World Bank,2017).

High food prices, pests and diseases that affect crop production and low use of farm inputs, are among the factors affecting population´s food security.

Map of Tanzania

Source: Tanzania profile 2018

According to the Ministry of Agriculture, report of vulnerability assessment in 2017 the country had 188,603 individuals that are food insecure but also, high level of aflatoxin is chronically exposed in their diet. Aflatoxins are secondary toxic that, metabolites products by two species *Aspergillus flavus* and *Aspergillus parasiticus* are naturally occurring contaminant of food. Ingestion of large amounts of toxin can cause death and chronic exposure to aflatoxins leads to liver cancer and may contribute to enteropathy, immune suppression and stunting (Grace *et al.*, 2015). Aflatoxins are widespread in crops in tropical and subtropical regions, affecting more than 40 susceptible crops, mainly maize (**figure 1**) and groundnuts and are also found in dairy products and traditionally fermented foods (Yunus *et al*.,2011 and Grace *et al*., 2015). Aflatoxins contaminate estimated by 25% of crops worldwide, with 4.5 billion people living in developing countries exposed to chronic toxicity and in Tanzania, every year lose over US$ 264 million due to aflatoxin poisoning (Zain, 2011 and M.E.K.T., 2016).

Aflatoxin contamination can occur at both pre-and post-harvest stages of food production. Poor agricultural practices during planting, insect damage, drought, harvesting, drying, transportation and storage are predisposing factors. However, this may vary between geographic locations, including commodity susceptibility to fungal invasion during production to storage (Sugri *et al.*, 2015). Many people in Tanzania produce and consume food crops which are at risk of aflatoxin contamination, the estimation of the health and economic impact due to aflatoxins shows that there are about 3,334 cases of hepatocellular carcinoma (HCC), annually and that 95% of these cases (3167 persons) die each year from the disease (M.E.K.T. 2016).

Figure 1: A photo showing aflatoxin in maize

Source Jagger, (2013)

According to (Wilson and Lewis, 2015) it is approximately 30 million Tanzanians (65 per cent of Tanzania's population) rely on farming and 70 per cent of the people eat maize as their staple food and is produced all over the country. The consumption of food highly contaminated with aflatoxin was reported to cause severe health problems including 14 deaths and 53 in Dodoma region were infected (Buguzi, 2016). According to the National Bureau of Statistic (NBS), Dodoma region has a projected population of 2.3 million people in 2017. The area produces maize, sorghum, groundnut and sunflower crops which are prone to aflatoxin contamination. Consumption of such contaminated produce affects the health growth (Seetha *et al.*, 2017). Many different efforts are required to move towards on higher quality food and reduce food safety risk thus, provide several perspectives on solutions for reducing aflatoxins (Unnevehr and Grace, 2013).

1.2 Characteristics of government programme on mitigation of aflatoxin

In June 2016, the Ministry of Health reported an outbreak of an unknown illness in Dodoma and Manyara regions. The four Districts of Dodoma region and one District of Manyara region were reported the case. Laboratory analyses indicated heavy contamination with aflatoxin occurrence as high as 300 ppb1, more than 30 times than the recommended safe limit (AfDB, 2018). A country situational assessment on the aflatoxin problem conducted with the support from Partnership for Aflatoxin Control in Africa (PACA) confirmed low level of awareness on aflatoxin issues, limited access to guidelines for good agricultural practices and poor storage were behind the prevalence of aflatoxin in maize and groundnuts grown and consumed in Tanzania (Abt Associates, 2013). The Government and other key partners took immediate action on this outbreak, starting with an investigation of the outbreak then provision of food to the households (200kg of maize per person) who had experienced aflatoxin poisoning. Due to lack of knowledge among households on aflatoxins and their implication was considered vital in the country in

raising public awareness of aflatoxicosis by starting in two regions. Therefore, the MoA and FAO introduced a one-year 2016-2017 Technical Consultative Project (TCP) in Dodoma and Manyara for mitigating aflatoxin.

The project was implemented under the Ministry of Agriculture through the National Food Security Department in collaboration with FAO. The project had the components of application of Good Agricultural Practices (from field preparation to harvesting) and post-harvest management services in control of aflatoxin contamination (URT LoA, 2017). The project had two levels on implementation at National and District levels.

At National level were involved awareness raising through:

- Supporting preparation for participation in preparing the message, leaflets, guideline training material for agricultural stakeholders, and training the extension officers.
- Organising events and implementing to ensure that Ministers and other high-level decision-makers they have aware of the seriousness of aflatoxins as well as ongoing activities under TCP since they have a role in ensuring the safety of maize.
- In collaborating with FAO; awareness raising and communication about aflatoxins through TV, local radios and meetings were implemented.

At the districts level they were involved through:
Reducing the amount of problem of aflatoxin to farmers in different ways includes;

- Raising awareness in the villages through village meetings, leaflets distribution and training farmers about the problem and how to overcome it.
- Demonstrating basic practices of good agricultural, i.e. use of *aflasafe* and post-harvest technologies use of Plastic sheet for drying and PICS bags for storage.

The project includes awareness raising through communication, training good agricultural practices like (use of improved seeds, weeding, use of crop rotation, application of fertilizer), bio-control *(aflasafe*) and postharvest handling, including proper handling practices by actors along the maize value chain with the aims of improving food safety and nutrition security of farmers in the identified project areas. The project had the following specific objective (i) improved pre- and post-harvest technology; (ii) improve storage facilities (iii) Increased public knowledge and awareness and (iv) strengthening government institutional capacity through training. The project expectation was to minimize aflatoxin in the food system with the impact of improving food safety, food and nutrition security hence, improve the health of the communities as well as agricultural productivity (URT report, 2017).

1.3 Research problem

Since maize is the country number one staple food in Tanzania and also one of the crops used for complementary foods for children below five years, but they are most prone with aflatoxins contamination. The knowledge of aflatoxins is low and farmers recycle aflatoxin-contaminated harvests for household consumption (Stepman, 2018). The Technical Consultative Project (TCP) in 2016 was introduced mitigation of aflatoxin problem through the dissemination of appropriate post-harvest management technologies and creating awareness to communities on the emergence aflatoxin occurrence and severity in Chemba district.

The Ministry of Agriculture lacks the knowledge and practices of farmers since its introduction on raising the awareness to farmers on the aflatoxin mitigation through post-harvest technologies.

1.4 Research objective

The research objective was to assess the effectiveness of the project to farmers' knowledge and practices on aflatoxin mitigation in order to provide recommendations on the Ministry of Agriculture to address the aflatoxin contamination of maize in Chemba district and disseminate the knowledge to other districts. The findings of this study are to be used as a guideline in disseminating the knowledge to other districts.

1.5 Main research question

What is the effectiveness of the government programme on aflatoxin mitigation in maize on post-harvest to farmers in Chemba district?

1.5.1 Sub research questions

1. What are the characteristics of the programme and how was it carried out in practice in Chemba district?

2. What did farmers do in the past on post-harvest in Chemba district?

3. What is the farmer's knowledge of aflatoxin mitigation in maize post-harvest in Chemba district?

4. How was farmer informed about aflatoxin mitigation in maize post-harvest knowledge in Chemba district?

5. What are the reasons for using, not using or abandoning the use of post-harvest knowledge in maize in Chemba district?

2.0 CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter provides the review of the literature on post-harvest handling knowledge in general, local practices of post-harvest, the recommendation of post-harvest handling knowledge in maize to farmers and means of disseminating the recommended knowledge to mitigate aflatoxin contamination to maize.

2.2 Post-harvest handling technology

The post-harvest handling system aimed to minimise the level of aflatoxin in maize include drying, sorting and storage. Maize in Africa is harvested by farmers when there are physiologically mature at a moisture content of 20-30 per cent (World Bank, 2011) at this stage the grain is very susceptible to pest attacks. Based on the previous studies in Benin and Tanzania (Hell, 2008 and Kamala, A. *et a*l., (2016)) drying, sorting, storage and preventing maize against grains borer insect's infestation are practices are reported to be the most critical factors that discourage aflatoxin production and contamination of maize.

2.3 Means of disseminating the recommendation Post-harvest practices

Postharvest interventions that minimise aflatoxin include proper drying, proper sorting, proper storage, cleaning, post-harvest insect and pest control in the store. The following studies of Kenya and Tanzania have suggested the means of disseminating the methods of post-harvest to farmers.

The authors from Kenya recommended the strengthening of existing public extension services system to enable it to deliver up-to-date information through a variety of channels, on aflatoxin and its management to farmers in a more effective and timely manner (Marechera and Ndwiga, 2014). The study involves 60 farmers in four districts comprised 30 trial and 30 non-trial farmers. Trial farmers were those involved in the aflasafe trials non-trial framers were those outside the tests. They aim to assess farmers' attitude toward and knowledge and perception of the nature, cause and the use of biological technologies in aflatoxin control. The Kenya Agricultural Research Institute conducted it. The results show that proper storage, proper drying, sorting and use of post-harvest pesticide recorded a high level of awareness among both trial and non- trial farmers (Marechera and Ndwiga, 2014).

Also, in Tanzania, the authors recommended if the non-trained farmers will receive the aflatoxin mitigation training on proper drying, sorting and proper storage are practices that show significant association with aflatoxin contamination of maize it will lower the aflatoxin (Kamala *et al*., 2016 and Seetha *et al*.,2017). Thus, a total of 120 farmers; from three districts were selected to participate in the study. A data of local post-harvest management practices associated with aflatoxin contamination of maize. It was carried out by the Tanzania Food and Drugs Authority. The information collected was drying methods, sorting before storage, storage forms, and types of a storage facility in four farmers per village were interviewed between August and September 2012 (Kamala et al., 2016).

2.4 Drying maize

There are several strategies according to Hell *et* al., (2008), to increase the efficiency of drying grains and reduce the contamination of the toxin even under a poor condition such as drying on the mats, platforms and the field. The study in lower Kenya on farmers perceptions of aflatoxin management strategies found that; the main post-harvest aflatoxin control technologies used were proper drying, sorting and use of pesticide to manage pest (Marechera and Ndwiga, 2014).

2.4.1 Local farmers practice in drying maize

In Tanzania, drying of maize usually is done on the ground in-house, based on the study of Kamala et al., 2016 in three zones drying maize were observed to be similar practices on the bare ground, plastic sheet and elevated platform. A study was found in Uganda, drying maize on a bare ground was the most practised by farmers. Drying maize on the bare ground is a positive associated with aflatoxin contamination due to the grain to contact directly with soil which is a primary source of fungi. Therefore, make maize cobs vulnerable to contamination with aflatoxins (Atukwase, Kaaya and Muyanja, 2009). A study in South-Eastern Kenya region showed that post-harvest practices, indicating that more than 50% of farmers do not use canvas to dry maize but throw on the ground where the soil with aflatoxin may contaminate it. Also, 91% of farmers shell maize by beating which breaks the grain exposing them to fungal growth that leads to aflatoxin. 84 % of farmers agreed on the growth of fungus due to poor storage, poor ventilation and keeping the maize on the floor without wooden platforms. Poor package of shelled maize is another entry point where 88 % of farmers do not use sisal bags, but jute bags which are not well aerated and this encourages mycotoxin growth (Kuisa, Kimatu and Kanui, 2017).

An aflacontrol project by IFPRI, 2010 identified that maize at the household level is either dried on the cobs or shelled before drying on the bare ground or a plastic tarp. The use of a tarp during drying can prevent some level of aflatoxin contamination. But the project identified few farmers who own a sheet for drying, and hence most farmers associated with risk of aflatoxin contamination because of inadequate drying but not specifically with the importance of avoiding contact between the maize and the soil. Promoting is needed for the awareness of Aflatoxins among the consumers for in-depth knowledge of the problem.

2.4.2 Recommended practices for farmers in drying maize

The first recommendation from Tanzania, drying maize on the mat/raised the platform, sorting and application of synthetic insecticides during storage are practices that were associated with less contamination of maize with aflatoxins (Kamala *et al.*, 2016). The author suggested the results to be used to advise on effective post-harvest strategies for prevention of aflatoxins contamination of maize in rural Tanzania. Also, a study by Seetha *et al*., 2017 in Kongwa-Tanzania on the occurrence of aflatoxin and its management show that farmers who adopted recommended post-harvest management practices after training had considerably lower aflatoxin contamination in their stored grains. The second recommendation from Kenya, the author recommended timely harvesting, proper drying, and proper storage of the maize. The knowledge of farmers, extension staffs, researchers, trades and consumers on dangers of aflatoxin contamination of food is essential to reduce the aflatoxins contamination in the maize production chain (Kuisa, Kimatu and Kanui, 2017). Similarly, in North Rift-Kenya all farmer they knew how to prevent aflatoxins by “drying maize properly” and “storing it properly” on a raised platform in a dry store (Unnevehr *et al.*, 2013). Therefore, drying grains in such a manner that damage to the grain minimises and lower moisture levels (13-15 per cent) is effective in reducing the level of aflatoxin in maize (World Bank, 2011).

2.5 Sorting maize

Sorting is the physical separation of damaged and infected grains from the healthy ones, is an efficient and feasible method of reducing aflatoxin contamination. Electronic sorter or manually are the methods used during sorting (Bankole and Adebanjo, 2003). In Tanzania, sorting is usually done with the hand.

Hand sorting is a more appropriate aflatoxin reduction strategy for rural subsistence farming communities, owing to its low cost and simplicity (XU *et al.*, 2017). According to Hell *et al*. (2008), the effective way to reduce aflatoxin levels in maize is to sort cobs that are damaged, insect infected, and mouldy grain from the rest of grains.

2.5.1 Local farmers practice in sorting maize

According to IFPRI project, (2010) were surveyed many farmers that, they remove manually maize that appeared discoloured or mouldy at the household, but the discarded maize could still enter the food chain as animal feed. Also, other farmers reported mixing rotten maize with fresh maize to decrease the level of mould consumed. A study in the Gambia shows that sorting is a local practice which is a low-cost and straightforward post-harvest intervention method that involves the identification and then removal of discoloured mouldy food (Xu *et al.*, 2017).

2.5.2 Recommended practices for farmers in sorting maize

A simple knowledge of sorting cobs in West Africa was suggested that can be used to reduce aflatoxin exposure (Afolabi *et al.*, 2006). The author recommended that proper sorting of cobs is an appropriate knowledge to use by subsistence farmers to minimise their exposure to aflatoxins, but it will be useful in reducing overall aflatoxins exposure only if farmers they consume the right quality grains. Based on a study of (Matumba *et al.*, 2015) in Malawi the authors recommending proper hand sorting of maize grains to be the last line of protection against aflatoxin exposure among subsistence farmers.

A study by XU. *et al.* (2017), recommended that training a woman to correct identification and removal of contaminated grains would, therefore, be a useful aflatoxin prevention strategy for the entire community. Women they are responsible for cooking family meals. An author from Malawi recommended integrating sorting into maize production and utilisations chain. In that regard, governments and relevant developing partners in agricultural communities should venture to popularise the technique among the substituent farmers. Understanding the methods would demand huge incentives and advocates of such need through awareness on health risk associated with consuming aflatoxin contamination food (Matumba *et al.*, 2015).

2.6 Storage maize

Storage is a critical stage and considered as the essential post-harvest activities where infection and accumulation of aflatoxin can occur to maize grain. Care must be taken to store grains that are nutritious and healthy. IFPRI project, (2010) suggest to avoid contamination with aflatoxin; maize storage must be in conditions that prevent exposure to and growth of Aspergillus fungi, such as maintaining cool air temperatures and low humidity. According to International Maize and Wheat Improvement Center (CIMMYT), (2011), during the storage insect is the main factors affecting aflatoxin formation in the storage products, which produce humidity via metabolic activity and spread fungal spores.

2.6.1 Local farmers practice of maize storage

Many farmers store their grain in bags like polypropylene which are not airtight, with evidence that this method facilitates fungal contamination and aflatoxin development (Hell and Mutegi, 2011). Mendoza *et al*., 2017 in Guatemala study show that; “among storage practices, 62% of surveyed farmers store the maize as shelled kernels; while 38% store it on cobs. Among farmers who stored maize on cobs, 74% use the *tapanco* as the preferred storage structure”. And 41% of farmers indicated storing the maize for at least four months (Mendoza *et al.*, 2017).

2.6.2 Recommended practices for farmers in storage maize

The Purdue Improved Storage (PICS) technology is a triple layer sealed plastic bag that cuts off the oxygen supply to create hermetic conditions, thereby eliminating insect damage in the storage of dry grains. A study of maize test in West Africa for aflatoxin between PICS and woven bags was done where, samples from PICS bags were less contaminated than those from woven bags (Baoua *et al*., 2014), the author recommended currently to use PICS bags by applying appropriate post-harvest practice to reduce the risk of aflatoxin contamination. Tubbs *et al.*, (2016) found that farmers in several Africa countries use small PICS bags (50-100 kg) because it has proven a low-cost solution for preventing storage insects. Authors further recommended that PICS bags are effective in blocking the effects of external humidity fluctuation as well as the spread of aflatoxin to non-infected grains. This recommendation is the same as the study by Williams *et al*., (2014) demonstrated that storage of maize in PICS bag is a viable management tool for minimising aflatoxin accumulation in storage in West Africa.

Studies in Kenya recommended the maize grains to be stored at moisture less than 12.5% and the stores should be well ventilated. Permanent storage structures include metal silo, improved storerooms, baskets, large pots and traditional cribs (IFPRI project, 2012) and De Groote *et al.,* (2013), show that hermetic storage containers, such as metal silos and super grain bags (made from high-density polyethene to cut gas exchange), may enable farmers to reduce post-harvest losses associated with aflatoxin. The stores should be constructed to exclude fungal growth, dry, well-ventilated structures, provide protection from rain, drainage of groundwater, prevent entry of rodents and birds, should allow minimum temperature fluctuations and to avoid moisture from getting into the grains (Guadalupe *et al.*, 2013). The use of meta silo technology was found to be effective against maize storage pest that influences aflatoxin contamination and its adoption can significantly improve food security in rural farmers (Zachary, Hugo and Tadele, 2015). Also, careful to handle and to store maize grains prevent post-harvest aflatoxins contamination and educating farmers about maize grains handling methods to reduce post-harvest contamination is vital to the overall objective of providing safe food and feed grains (Bruns, 2003). A new study in Zimbabwe has also proven that PICS bags and metal silo technologies of storage are effective against pests and in reducing aflatoxin contamination (Bafana,2017). Generally, post-harvest management including proper drying methods, effective cleaning of maize before storage, use of hermetic bags such a PICS and adequate storage conditions are under-utilised in Sub-Sahara Africa (James and Zikankuba, 2018).

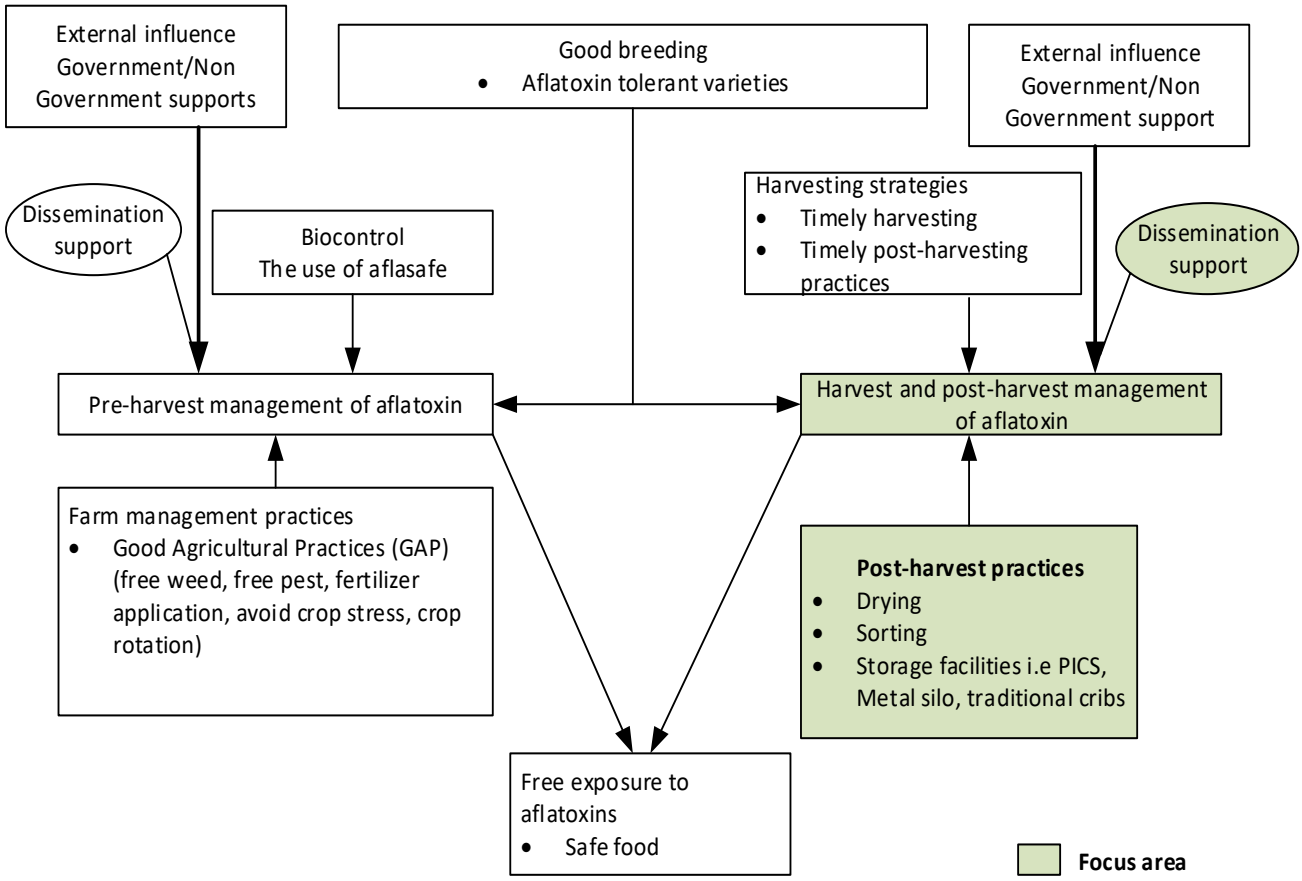
Hell, and Mutegi, (2011) recommended that public education and awareness can sensitise the farmers on aflatoxin risk and its management practices on post-harvest knowledge. The International Maize and Wheat Improvement Center (CIMMYT), (2011) has implemented the project entitled "*effective grain storage for sustainable livelihood of African farmers*", in Kenya and Malawi by training the farmers and artisan/metal silo constructors. Demonstrations and media were used to promote metal silos in Kenya and Malawi countries, which directly and indirectly created a critical mass among the stakeholders, including farmers, artisan, NGOs, government line ministries and consumers in general (CIMMYT), (2011). An intervention study by Turner *et al.*,(2005) on subsistence farmers in the lower Kindia region of Guinea, they recommended mitigation of aflatoxin exposure by working with local farmers should be done. And by use of readily available materials, and local expertise could be a rapid and inexpensive approach to reduce the burden of aflatoxin associated diseases in many parts of sub-Sahara Africa. The same author highlighted the introduction of the intervention of proper drying, sorting, wooden pallets, insect control and storage of maize are the strategies of post-harvest package knowledge.

2.7 Conceptual framework

The information during research from the post-harvest management of aflatoxin information was generated. The effective reduction of aflatoxin contamination in the food value chain would require multiple approaches. Like good crop breeding, pre-harvest and post-harvest management of aflatoxin. Breeding a resistance crop is the right strategies to mitigate aflatoxin contamination in maize. Therefore, breeding, pre-harvest and post-harvest management of aflatoxin are influenced by the Government support and disseminate the technologies to farmers.

In this research information on post-harvest management of aflatoxin was collected based on the following conceptual framework

Figure 2: Conceptual framework



Conceptual framework adopted from Kimatu *et al.*, 2015

2.7.1 Definition of operational terms and concepts

In this research, the following key concept definitions were used;

Aflatoxins are toxic secondary metabolites produced by some species of the Aspergillus fungus and are identified as the most important human health concern associated with staple crops (Grace *et al*., 2015).

Harvesting practice: This is manually carried out. The cobs are detached from the plants and dehusked, ready for transportation to the store (FAO,1994). Farmers should undertake this set of activities. The sequence of such interconnected farm activities forms a post-harvest management system for the crop.

Post-harvest practice: These are the whole process or activities taken from physiological maturity of a crop to consumption. Post-harvest begins when the process of collecting or separating food of good quality from its site of next production has been completed (Mutenyo, K.M., 2013).

Maize (*Zea mays L*.): is the most important cereal crop in Tanzania with an estimated annual per capita consumption of more than 112.5 kg per person (Manoza *et al.*, 2017). Maize was introduced in Tanzania mainland (Tanganyika) in the 17th and spread inner parts by the mid-19th century (Ashimogo, 1995).

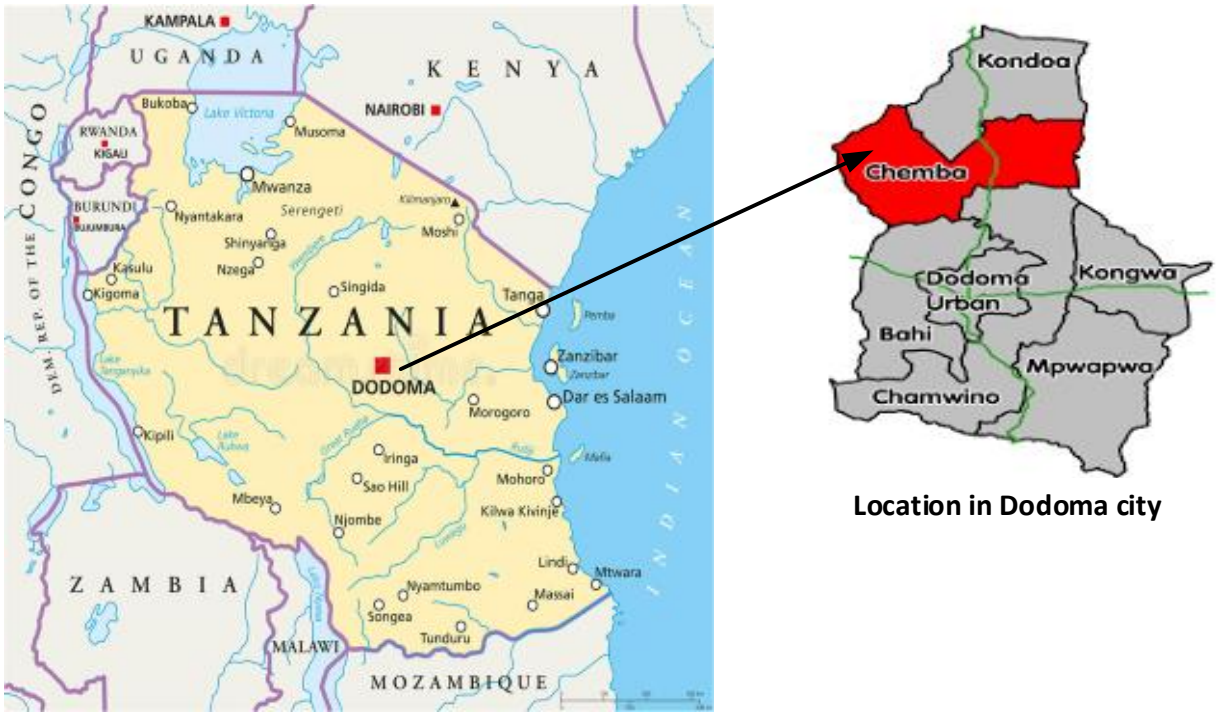
3 CHAPTER THREE: RESEARCH METHODOLOGY

In this chapter, is describing the whole process of research field presenting the study area, research design, sampling, data collection, data analysis, ethical of research and research limitations.

3.1 Study area

The study was carried in Chemba district which is among the seven districts in Dodoma region. In 2016 the farmers from nine villages were affected by consuming maize that was contaminated by aflatoxin. The District covers a total area of 7,290 square kilometres with the population of 235,711, and the population density is 32.33 persons per square kilometre (National Bureau of Statistics- NBS, (2012)). Maize is the dominant annual crop grown in Chemba district, other annual crops are bulrush millet, groundnut and sorghum and the average cultivation area per household are 2.4ha. The area is a semi-arid midland zone which lies between 900 and 1,200 meters above the sea level. The total annual rainfall average is 556 mm distributed between the end of October and May. The crops and livestock production are the main economic activities in the agriculture sector, poultry, goat, sheep and cattle are the common livestock (NBS,2012).

Map 1: Map of Tanzania indicating the study area



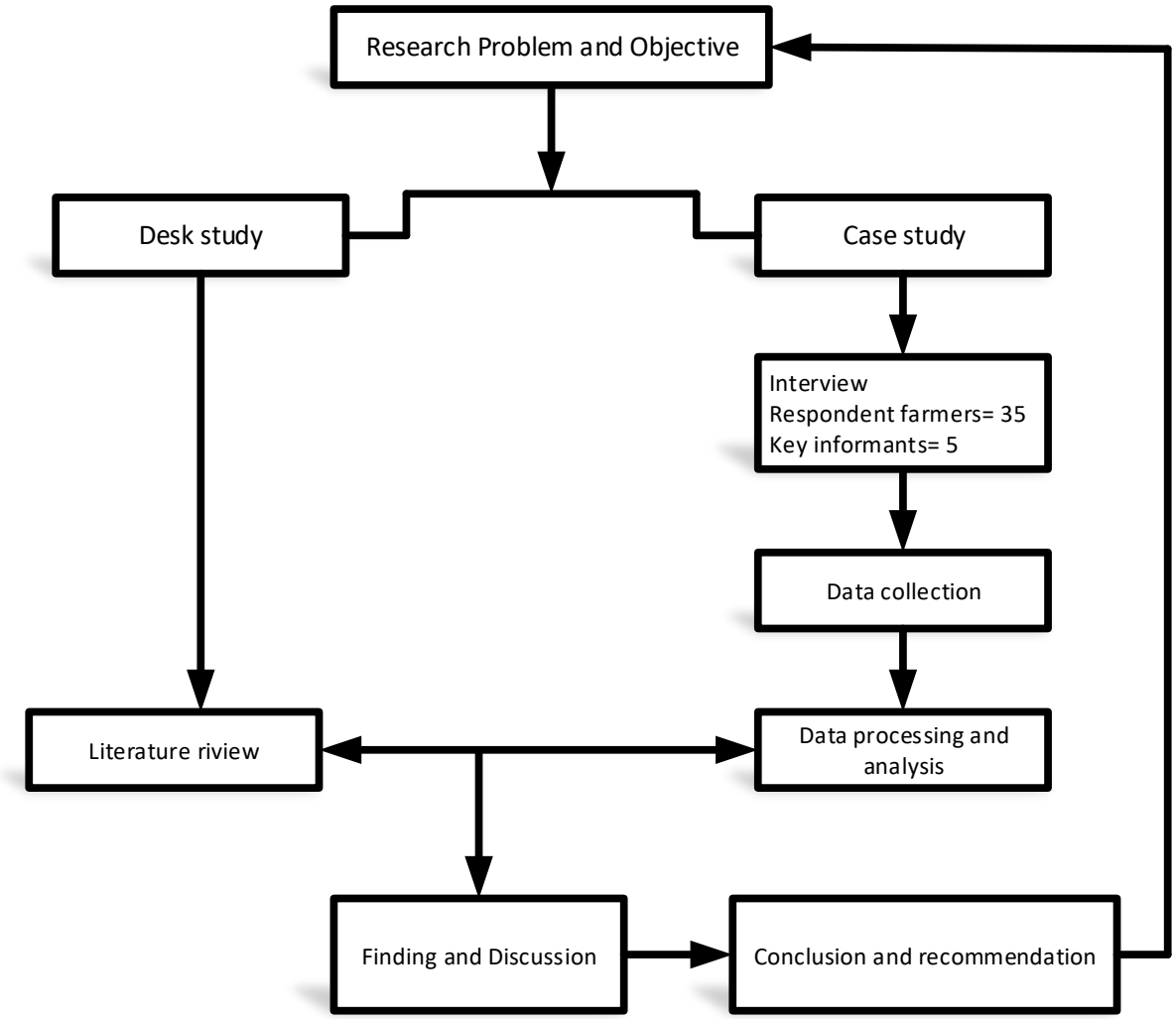
Source: Tanzania profile 2018

3.2 Research design and strategy

The research was designed into two phases as shown in **figure 2** below. The first was involved in the desk study in which theoretical information was gathered to understand the basic concept of the study. Data based on desk study was collected using various literature search; using the internet and digital library of the Van Hall Larestern University of Applied Science. The second phase was a collection of the qualitative data. A case study was used to get in-depth information as explained in Baarda, (2014) on the farmers'

knowledge and practices of aflatoxin mitigation using the recommended post-harvest methods from the government project. It was to get more detailed and broader understanding.
The checklists with semi-structured questions were used to explore the information. However, in this phase, the researcher was also using observation as a means of verifying the information, i.e. Plastic sheet and storage facilities during the interview to the house of the respondents were observed. It was important because the researcher understands the first-hand information through observation. 35 respondents from the categories of very poor (VP), poor (P), middle (M) and better off (BO) farmers were selected. This reason for choosing these categories was to find out which group is adopting the recommended post-harvest knowledge from the project. Five key informants were selected during the data collection because they were involved in the project implementation.

Figure 3: Research plan



Source: Author, 2018

3.3 Sampling and sample size

The research was conducted in three villages where the interventions project was implemented, to create a better understanding of the prevention of aflatoxin on post-harvest maize, in Chemba district. With the help of district agriculture officer nine (9) villages were identified Mondo, Itolwa, Kinkima, Soya, Mlongia, Mwaikisabe, Mwailanje, Igunga and Isusumya village which was affected by aflatoxin contamination.

The researcher purposively selects three (3) villages Igunga, Mwailanje and Soya, **table 1** based on the occurrence of the aflatoxin in 2016 these were most affected. By involving district agriculture officer and researcher of this research, the respondents were purposively selectively. In each village, a total number of 12 farmers and 1 key informant for interview were selected each village and from the MoA, Chemba district and to get the information. An extension field officers were involved as a key informant because they provide services to farmers.

Table 1: List of selected respondents from three villages

District	**Wealth group**	**Villages**			**Total**
		Goima ward	**Kimaha ward**	**Soya ward**	
		Igunga	**Mwailanjee**	**Soya**	
Chemba	Better off	3	2	3	8
	Middle	3	3	3	9
	Poor	3	3	3	9
	Very Poor	3	3	3	9
Total number of interviewees					**35**

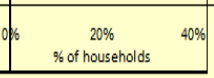
Source: Author, 2018

They were three key informants from each village one and two from the district and the Ministry of Agriculture.

Socio-Economic status was used to get the respondents of four groups using their wealth ranking (Better off, Middle, Poor and Very poor) farmers as shown in **table 2** to measure the effectiveness based in different groups of wealth status. According to Tanzania Livelihood Baseline Profile, Chemba district is under Livelihood zone 55, their wealth was determined mainly by the amount of land a household can cultivate, which are related to some factors, including how much property it owns (both through

inheritance and purchase) as shown in table 2 below. This wealth status in groups was used to show out the level of adoption the recommended post-harvest method by comparing in the wealth groups.

Table 2: Showing the wealth groups characteristic in the study area

		Wealth Groups Characteristics					
		HH size	Number of wives	Land cultivated (acres)	Livestock	Poultry	Other
Very poor		5 - 7	1	1 - 3	none	0 - 15 chickens	1 cell phone; 0-1 bicycles
Poor		5 - 7	1	2 - 6	0 - 4 oxen; 0 - 4 cattle; 4 - 10 goats	5 - 15 chickens	1 cell phone; 1 bicycle
Middle		6 - 8	1 - 2	5 - 10	2-6 oxen; 7-20 cattle; 8 - 12 goats;	10 - 15 chickens	2 cell phones; 1 bicycle; 1-2 ox plows; 0 - 1 ox cart
Better off		6 - 8	1 - 4	10 - 20	4-8 oxen; 10 - 25 cattle; 10 - 25 goats; 0-12 sheep	10 - 25 chickens	2 cell phones; 1 bicycle; 2 ox plows; 0 - 1 ox cart
							

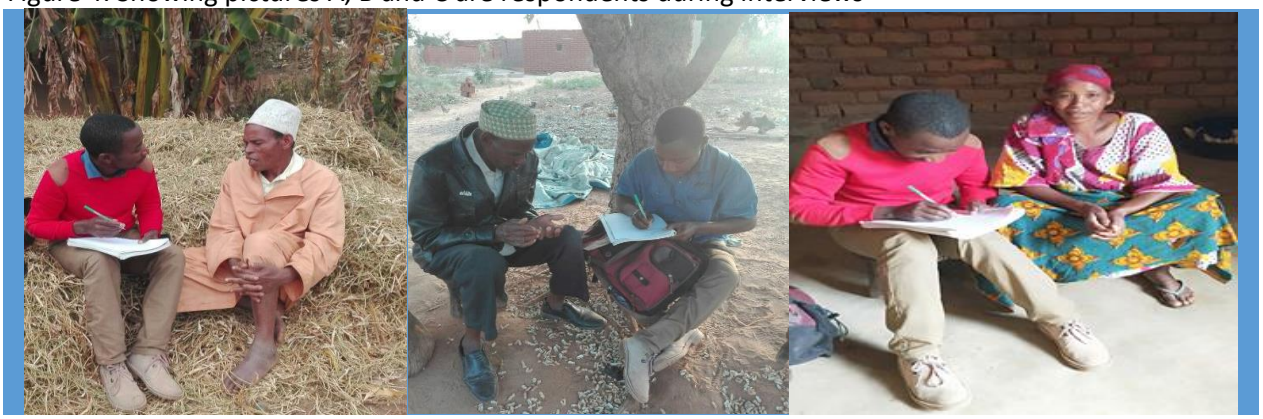
Source: Tanzania Livelihood Baseline Profile zone 55, (2015)

3.4 Data collection

Both primary and secondary data were collected. The primary data on the field were collected by interviewing the farmers (**figure 3**) below. The secondary data were supplemented with the primary method and was provided with the opportunity to the researcher to gain more information about the context of research problem by reviewing different sources of information including books, journal, newspaper using an internet search. The researcher explores the qualitative data of the effectiveness of the project in aflatoxin mitigation on maize by using a semi-structured interview with checklist questions (**Annexes**) to four groups of farmers as shown in **table 2** above.

Observation and interaction with the respondents as a tool were used to collect the information on how they dry and store their maize. Other information was techniques to know whether the grains are already dry for storage, whether the farmers protect maize during storage and information on whether the farmer cleans the store and use pallets during loading new stock in the store. The voice notes and other as videos were recorded during interviews.

Figure 4: Showing pictures A, B and C are respondents during interviews



A **B** **C**

Source: Field data, (2018)

3.5 Data Analysis

A qualitative method was used to analysed data in group-wise by organising and coding the data of very poor, poor, middle and better off according to the similar responses from the interviews. Information collected from the field was summarised and rephrased to make the point clear by maintaining their original meaning. Other data by using Microsoft Excel Sheet were analysed. Further were ensured that the information given by respondents was accurate, complete and consistent.

3.6 Ethical of the research

During the data collection, the ethics of the study as a professional researcher were considered. Moral principles of voluntary participation, confidentiality, privacy, right to service and inform consent was observed (Asa, 2011). Action on the right to service, technical questions were asked about the effectiveness of the project in aflatoxin mitigation through post-harvest technologies. The researcher gave explanations before every interview, to each respondent what, why, how and to whom the study is being carried out including their expectations as a participant. For farmers, willingness and voluntary to be interviewed were considered before conducting the interviews. And with the key informants, they were allowed to read and sign the informed consent form, as a confirmation to willingly to participate in the interview exercise (**annex 4**) After data being collected, the researcher will engage in data analysis with the aspect of qualitative data analysis in publishing ethical research. The result of the data analysis needs to be trustworthy, credible and dependable (Wester, 2014).

3.7 Research limitation

The research was carried out from July to early August, at the beginning I was delay two days because of the permission from the District Executive Director because of being with other duties to do. In the field, in all three villages, the majority of the community are Muslim in where men are dominant on giving the information in the household. Due to that, the researcher ended up with 7 females and 28 males for respondents and 5 (1Female) for key informants. The data collected on the effectiveness of Government project in aflatoxin mitigation may have a low reflection due to the project it was a one the year 2016-2017 to implement. During the study, I thought I would find the government strategy for aflatoxin mitigation in the country, but the Ministry of Agriculture lacks the policy, so these findings are based on my study

4 CHAPTER FOUR: RESEARCH FINDING

4.1 Introduction

This chapter presents the findings from a farmer on the effectiveness of government project on mitigating the aflatoxin on maize in Chemba district based on the post-harvest practices from the category of very poor, poor middle and better off farmers. The results of the study focused on the post-harvest practice of maize from drying, sorting and storage in three villages of Chemba district, among the area which was affected by aflatoxin contamination in Dodoma region. The study included 35brespondents.28 were males, and 7 were females. Key informants were 5, among them female was 1 and four (4) males.

4.2 Characteristics of the project on disseminating the knowledge of post-harvest to mitigate aflatoxin

The project was formed due to the outbreak of aflatoxin and help the households that were contaminated by aflatoxin problem. The first information about proper drying, sorting and storage were given to farmers through national TV and Radio, followed by visiting and distributing a warning letter to farmer via Village Executive Officers to the contaminated villages.

The farmers were informed about the aflatoxin mitigation by different methods; awareness and communication through National TV and local radios this was reported by the Ministry of Health. From the District Executive Director (DED) a warning letter to farmers was distributed to Village Executive Officers (VEO) on post-harvest methods including sorting, washing and dehulling of grains before granting to flour. The awareness and communication were in August 2016.

Two meetings operated for awareness raising and post-harvest meeting. All session of the meeting was about the effect and how to mitigate the aflatoxin problems in the village this it was done by FAO expert, District focal leader and Extension field officers. The information for the meetings around the communities was disseminated by using the Mosques speakers and using druma and announcing this was in February for awareness meeting and May 2017 for the post-harvest meeting. The sessions were emphasising on the proper drying, sorting and storage using the PICS bag on the pellet to prevent moisture to bags. Other methods were the distribution of leaflets that were in the Swahili language "*Ukweli kuhusu sumu kuvu=Truth about aflatoxin"* this was done by IITA and FAO experts for aflatoxin mitigation (**Figure 4 C**). According to the District focal leader (personal communication with Ministry and village leader's Key informant; (2018), the awareness raising and meeting were in ten (10) out of the 11 contaminated villages (figure 4 A). 16 Dry Cards to five villages (**Figure 5**) were given these are used to determine the farmers' grains whether are dry for storage. According to the key informant from the district, the attendance for the awareness raising meeting and post-harvest meeting were 270 and 276 farmers respectively.

Also, there is a high testimony on the proper storage to a farmer who has used the PICS bags through village meeting as a researcher observed during the data collection in Mwailanje village an Extension field officer (**figure 4 A**) continue with informing farmers on post-harvest method and farmer in (**figure 4 B)** testifying the importance of PICS bags. During the research, the researcher found that the farmers who were using the recommended post-harvest knowledge were experienced a significantly higher improvement in food security because it was safe from storage pests, i.e. mouldy causing aflatoxin. All of the respondents suggested that the information methods that were not sufficient. They recommended reaching many farmers village meeting and groups that are existing with villages for disseminating the knowledge for reducing the aflatoxin are to be used.

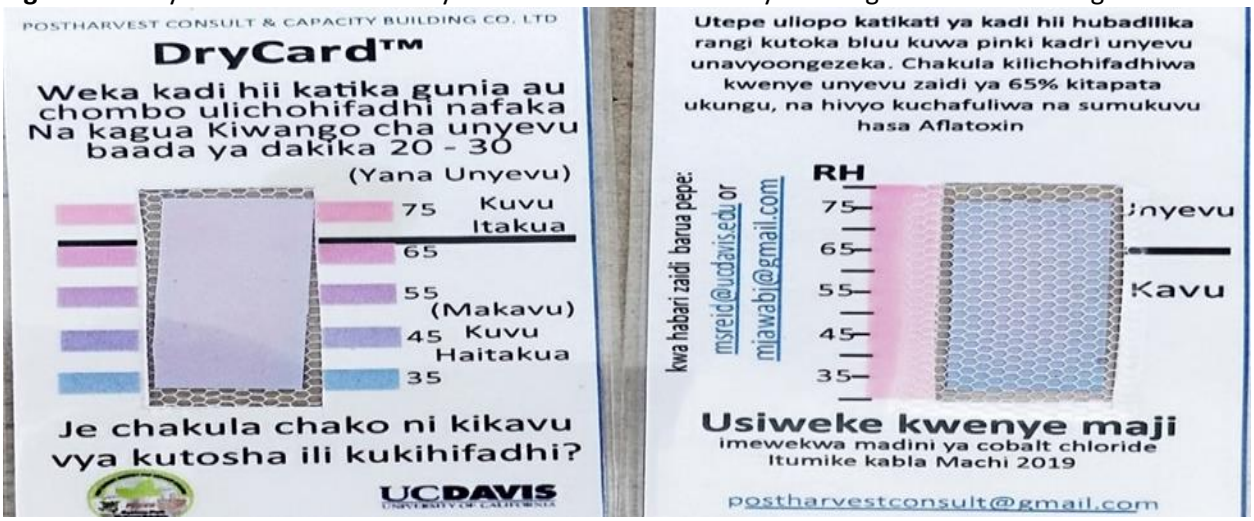
The figure 4 A and B below are among the dissemination of the knowledge to reduce the aflatoxin during post-harvest figure A an extension with villager disseminating the knowledge on drying, sorting and storage on July 2018 before the harvest. Figure 4 B, a farmer testifying during the village meeting on the use of PICS bags to farmers.

Figure 5: Pictures showing among the methods in figure A, B and C used for disseminating the knowledge to farmers

Figure A: training in village meeting. B: Leaflet distribution C. Farmer testifying on PICS bag

Source: Field data, (2018).

Figure 6: A Dry Cards that are used by the farmer to measure dryness of grains before storage



Source: Field data, (2018).

4.3 Drying maize

This section reports on local practice before the project, farmers' knowledge about the recommendation and farmers' practice after the project.

4.3.1 Drying maize; Local practice before the project.

This study found that all the interviewed farmers that were drying maize on the bare ground in the past. A farmer is selecting an area in the field which has hardpan and prepares it as a drying place during harvesting maize. The respondents reported the skill of using bare land grounds that is hardpan was a heritage from their elders.

Figure 6: A farmer drying maize cobs on bare ground

Source: Field data, (2018)

4.3.2 Drying maize; Farmers' knowledge about the recommendation

On the farmers' knowledge about the proper drying, the research found that 30 respondents out of 35 were informed about the recommendation of drying maize using the plastic sheets to mitigate the aflatoxin problems. The farmers were told in the village meeting during the project implementation, while five (5) respondents lack the village meetings and neighbour on the knowledge. Below is a picture of the respondents showing the understanding of drying tools and the leaflets explaining how to avoid the aflatoxin by proper of maize drying. The leaflet obtained it during the village meeting and the plastic sheet she bought at 20,000/=TSH in the village market.

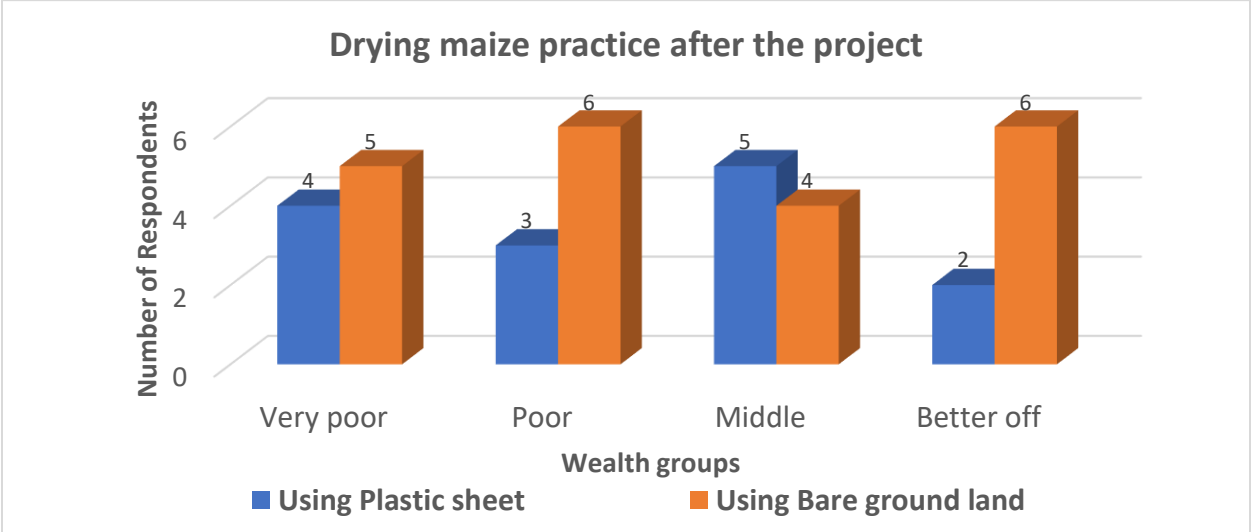
Figure 8: Picture of farmer who adopt the recommended maize of drying maize

Source: Field data, (2018)

4.3.3 Drying maize; Farmers' practice after the project

Together with the awareness provided during the project implementation results shows that only 14 respondents begun to use the plastic sheet in 2017 after the intervention of the project. The practice of drying was found to be different from poorer and richer communities as was revealed during the interviews; Poorer farmers (very poor and poor) were seen to use less time compared with middle and better off farmers. The richer group they have a high amount of production. Figure 7 showing the practices of a farmer in drying maize after the project whereas 14 are using the proper drying and 21 continue using the traditionally in the bare ground.

Figure 7: Showing the farmers' practice after the project



Source: Field data, (2018)

4.3.4 Reasons for not using the recommendation

Given the awareness plastic sheets as a tool for drying maize to minimise aflatoxin still majority of farmers are not using it. During the interview, farmers reported that because of the behaviour and attitude they don't use it, also other said that plastic sheets are expensive. Also, the key informants reported low income to buy the plastic sheet, behaviour to adopt the practice and little education on post-harvest method were among the factor limit the farmer on drying. While for those farmers who not get the awareness still primitive though they are slow to adopt the recommendation practice and other farmers are reluctant they take until they got problems in their households.

According to the key informant from district and Igunga village discussion, the most challenging stage for farmers it was found that in the post-harvest knowledge that leads to the aflatoxin contamination was at the drying stage.

Although thirty (30) farmer were informed, 16 farmers were not using the plastic sheet for drying complaining about the high cost and fearing from thieves. One of them said: …"*this year I will buy the plastic sheet but I fear the thieve because I have to leave in the field and they can take it and make and use it to their house*" (Interview No.15.P,2018).

Another respondent reported that is their habit and attitude of not using the plastic sheet during drying and continue by *saying that* ….."*plastic sheet normally they are not quality you cannot use more than one season"* (Interview No.35. BO, 2018).

Also, high production from richer groups (middle and better off) was a reason for not using the sheet instead of being used during threshing…. "*Buying the sheet that will accommodate all the yield is expensive*" (Interview No.24 M,2018). One sheet was ranging from TSH. 20,000-30,000/=, (8-12 EURO).

4.4 Sorting maize

This section presents on sorting maize; local practice before the project; farmers knowledge about the recommendation and farmers' practice after the project.

4.4.1 Sorting maize; Local practice before the project

During research, 14 respondents out of 35 were not sorting maize. 21 respondents were sorting maize as locally by removing the decayed cobs in the field before they thresh as it was a heritage from their elders. Reported to remove the unwanted decayed cobs directly during harvesting stage at the field.

4.4.2 Sorting maize; Farmers' knowledge about the recommendation

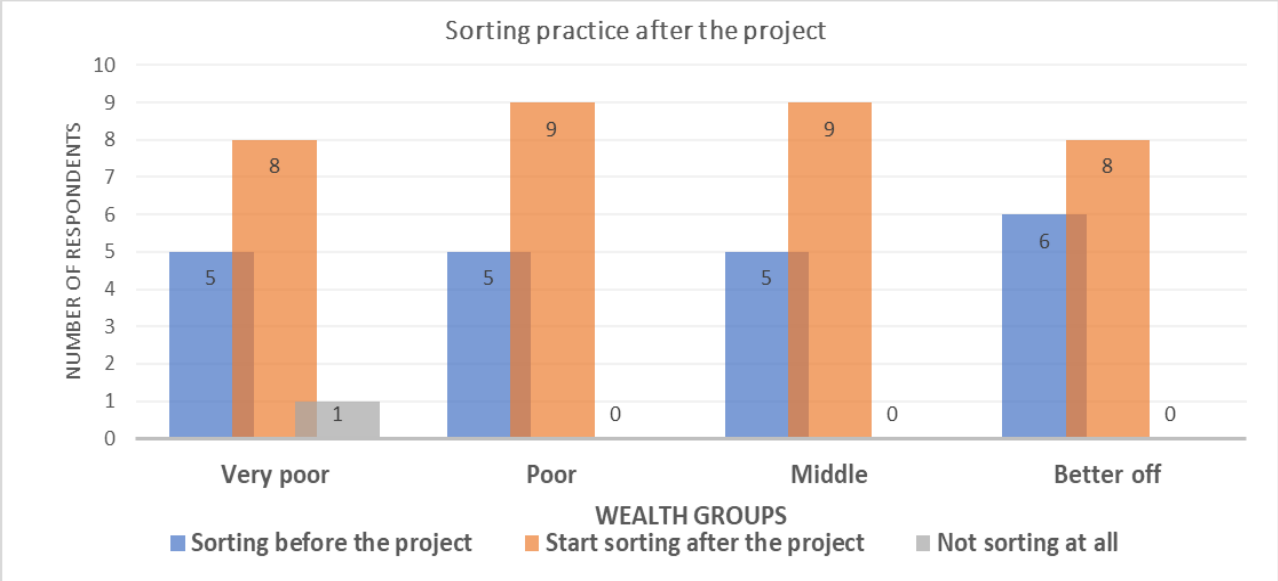
Out of the 35 respondent interviews, thirty-four or 97% of 35 farmers that sorting is among the method of aflatoxin mitigation. The understanding of recommended sorting was told at the village meeting. The removed cobs were reported to be left in their field.

A key informant from District said, "*a farmer has aware on the sorting before they threshing they do sorting but also wash the grains before they process to flour to avoid aflatoxin contamination*". Another key informant from Igunga village mentions that "*a farmer sort to get better grains for consumption and quality seeds.*"

4.4.3 Farmers practice after the project

Almost all majority heard the importance of sorting and they are practising it except one respondent from the very poor group was not sorting as after the project. All the 34 farmers reported using manual sorting either directly during harvesting, threshing and when preparing for a milling machine. The figure 9 below showing the farmers' practice in sorting maize after the project.

Figure 7: Summary of finding for sorting maize practice after the project**.**



Source: Field data, (2018)

After the project, ten farmers have started sorting after knowing the importance of doing sorting as one of them said that:

……*"I am sorting by removing fungus cobs to avoid aflatoxin". He continues by …..*"*saying before I was not sorting, only last year after getting the training from the government on how to identify the contaminated maize cobs and how to protect it now I know how to sort maize which has a sign of aflatoxins"* (Interview No.24.M,2018).

Another respondent said that;….. *"if you sort you will get quality food and if you store, you storing the quality products"* (Interview No.22.M,2018). Majority of a farmer after the project they have aware that if they don't sort they are likely to get the problems of aflatoxin contamination. The skills of sorting as reported by farmers was a heritage from their parent and extension officers.

4.5 Reasons for not using the recommended knowledge of sorting

Behaviour and attitude were the reason of the farmer who was not sorting at all. According to the discussion with the key informants, the reason for the farmer not to practice sorting are time-consuming and tedious work if the farmer has high production, i.e. better off farmers, the very poor farmers feel sorting as a loss of the grains hence reduction of the product.

4.6 Storage maize

This section reporting the finding of storage maize in local practice before the project, farmers' knowledge about the recommendation and farmers' practice after the project.

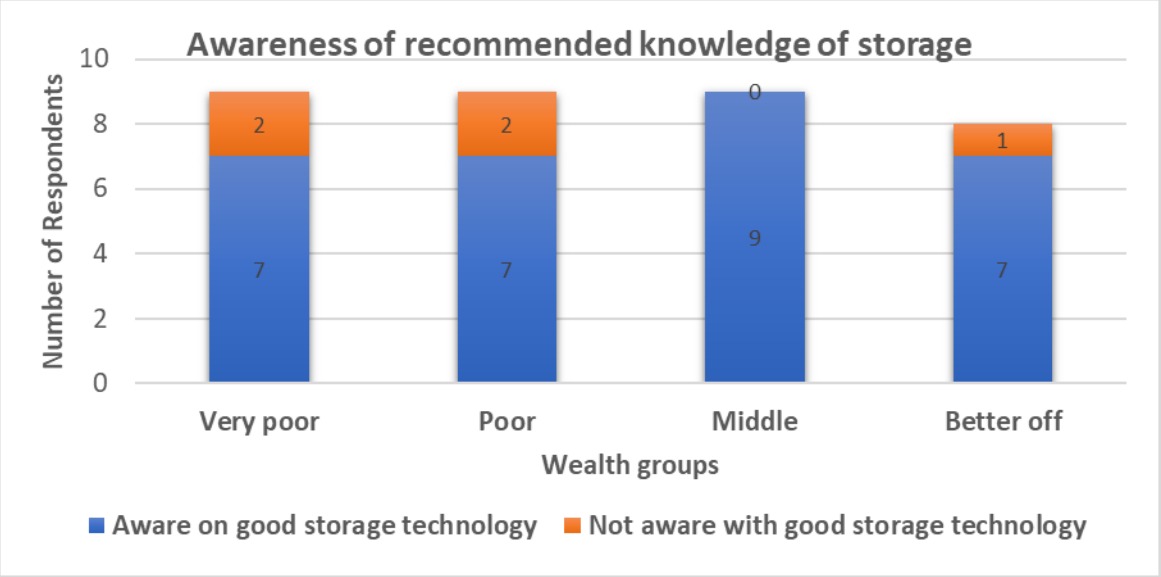
4.6.1 Storage maize; Local practice before the project

All the 35 respondents are reporting to store the maize using the plastic bags on the pallet against termites and moisture to the maize. It was a heritage from their elders. Other practices that the research was found done by farmers were the use of actellic super powder to control the grain borer pests that they got the skill to the Extension field officer and from Agro-dealers. Pallets the farmers use to prevent the termites from destroying the bags with maize.

4.6.2 Farmers knowledge about the recommendation

Out of 35 respondents, 30 respondents during the interview reported to be aware with the modern storage methods include the use of PICS bag and Metal silo. All they have informed the recommended knowledge during the meeting after the problem of aflatoxin. Among the 30 respondent that were told about post-harvest storage only 12 respondents begun to use it in the harvest of 2017. The figure below shows the farmers that were informed about the knowledge and farmers that were not informed of the knowledge.

Figure 8: Showing the awareness and not aware of the recommended knowledge of storage



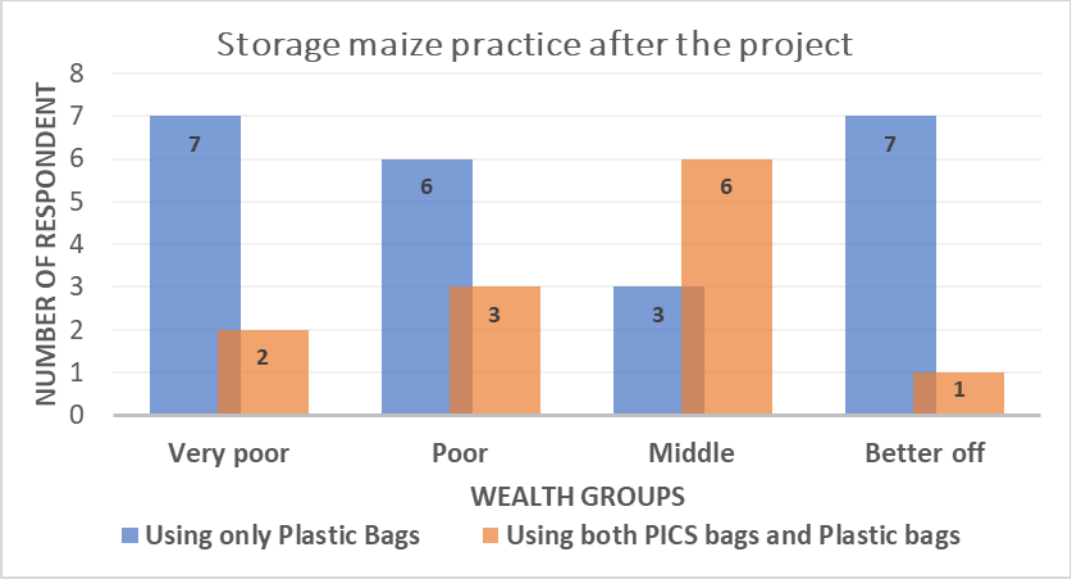
Source: Field data, (2018)

4.6.3 Storage maize; Farmers' practice after the project

Twelves (12) respondents reported storing grains for food using PICS bags and for selling using plastic bags while the 23 respondents were only using the plastic bags as shown in **figure 11**. The middle farmer's group were the highest group that use good storage technologies followed by the poor group. Their main house reported being used to store the bagged maize on the pallets. After the intervention project, a

farmer has begun the post-harvest practice of using PICS bags (Key informant from District, 2018). The figure below showing the farmers' practice in maize storage after the project.

Figure 9: Showing the maize grains storage



Source: Field data, (2018)

This finding revealed that all farmer uses the local practice of using plastic for storage their product except twelve (12) farmers who reported to use both with the recommended PICS bags for storage grains for food in 2017 harvest and plastic bags for selling. Though knowledge of the post-harvest show to be expensive, farmers have begun to use it (**figure 12**). In this results, middle farmers were doing better in adopting the recommended post-harvest method as shown in figure followed by poor farmers on using PICS bags for maize storage.

Figure 10: Picture showing the store of farmer who store maize using both PICS and plastic bags

Source: Field data, (2018)

4.6.4 Reasons for not using the recommendation storage techniques

Given the problems of aflatoxin, few farmers reported had used the modern post-harvest knowledge like the storage knowledge during the research period. Some of the reasons that hinder the farmers not to use the recommended storage post-harvest method were; low income to purchase the storage tools, lack of education about the knowledge, the respondents were reporting that the PICS bags and Metal silo are at a high price and are not available in a local market. All the farmer reported by saying that the local bags are available and cheaper TSH. 800-1000/= (EURO 0.3-0.4 sent), while the recommended bags are sold five times the local, is TSH 5000/= (EURO 2) and is not available as compared to local bags.

During the discussion interview with the key informants, the main reasons for the farmers not to adopt the recommended post-harvest knowledge for aflatoxin control included farmers' behaviour and attitude with the knowledge also other farmers are complaining that the PICS bags are not familiar to their area, low understanding of the knowledge and the knowledge is expensive.

4.7 Reason for using post-harvest knowledge

The table 4 below is the summary of the reasons why farmers are adopting the post-harvest knowledge.

Table 3: Table from the farmers showing the reason for using post-harvest knowledge

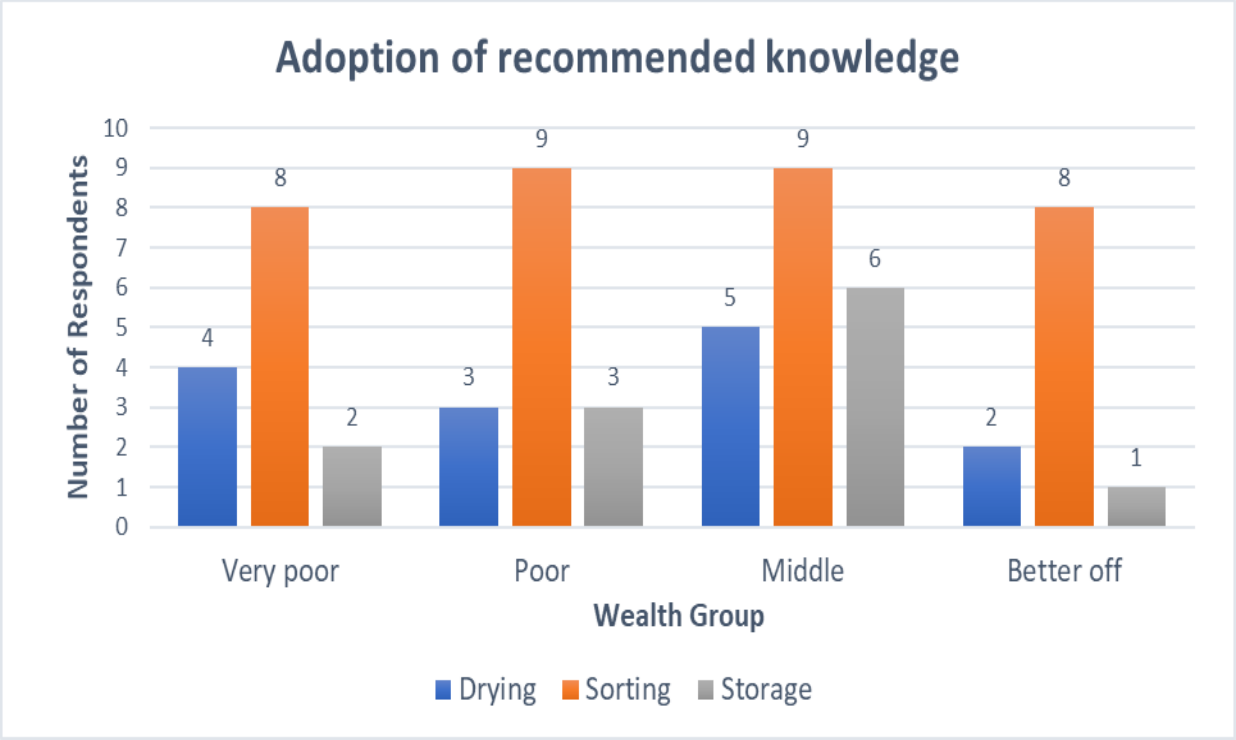
The practice of post-harvest technology	**Reasons**
Drying practice	*Dried cobs are the best hence is not easy to be affected by storage pest. Grains with high moisture content is easy to be attacked by mouldy.* *If grains are adequately dried you get good quality of food. Hence you avoid the moulds if the grain has a higher moisture content.* *The dried grain its weight and sound are different from the grain with moisture content.*
Sorting practice	*Through sorting you get quality seeds, you get assured about the food, and it will stay for a long time without pest destruction.* *Its importance because of avoiding the health diseases that result from aflatoxin, not good for health and it lowers the quality of grain if not sorted.*
Storage practice	*If you use PICS bags the food remains clean without chemical use; you avoid the cost of buying chemical and save the time of applying chemical every three months.* *PICS bags are the best for food security you can store food for three years without destruction by storage pests and hence solve the problems of food insecurity in the household.*

Source: Field data, (2018)

4.8 Adoption of recommended knowledge

The figure 10 below re showing the adoption of the recommendation knowledge were the middle the best while very poor, poor were doing similar and for the better off farmers were doing worse. High production, behaviour and poor attitude towards the knowledge could have the reasons for not doing better.

Figure 11: Showing the adoption of knowledge per group wealth



Source: Field data, (2018)

5 CHAPTER FIVE: DISCUSSION OF THE FINDINGS

The results of this research presented according to the characteristics of the project on disseminating the awareness raising of aflatoxin mitigation, drying maize, sorting maize and storage maize from the government project of aflatoxin mitigation using the recommended post-harvest methods as was shown on the conceptual framework in chapter 2. Therefore, below are the discussion on the effectiveness of government project in aflatoxin mitigation.

5.1 Characteristics of the project on disseminating of the knowledge of post-harvest to mitigate aflatoxin

The research found that different methods were used to make the farmers aware of the problem of aflatoxin to minimise aflatoxin in the food system. Awareness through Tv, radios, distribution of a warning letter to the for the farmers on using the post-harvest technologies including sorting, washing, drying and dehulling the grains when they want to process flour through the village executive officer (VEO) to street leaders to raise the awareness to the households. Visiting were made to the contaminated villages with different leaders from the National and District levels and communication with the leaders of the village on how to mitigate the problem.

Other methods were leaflets distribution during village meeting, demonstrate post-harvest knowledge and distributing sixteen dry cards per village for determining the grains if they are dried enough for storage in five villages. The respondents reported awareness on the using of proper postharvest methods that it was only once in May to June 2017 per village in ten villages that were not sufficient. This finding differs from PAEPARD, (2017) in Malawi who used a 15 minutes video documentary on awareness of aflatoxin for causes, risk, prevention and controls.

5.2 Drying maize

According to the result obtained on drying maize, if the farmers use the plastic sheet as the method of mitigating aflatoxin contamination through soil during drying. About 30 out of 35 respondents were informed on the importance of plastic sheets through the village meeting during the awareness raising of aflatoxins. Forty-seven (47%) or 14 out of 30 respondents reported using the plastic sheet and more than 53% in the research area farmers use the bare ground to dry their maize. This adoption, is high compared to a study of (Atukwase, Kaaya and Muyanja, 2009) in Uganda that was found drying maize in the bare ground was most practised by farmers in the mid-altitude (dry) zone (78.4%) and mid-altitude (moist) zone (64.1%). However, with the adoption majority of the farmers reporting drying on bare ground was the most common traditional practice of drying maize compared to sunflower crop in the research area. These could be the reasons why drying the maize on bare ground was positively associated with aflatoxin contamination. Although many farmers are aware of the use of plastic sheet for drying maize, the price of the plastic sheet could explain why the farmers use the bare ground to dry maize.

5.3 Sorting maize

Removing the mouldy and decayed cobs through a physical separation was public knowledge by both groups of farmers. Before the project (60%) or 21 of the respondents were practising sorting after the project 97% or 34 out of 35 farmers reported exercising sorting before they store and washing and dehulling during processing flour. This finding is revealed with the study (Fandohan *et al*., 2005) in Benin 91% of the sorted, winnowed and washed maize were observed, a high amount of aflatoxin was found the discarded mouldy and damaged grains during sorting as well as in the upper floating grains collected

during washing. Also, is similar with (Marechera and Ndwiga,2014) study that shows 78.6% of 280 respondents were able to identify fungal growth associated with aflatoxin contamination. These are an indication of the extent of the knowledge of the aflatoxin problem in the study area although in other districts in Tanzania is sorting is not common practice.

During the research, 3% of the respondent was not sorting their products this could be due the perception and attitude toward sorting that they reduce their yield and is time-consuming. Sorting and other good maize post-harvest practice should be advocated to minimise the exposure household to aflatoxin in Chemba district. Sorting maize before storage reduced the percentage of families with unacceptable exposures to 6% (Kimanya *et al*. 2009). Therefore, identification of aflatoxin-producing mould is thus a critical component to successful aflatoxin mitigation and yet the main concern is household level, awareness of aflatoxin and the risks associated with consumption contaminated grains (Jelliffe *et al*., 2016).

5.4 Storage maize

The most common methods of maize storage in the study area were found storage in plastic bags and PICS bags. The research found 30 or 85.7% of the 35 respondents they were aware of the PICS bags and only 5 reported not conscious with PICS bags. Out of 30 respondents, only 12 or 40% of 30 respondents were using the PICS bags to store maize. In response to aflatoxin mitigation measures, the respondents show that they understand the technologies of storage. Baoua *et al*., 2014 study was found that the lowest level of aflatoxins was found to be less contamination in PICS bags than those from Woven bags. Also, Njoroge *et al*, (2014) found that there was a 0%-2% weight loss in PICS bags compared to 36.3%-47.7% weight loss in Woven polypropylene bags. Among the respondent groups, the middle was the higher number of farmers that use the modern storage method followed by poor, very poor and better off as shown in **figure 11**. The high cost of the PICS bags and its unavailability in their local market could be the reasons for low percentage who are using the PICS bags.

All the respondents were using a pallet to prevent stored bags from wetness to avoid the aflatoxin-fungi generation. It is similar with Diao *et al.,* (2015) that preventing the increase of aflatoxin in the store is important to control the moisture content (m.c), temperature and the hygienic condition and inappropriate grain moisture content during storage can proceed to activate the aflatoxins fungi to generate. Also, the research found that farmers were using the actellic super powder against the problems of storage pest like large grain borer, such pests help create conditions conducive to aflatoxin contamination. This finding is contrary with farmers in Guinea that believed that they would incur additional expenses regarding the purchase of pesticides for controlling the pest that was the most common in their storage (Udoh, Cardwell and Ikotun, 2000). Therefore, Bankole and Adebanjo, (2003), Hell and Mutengi, (2011) conclude that essentially the stores are constructed to prevent insect and rodent attack and to prevent moisture from getting into the grains.

6 CHAPTER SIX: CONCLUSION AND RECOMMENDATION

This chapter presents the major conclusion and recommendation of this study based on the results from the previous chapter 4 on the effectiveness of Government project on mitigating the aflatoxin in maize. Aflatoxin mitigation in post-harvest maize as it is in the literature describing the proper drying, proper sorting and storage facilities. We can observe that awareness on the practice of recommended knowledge of post-harvest methods was high, while the practising that knowledge was 40% -47% below average for proper storage and drying except for sorting practising was high. This knowledge of post-harvest is essential for mitigating aflatoxin at the level of post-harvest. Therefore, based on the conclusion and the recommendations in this chapter are suggested.

6.1 Conclusion

Post-harvest knowledge is the most crucial stage to control the aflatoxin for farmers in Tanzania. In general, an intervention on post-harvest methods for the farmers in Chemba district was conducted after the occurrence of death people from eating the contaminated maize to reduce the problem of aflatoxin at a post-harvest level. The technical consultancy project was implemented in 2017 and has succeeded to some extent by achieving the outcome in farmers adopting the recommended post-harvest method.

6.1.1 Characteristics of the project and the way it carried out in Chemba district

The research found that the project was formed due to the outbreak of aflatoxin and help the households that were contaminated by aflatoxin problem. During the implementation of the project, it was recommending the proper post-harvest method for preventing the aflatoxin in maize. Postharvest management including proper drying, sorting and storage methods and using the pallet to avoid wetness in bags were hardly reduced the aflatoxin level in the study area. The research found that the project implemented in 10 villages out of 11 that were affected by aflatoxin contamination.

6.1.2 Farmers' practices on maize post-harvest before the project in Chemba district

The research found that before the project all the farmers that were drying maize on the bare ground. For the sorting, 14 respondents out of 35 were not sorting while 21 were sorting traditionally. Also, all the respondents were using the plastic bags for storage and using a pallet. All the three practice were found to be a traditional habit as they were a heritage to their elders. The research found the aflatoxin contamination of maize was associated with the postharvest practice as explained by the fact that maize drying, sorting and storage conditions were found to be more favourable for aflatoxin contamination.

6.1.3 Farmers' knowledge of the aflatoxin mitigation in maize post-harvest in Chemba district

The project was recommending the knowledge of using the plastic sheet for drying, sorting and using PICS bags and metal silo for storage on a pallet to prevent moisture. The research found 30 farmers were informed about the knowledge of drying maize using plastic sheets. 14 farmers were found to practice the recommended drying knowledge. For sorting after the project, 34 farmers out of 35 were exercising the recommended knowledge. In the knowledge of storage 30 farmers were informed and 12 farmers were practising the knowledge of using the PICS bags. The research found that 5 respondents lack the information due to the absence in the meeting. Proper drying, sorting and storage will reduce the aflatoxin to spread in maize during storage to the store and hence improve the quality of maize value chain

especially for farmers in the rural areas has provided a positive impact to a farmer who used it in the study area.

6.1.4 How was informed to farmers about aflatoxin mitigation in maize post-harvest knowledge in Chemba district

Generally, the study found that the farmers were told about the aflatoxin problems through awareness raising using advertisement to national TV and radio to all villages with aflatoxin problem that were highlighted by the Minister of Health this was done in August 2016. Also, from the District Executive Director (DED) a warning letter to farmers was distributed to Village Executive Officers (VEO) on post-harvest methods including sorting, washing and dehulling of grains before granting to flour. Last methods were villages meeting and leaflet distribution in the Swahili language this was done on May 2017. The first information about proper drying, sorting and storage were given to farmers through national TV and Radio, followed by visiting and distributing a warning letter to farmer via Village Executive Officers to the contaminated villages. A Mosque speaker was used to announce the meeting information on the place to be, and druma also was used in the street to make farmers aware of the meeting. Despite the methods that were used to inform the farmer on mitigating the aflatoxin. The respondents they realised that the methods used for dissemination of the knowledge on post-harvest were insufficient hence there is a need for the government to continue providing the awareness on the knowledge through the village meeting and using the groups that are existing in the village.

6.1.5 Reasons for using and not using the improved post-harvest knowledge

a) The research found that

The study found that farmers who are using the recommended knowledge of post-harvest method are most safe from being exposed to aflatoxin problems as reported in chapter 4 in the findings. The dried grains with sorted and stored well is the best way of mitigating the aflatoxin in post-harvest maize.

b) reasons for not using the improved post-harvest knowledge

Although a smaller number of farmers were reported to use the plastic sheets and PICS bags that are the proper methods for storage maize. Several reasons were given for not using the recommended knowledge of post-harvest maize the significant reasons were low income, behaviour and attitude of using the modern post-harvest methods. Time-consuming in sorting for the farmers with high production (richer farmers) and the majority of them feel sorting as a loss of the grains (very poor and poor farmers) hence reduction of the product were the reasons given by the farmers and key informants for those who don't sort their products. These indicate that awareness of aflatoxin mitigation should be continuous to promote the use of improved drying, sorting and storage methods though Extension field officers.

The research found, most farmers are using the traditional practice of post-harvest methods, during the discussion with farmers, they were a willingness to buy the PICS bags but the challenges that they were facing is the unavailability and high price of the PICS bags limit other farmers not to use it as they were comparing with the plastic bags that are cheap and highly available in their local markets. Such investment would have added benefit of helping to reduce the aflatoxin levels. The PICS bags have to be available as other plastic bags in their local markets for farmers to improve food security and income generation.

Generally, the research found the difference between the wealth groups. The middle farmer's group were found leading all the intervention methods of post-harvest technologies towards aflatoxin mitigation. While very poor and poor farmers were similarly doing better on adoption, the improved post-harvest methods and better off farmers were the last in adopting all the recommended post-harvest methods. Better off farmers were the latest in adoption in all practice of post-harvest methods, behaviour and poor attitude towards new technologies and high production could be the reasons for not using the recommended knowledge in post-harvest maize

6.2 Recommendations

The research found that post-harvest technology is to address the problems of aflatoxins contamination at households' level in Chemba district, based on the findings the following advice is suggested to the Ministry of Agriculture:

The research found the awareness raising in aflatoxin problems that, farmers were informed only once on TV, radio and village meeting for postharvest technologies and respondent reported that it was not sufficient. In this basis, it is recommended to the Ministry of Agriculture to increase awareness campaigns through village meetings, in the exhibitions on Farmers day and World food day, distribution of Swahili leaflets that will help the communities to be more aware and straightforward communication message to be provided to different stakeholders (Government and Non- Governmental) on aflatoxin management in maize. The message should put on emphasizing harvesting, adequate drying, safe moisture content, sorting on poor quality grain and grain cleaning and storage using the improved methods.

On drying maize, the research was found the majority of the farmers use the bare ground to dry maize only 40% of the informed farmed during the village meeting was reported to use the plastic sheet for drying maize. The farmer said the cost of the plastic sheet and there is a slight awareness of the use of excellent maize drying methods. Hence, it is recommended to the Ministry of Agriculture to provide the drying materials at a subsidise or affordable price to pull the farmer from the aflatoxins exposure and improve the food value chain.

The research also found the awareness intervention on how to identify and remove mouldy maize was the simple and effective method by hand sorting in maize production, therefore potentially reduce aflatoxin contamination in the food value chain. Since the result in sorting was found a significant high, it is recommended to the Ministry of Agriculture to continue promoting the importance of sorting maize at household level since in other districts in Tanzania is not common practice.

Another finding it was found that farmers are aware of the improved storage methods but the challenge was the PICS bags and metal silos were expensive and not available in the local markets. Therefore, its recommended to the Ministry of Agriculture that storage tools should be distributed in a subsidise as they do in inputs like fertiliser and seeds, to minimise the aflatoxin contamination at the household levels.

CHAPTER SEVEN: REFLECTION PAPER ON RESEARCH THESIS

The completion of my research proposal, gave me a skeleton of how to undergo my fieldwork in order to finish my thesis research. This is reflection of my personal growth as well as the research process l undertook in Chemba district, Tanzania with the objective of assessing the effectiveness of the government project to farmers knowledge and practice on aflatoxin mitigation. Findings would be used to provide recommendations to the Ministry of Agriculture to address the aflatoxin contamination of maize in Chemba district and disseminate the knowledge to other districts. This research data collection was done in the month of July 2018. I focused specifically on Chemba district to explore the information on aflatoxin mitigation in maize. First and foremost, I designed a strategy on how I was to collect the data during the interview process in a systematic manner. It was a new experience for me to conduct a research. The beginning of the research was quite challenging and I felt jittery over the course of time, my confidence grew and l was now competent in the art of probing. During the course of the data collection l was summarising my findings at end of day. This became my first stage of data analysis in the field. After completing my research, I come up with various findings on my research. It is from these findings and the research process itself that l writes this reflection.

During my research process, I had a challenge at the District level in getting permit for field work and I had to spend two days waiting for the District Executive Director to grant me permission for the data collection. As per my schedule, I was supposed to stay for just one day at the district and had also arranged a meeting with the village leader the following day. Due to the delay l encountered, l had to communicate with the village leader and apologise for not making it for my appointment as per our arrangement. This experience made me realise that one needs to be flexible in the field as different encounters arise that affect our set plans. In the field before starting interviews l got a household status list from the village in terms of household wealth with categories very poor, poor, middle and better off. The grouping was a measure for me to try understand which group has adopted the techniques on mitigating of the aflatoxin. Throughout the interview process, all of my audience targets were cooperative enough to speak with me in the Swahili language. The translation of my semi-structured interview questions from English into Swahili, also may influence the findings of this research as interpretation and translation sometimes differs.

On the other hand of being a researcher in conducting these interviews made me feel more confident during the data analysis and report writing. This experience made me know more about Chemba district because Tanzania has 186 districts. Talking and interacting with people made me draw a deeper connection with the community but also the issue at hand of “aflatoxin mitigation” using the improved post-harvest techniques. During field research interview I was very tactical in probing so as to fully get data that would allow me to answer my research question. To support my interview findings l would then after interview make observation on the farmer’s drying, sorting, storage practices and store conditions. The data l managed to collect was eye opening but at the same time adequate enough for me to make analysis to begin my analysis.

I used the respondents from the group of very poor, poor, middle and better off farmers to find out what the category of the group which are adopting the government intervention on mitigating the aflatoxin in maize. After the interview, some of the assumptions I had before the research were proven to be inaccurate such as category of better off households been the ones able to adopt better practices of the

intervention in the post-harvest management of aflatoxin mitigation in maize. Because of their wealth status, I was hoping they will buy the tools for post-harvest management of aflatoxin in maize and I found middle, very poor and poor farmers they were doing better in adopting the interventions. Having interviews with women farmers was a challenge because of religious beliefs. The religion in question doesn't allow for women to give interviews to man if not in the presence of the husband. For this reason, with women been at forefront of storage of food stocks, it may have affected my findings as most farmers interviewed are men. As a government worker, most farmers view our presence as get way to get assistance and for such a reason, information got might be compromised with farmers portraying different scenario than one experienced in anticipation of future benefits. My findings might also be different due to the period I collected the data, as it was one year later after the intervention was done. Due to the short time period, it might be that farmers are still fresh with the intervention received and possibility of determining impact is not yet significant.

I analysed the data using a qualitative approach through organising and coding themes of drying, sorting and storage practices. The data analysis was a difficult process for me to undergo considering the large amount of data I gathered in the field. The knowledge and practices of farmers in aflatoxin mitigation made sense to me as I got to hear more than I hoped. The information I got and what I had in mind before undergoing fieldwork, was totally different and it made me realise the importance of fieldwork in verifying desk study work. What one finds during desk study and on the ground might prove to be totally not in synchronise.

Finally, I did with my field research I felt if I had a chance to evaluate the project on the different group as the pathways of the interventions of post-harvest management of aflatoxin, I would say the project had an effective to very poor, poor and middle farmers. By observing the adoption of knowledge in proper drying, sorting and storage methods to the categories group have enabled me to draw a better conclusion on disseminating the knowledge to other districts. Now as a researcher if I had the chance in another field I found, I need to be specific on what I am writing to make the reader understand. To air this out, my supervisor during feedback session highlighted to me on use of the term 'plastic bag' in one sentence and for the same item term it as 'otherbags' in other sentences. This made me realise the importance of not making assumptions of reader understanding what I am wirting. Also, I felt like I missed some information from the respondents because I didn't include the question of the level of formal education. I should have made a comparison if education has a influence on adopting the intervention.

On a personal growth perspective, this program as a whole has managed to improve my English communication skills both writing and speaking tremendously. One of my objectives at beginning of this program was to enable my presentation skills, to which I grabbed any opportunity presented to me during group works and the feedback I got from peers is I have improved. In the beginning I had stage scare but over the course of the year, I was confident enough, and this is also because of the manner in which the program is taught in a more practical way. My professionalism in the field of food security has increased I am confident enough to go back home to a change agent within my organisation. I have come to value to value stakeholder consultation as well as participation of beneficiaries in every project, a thing I previously did not take much account of. In as much as I thought I knew interviewing process, the program has also made me into a real professional on understanding all the ethics involved. To single out a module as an example, the leadership and communication for change, greatly made me aware of my pitfalls and strength when it comes to both work and personal environment. Therefore, this research was relevant to my course and linked to my professional environment in Rural Development and Food Security.

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ANNEXES

Annex 1. Semi-structure interview guide for farmers

Section A: General information of the farmer

1. Village name…….
2. Age……
3. Gender…….
4. Wealth group…….
5. What is the yield of last season of maize production…….

Section B: Post- harvest practices

Recommendations	**Practice**	**Checklist questions**
Drying maize	Local practice	In the last three year were you drying maize after harvest?
		…… …….
	Recommended practice	How did you dry maize last year?
		…… …….
		Why do you dry maize produce after harvest before storage?
		…… …….
	How	To whom provide you with the knowledge?
		…… …….
		In which form of maize, you dry, cobs or shelled?
		…… …….
		Where do you dry it?
		…… …….
		When is grain dry enough for storage?
		…… …….
	Reason for using	Explain why you are doing such practice
		…… …….
	Stopped using	Explain why you stopped practising the good recommended post-harvest technologies
		…… …….
	Reason for not using	Explain why you are not practising the recommended practice

		…… ……
Sorting	Local practice	In the last three years how sorting was done?
		…… …….
	Recommended practice	How do you sort grain?
		…… …….
	How	How did you know the importance of sorting?
		…… …….
	Reason for using	What is the importance of sorting?
		…… …….
	Stopped using	Explain why you stopped sorting maize?
		…… …….
	Reason for not using	What factor that limits you in the practice of sorting maize before storage?
		…… …….
Storage	Local practice	How did you store maize in the last three years?
		…… …….
		Which practice were you using in the last three year?
	Recommendation practice	Which types of store do you have?
		…… …….
		Do you use traditional or modern storage of maize produce?
		…… …….
		What types of storage bags are you using?
		…… …….
		How do you aware about PICS bags/Metal silo?
		…… …….
		How do you prepare the store before other storage?
		…… …….

		How do you protect bag/ PICS bags/ Metal silo against wet in the store?
		…… …….
	How	Where did you get the skill of using PICS bags/ metal silo?
		…… …….
		Where did you get the skills of controlling pest in maize?
		…… …….
	Reason for using	Why are you using bags/PICS bags/ metal silo
		…… …….
	Stopped using	Why did you stop using the PICS bags?
		…… …….
	Reason for not using	Why not using the modern ways /practices of maize storage?
		…… …….
What are the factors that limit you not to use the post-harvest technologies? …… …….		

Thank you for your contribution

Annex 2. Semi-structure interview guide for key informants

Village…….....

Name…… Title…….

Phone No…….

Sub research question	**Checklist**
What are the characteristics of the programme and how was it carried out in practice?	What was the purpose of the programme in this village?
	…… …….
	How was the programme operated?
	…… …….
	What method did you use to make awareness to farmers on aflatoxin problem?
	…… …….
	How did the programme inform farmers about the practice of post-harvest technologies?

	…… ……
What is the farmer's knowledge of aflatoxin mitigation in maize post-harvest?	What is the farmer's knowledge/practices of using post-harvest handling technologies?
	…… ……
	What practices are needed for in post-harvest handling to mitigate the aflatoxin contamination to farmers in maize?
	…… ……
	What do you think is the most difficult stage to farmers in post-harvest handling technologies that lead to the aflatoxin contamination?
	…… ……
	Which are the best methods do you think in disseminating maize post-harvest technologies to the farmer?
	…… ……
What did they do in the past on post-harvest?	Before the programme, what were the farmer's practices after harvest? In term of *Drying, ……* *Sorting and ……* *Storage……*
Reasons for drying maize after harvest	Explain how the farmer dry their produce after harvest since the programme of aflatoxin?
	…… ……
Reasons for farmers who stopped drying practice	What are the reasons for the farmers who stopped to dry their maize after harvest
	…… ……
Reasons for farmers not drying at all	What are the reasons for the farmers who are not drying their maize
	…… ……
	What are the factors that limit farmers from drying maize?
	…… ……

Reason for sorting	Explain why farmers sort their maize before storage?
	…… ……..
Reason for stopping sorting	Why has farmer stopped sorting maize before storage?
	…… ……..
Reason for not sorting maize before storage	Why does farmer not practice sorting before storage?
	…… ……..
	What are the factors that limit farmers from sorting their maize before storage?
	…… ……..
Reason for storage maize	Explain how farmers store their maize
	…… ……..
Reason for farmers who stopped using the PICS bags/ metal silo	Why farmers are stopped using the PICS bags/ metal silo for maize storage
	…… ……..
Reasons for farmers who are not using the recommended storage practice?	What are the factors that limit farmers to use the recommended storage technologies to mitigate aflatoxin?
	…… ……..

Thank you for contribution

Annex 3. Observation checklist

1. Post-harvest management practices which facilities are used
   a. During drying
   b. During storage

Annex 4. Informed Consent

My name is Abas Alfa Kambo
I am currently a Master student at Van Hall Larenstein University of Applied Science in the Netherlands. You are being asked to participate in a study on assessing the effectiveness of the government project on mitigating aflatoxin in mitigation on maize in Tanzania: a case study of Chemba district in Dodoma region. You are selected as a staff who participated during the implementation of the project.

The information given for me will be confidential and I am the only who will use it for academic purposes in fulfilment of a master degree in management of development with specialization of rural development and food security.

Your decision to participate the interview is voluntary, and during the interview you are free to withdraw it at any point without any problem. The information you provide will be kept strictly and confidential. If you have any questions about the study, please do not hesitate to contact us, either by email or phone. kamboabas13@gmail.com +255756916906

Consent
Your name and signature below indicate that you have to volunteer as a research participant.
Name of the respondent……. Signature……..
Date…….

Annex 5. Swahili Project Leaflet

Leaflet that was distributed during the project

IITA
Research to Nourish Africa

Ukweli kuhusu sumu kuvu

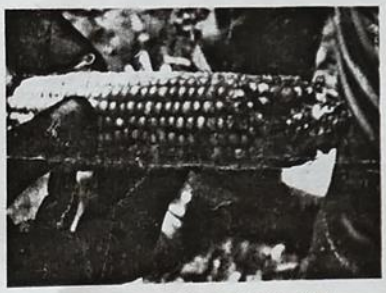
Sumu kuvu ni sumu zitolewazo na aina ya ukungu kuvu (fangasi) unaoota kwenye mbegu za nafaka na jamii ya kunde, mazao ya mizizi, karanga, vyakula na malisho ya wanyama vikiwa shambani au kwenye ghala. Ingawa aina nyingi za kuvu zinaweza kuota na kukua katika vyakula hivi, ni wachache tu amabao hutoa sumu kuvu. Endapo vayakula anavyokula binadamu au mnyama vina sumu kuvu nyingi afya zao hudhurika kwa kiwango cha juu. Sumu kuvu haionekani kwa macho, haina harufu, haina kionjo, wala rangi, lakini kuvu anayetoa sumu hizo anaweza kuwa na rangi ya kijani, chungwa, kijivu au njano chafu na anaweza kutoa harufu ya uvundo. Karibia asilimia 25 ya vyakula ulimwenguni vina maambukizi ya sumu kuvu na watu bilioni 2.5 wako katika hatari ya kudhurika. Kuvu wanaotoa sumu hii hustawi ikiwa mazao yamekumbwa na ukame yakiwa shambani au kushambuliwa na wadudu waharibifu, na kwenye ghala ikiwa joto na unyevu viko katika kiwango cha juu.

Hatari zitokanazo na sumu kuvu

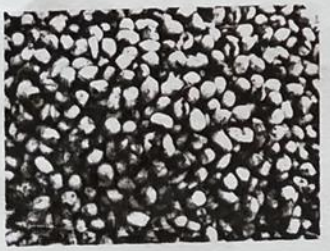
Kama chakula au kinywaji chenye sumu kuvu kitatumiwa na binadamu au mnyama ataugua kwa kutegemea na kiasi cha sumu kuvu kilichomo. Vyakula ambavyo vinaweza kuambukizwa sumu kuvu ni kama vile mahindi na unga wake, karanga na mazao yanayotokana na karanga, muhogo, nyama, mayai na maziwa (vitokanavyo na mnyama au ndege aliyeambukizwa pamoja na mazao yao) na vyakula vya mifugo (vyenye mbegu zilizoambukizwa au nyasi au vyaluka vya mifugo vya kutengenezwa). Saratani, hasa ya ini, kushusha kinga ya mwili, kudumaa hasa kwa watoto, sumu kwenye figo na vifo kwa binadamu na wanyama ikiwa viwango vya sumu kuvu ni vikubwa. Baadhi ya sumu kuvu hutoka kwa mama kwenda kwa mtoto akiwa bado tumboni. Kutokana na madhara ya afya yanayosababishwa na sumu kuvu kwa binadamu na wanyama sumu kuvu haziruhusiwi kuwepo katika mazao yaliyokusudiwa kwa biashara na kama zikigunduliwa katika mazao ya kilimo hayatauzika na badala yake yatateketezwa. Kwa kiwango kikubwa sumu kuvu huathiri biashara, faida na afya za wazalishaji.

Njia za kudhibiti maambukizi ya sumu kuvu

- Lima aina za mazao zenye ukinzani dhidi ya kuvu wanaotoa sumu kuvu (kama aina hizo zinapatikana)
- Vuna mazao yakiwa yamekauka vizuri kama inavyoshauriwa na bwana/bibi shamba na epuka kutia majeraha kwenye mazao yako
- Usianike mazao yako kwenye udongo mtupu. Anika sehemu iliyoinuka kama meza na utumie turubai au aina nyingine ya kifaa cha kuanikia
- Wakati na baada ya kuvuna tupa mbegu au mazao yaliyooza
- Hifadhi mazao mahali pakavu na pasipo na joto. Hakikisha mazao yaliyohifadhiwa hayalowi
- Ghala liruhusu mzunguko wa hewa, zuia wadudu waharibifu na kuvu kwa kunyunyiza madawa yaliyokubalika na kushauriwa
- Kama yanapatikana, tumia madawa ya kibayologia kama vile AflaSafe™ (aina ya kuvu ambaye hukinzana na yule atoaye sumu kuvu)
- Tumia madawa yanayodhibiti na kuondoa sumu kuvu wakati wa usindikaji wa vyakula vya binadamu na vile vya wanyama



Mahindi yaliyoshambuliwa na kuvu wa sumu kuvu



Karanga zilizoshambuliwa na kuvu wa sumukuvu

Ndege waliokuzwa na vyakula vyenye maambukizi ya sumu kuvu

Kwa taarifa zaidi wasiliana na Simon Boniface b.simon@cgiar.org au Fen Beed f.beed@cgiar.org wa IITA

Annex 6. Field Photos

Reseacher and respondent looking for Drying sheet

Researcher and respondent showing the PICS bags