Influence of Selected Information Sources on Knowledge and Skills in Prevention of Aflatoxin Contamination among Smallholder Maize Farmers in Kitui West Sub-County, Kenya

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Abstract: Aflatoxin is a worldwide problem with a tendency to be more common in countries with tropical climate that have extreme ranges of rainfall, temperature and humidity, including tropical West African countries, South Western USA and India. Outbreaks of acute aflatoxins in Kenya occurred in 2004 and 2006, which caused deaths of about 200 people. In 2014, 14,500 tonnes of maize were found to be unfit for consumption in Kenya as they were infected with aflatoxin. The Kenyan Government has made efforts to reduce aflatoxin contamination on maize by creating awareness among farmers through extension officers. The farmers are therefore expected to have the knowledge and skills to prevent aflatoxin contamination, but despite this, the aflatoxin problem seems to persist. This study aimed at determining the influence of selected information sources on knowledge and skills in prevention of aflatoxin contamination in maize among smallholder farmers' in Kitui West Sub- County, Kenya. The study employed a cross-sectional survey design. The target population was 19,970 smallholder maize farmers and the estimated sample size was 202 using Cochran 1963 formula at 0.7 level of significance. Proportionate clustered random sampling was used to select respondents from every ward in order to ensure reasonable representation of the population. The Sub County has four wards namely Mutonguni, Kauwi, Kwamutonga/Kithumula and Matinyani, where these wards are different in that two are in low lands while two are in high lands. Researcher administered questionnaire was used to obtain data from the farmers. The collected data will be managed with computer program Statistical Package for Social Science (SPSS Version 21.0). The results will be presented by use of graphs, tables, percentages and frequencies. The findings of the study may help government agricultural officials, extensionists, policy makers and farmers to improve ways of preventing the aflatoxin contamination problem in maize.

Key Words: Aflatoxin, ICT, Information Source**,** Other farmers, Post-Harvest Practices, Private Extensions agents, Public Extension agents, Pre-Harvest Practices,

INTRODUCTION

In the world, maize remains as one of the major food crops produced and used as human food and livestock feed (Food and Agriculture Organization FAO, 2011). In Kenya, it remains as one of the staple food and an important crop in agriculture sector and this contributes immensely in the Kenyan economy (Kenya Economy Survey, 2017). It provides food to majority of Kenyans especially in the rural areas, where an estimate of about 80% of Kenya's population is dependent on agriculture (Otieno, 2013). However, one of the major food safety hazard associated with maize is from aflatoxins that are produced by many species of fungi, which contaminate maize during pre and post-harvest periods (Kang'ethe, 2010).

Major outbreaks have been seen in Taiwan, India and Malaysia (Herriman, 2016). In Africa, especially Sub-Saharan Africa which has ideal conditions that encourage aflatoxins, the contaminations have been reported in a number of countries. In Nigeria, aflatoxin

contaminated up to 65% of maize and groundnuts in 2011 (International Institute of Tropical Agriculture (IITA), 2017). In East Africa countries aflatoxin was reported in countries like Uganda where crops like maize, sorghum, peanuts, sesame, cassava and sunflower were affected by aflatoxin. The cause and proliferation of aflatoxin in Uganda was largely due to poor pre and post-harvest practices, poor government legislation, lack of awareness and low level of education of farmers. It was reported that 3700 cases of cancer were associated with aflatoxin exposure in Uganda (Omara, 2020). Aflatoxins have become a threat to food security in Kenya where in 2010, about 2.3 million bags of maize was declared unfit for human and livestock consumption and trade, reducing the reserve of the staple cereal even as some farmers lost their livelihoods. In 2014, 14,500 tonnes of maize were found to be unfit for consumption as they were infected with aflatoxin (Omondi, 2019).

Aflatoxins are types of mycotoxins produced by *Aspergillus* species of fungi such as *A. Flavus* and *A. parasiticus* (World Health Organization, 2018). They are contaminants of foods intended for people or animals as a result of fungal contamination. The most common foods implicated are cereals like maize, wheat and rice, oilseeds like peanuts and sunflower (Herriman, 2016). Aflatoxin contamination in maize occurs above safe levels in many African countries where in Kenya the safety levels are 10 Ppb (FAO, 2011). It is higher than the European Union, where aflatoxin standard is 4 Ppb. However, even aflatoxin exposure at low levels can result in measurable human health impacts (Partnership for Aflatoxin Control in Africa- PACA, 2012). Contamination of food supplies by these and other naturally occurring toxins is of particular concern in rural communities of developing countries (Bhat, Shetty, Amruth & Sudersham, 2011).

The Kenyan Government has equipped the extension officers on aflatoxin contamination. It is the responsibility of Agricultural Extension Officers provide the information on aflatoxin to the farmers (Asian Development Bank -ADB, 2014). Apart from extension agents Farmers also receive information from various other sources, especially mass media such as radio, TV, and newspapers. According to findings by Walker (2013), 60 percent of farmers in Makueni indicated that they heard about aflatoxins from the extension officers, while 67 percent of those in North Rift and 50 percent in Meru reported receiving their information from the media. The level of awareness of aflatoxins and other fungal toxins is affected by various socioeconomic characteristics like gender, income and education level. For instance, in Kenya, women were more informed on danger of fungal toxins and were more cautious to mouldy feeds than men (Kiama, Lindahl & Sirma, 2016).

Good agronomic practices reduce aflatoxin contamination in the field (IITA, 2017). The farmers who know about aflatoxins say it's due to high humidity, temperature and rainfall as well as poor soils, poor storage practices, drought stress, contaminated seeds, and delayed harvesting (Udomkun, Wassen, Nbahungu, Mutegi, Vanlauwe, & Bandyopadhyay, 2018). Aflatoxin contamination is attributed to inappropriate storage practices like lack of drying facilities in the country and a wide range of environmental conditions, such as high temperature and humidity as well as oxygen, which can trigger further increases in contamination (Kamika, Ngbolua & Tekere, 2016). Moreover, contamination usually increases during storage, thus if samples are taken after undergoing some storage time in markets, the values obtained were likely to be higher than others obtained before storage (Bankole, Schollenberger, & Drochner, 2006).

Farmers need to integrate variety selection, good agronomic practices, timely planting, weeding and irrigation since these influence contamination of maize. During harvesting, if the farmers throw maize on the ground as they remove the cobs from the husks and later pick up for storage before shelling, this practice exposes the maize cobs to fungal spores in the soil and increases the risk of aflatoxin contamination (Mureithi, Muthomi, Chemining, Gathumbi, & Mutitu, 2010). Timing of the harvesting for when the maize is mature and dry is critical in helping reduce the moisture levels and therefore the fungal growth and aflatoxin production rates (Mureithi et al., 2010). Post-harvest strategies begin before harvest and further drying is necessary until the crop is put in store (Turner et al., 2009). Threshing, shelling and winnowing should be done carefully to avoid damaged grains. Farmers should avoid

beating the crop with sticks which result in grain damage, eventually leading to mould development unless the grain is to be used quickly and not stored (FAO, 2011).

A previous study on causes of aflatoxin conducted in Kitui County shows that poor agronomic practices contribute much to attack of maize by aflatoxin. (Nyakundi, 2014). A study by Wanjiku (2010) identifies environmental factors and poor post-harvest practices as key issues encouraging aflatoxin contamination. However few studies if any, on the influence of selected information sources on knowledge and skills in prevention of aflatoxin contamination in maize among smallholder farmers' in Kitui West Sub- County, Kenya. This explains why this study would like to find out the influence of selected information sources on knowledge and skills in prevention of aflatoxin contamination in maize among smallholder farmers' in Kitui West Sub- County, Kenya. It is clear then that, despite the fact that farmers have the knowledge and skills about aflatoxin, the presence of aflatoxin contaminated maize indicates that there exist other underlying issues causing spread of aflatoxins. This is a gap this study tries to identify in Kitui West Sub County.

METHODOLOGY

The study was conducted in Kitui West Sub County, which is expansive Sub County in Kitui County with an area of 667 square kilometers of which 554 square kilometers being agriculturally potential and 113 square kilometers being uninhabited/ arable land. The altitude ranges from 800m to 1400m above sea level. The amount of rainfall ranges from 400-800mm with 60% reliability. Temperature ranges from 18 -33 degree centigrade. Soils in the area range from sandy clay to clay with top soils of sandy loam (Kitui West SCAO, 2019). The area was selected because despite of producing good maize harvest, it has faced a challenge of aflatoxin attack raising a lot of concern from the government. It is divided in four wards where two (Mutonguni with area size of 158 km^2 and Matinyani with 72km^2) are in upland area while the other two (Kauwi has area size of 245$km^2$and while Kwamutonga/Kithumula has 192 km^2) are in lowland area. It receives relatively high rainfall than the lowland. The area has two planting seasons with family members being the major source of labour force with limited hired casuals during peak periods. Mixed farming is the major system of farming, with less than five cattle, few goats or sheep and poultry keeping. Farmers in the upland area engage in agricultural activities like planting mainly maize, beans, cow peas sugarcane, cassava and trees like blue gum, cypress and wattle used to produce timber and poles. The population of Kitui West Sub County is 141,334 people while the number of farm households is 19,970 (KNBS, 2017). The target population for this study will be the smallholder maize farmers in the 19,970 farm households in Kitui West Sub County. The population of farmers as per ward includes: Mutonguni which has 6431 farmers, Kauwi with 3788 farmers, Matinyani having 5327 farmers while Kwamutonga-Kithumula has 4424 farmers. The target population involves small holder farmers who often cultivate less than two hectares of land. They produce food for their household and a little for the local market due to the poor resources available to them, especially capital. The study will employ a cross-sectional survey design. This design involves looking at people who differ on one key characteristic at one specific point in time. Cross-sectional studies are usually relatively inexpensive and allow researchers to collect a great deal of information quite quickly. Data is often obtained using self-report surveys and researchers are then able to collect a lot of information from a large pool of participants (Cherry, 2019).

Proportionate clustered random sampling was used. In this method the probability of selecting samples is proportional to its population size, so that a larger cluster has a greater probability of selection of more farmers than a smaller cluster. Each ward was considered as a cluster where samples were picked according to its size of population that was used in this study, because they differ in agro-ecological characteristics as well as accessibility, this gave a sample of 202 respondents

The Sampling frame was established using information from the Sub County Agricultural Office. Proportionate clustered random sampling was the most appropriate to select respondents from every location in order to ensure reasonable representation of population. For every ward, a random sampling was done to obtain the farmers for the researcher to administer questionnaire. The

researcher administered questionnaire to the small holder maize farmers. To ensure proper ethics are followed the researcher followed the data collection tools and ensured confidentiality to the farmers was guaranteed. It was also assured by providing authorization provided by the university, National Commission for Science Technology and Innovation and by the County Agriculture office. After data collection, the data was coded and entered in a computer and data managed with Statistical Package for Social Science (SPSS) computer program (SPSS Version 21.0).

RESULTS AND DISCUSSION

Farmer's Source of Knowledge and Skills on Aflatoxin Attack

A good number of farmers receive information about aflatoxin as inherited knowledge, from agricultural extension workers, radio/tv and from friends. Inherited knowledge in this case meant practices or knowledge that are perpetuated within the household from one generation to the next. The category others referred to sources of information such as agricultural meetings or agriculture fairs and from Non-Governmental Organizations (NGOs') (Wanjiku, Kumwenda, Zulu, & Munthali, 2021). According to findings by Walker (2013), 60 percent of farmers in Makueni indicated that they heard about aflatoxins from the extension officers, while 67 percent of those in North Rift and 50 percent in Meru reported receiving their information from the media.

Sources of Knowledge on Agriculture

Information sources are various means by which information is passed to create awareness, increase the knowledge of the user, to reduce his level of uncertainty or reduce the varieties of choices available to the users of information. For information to be effective, it must be accurate, timely and relevant. Sources of information about agriculture activities are: radio, television, extension workers, cooperative societies, friends and colleagues, newspapers and magazines, books/leaflets, phones, libraries and institutes. (Adio, Abu, Sheriff & Nansoh 2016). The table below shows selected information sources used by Kitui West Sub-County to obtain information about agriculture.

Table 1: Farmer's Information Source on Agricultural Activities

Information Source	Farmers Obtaining Information		Farmers who do not obtain Information	
	Frequency	Percentage	Frequency	Percentage
Public Extension Officers	96	47.5	106	52.5
Private Extension Agents	91	45	111	55
Other Farmers	176	87.7	26	12.9
ICT(Radio, TV, Internet)	163	80.7	39	19.3

Farmers who obtain agriculture information from public extension officers accounted for 47.5% while those who do not had 52.5 %. Those who receive information from private extension agents were 45% as 55% did not. From others farmers 87.7% obtained information compared to 1.9% who do not, while 80.7% obtained information from ICT(Radio, TV, Internet) as 19.3% do not. Famers do not greatly obtain information from Public and Private extension officers due the government policy that the supply of extension services be demand driven, requiring that farmers must request the services they want from the government officers, this idea keeps off most farmers from the extension officers and again as very few extension officers are present to man the areas (Ministry of Agriculture, 2011). Radio is a very familiar source of information since the local radio stations have programs sponsored by firms selling agricultural inputs. In these programs farmers are allowed to call in and ask questions on the challenges they face on

farming. Other farmers are also a common source of information because the farmers had merry-go-rounds where farmers meet and exchange information and experiences about agriculture.

Access to Public Extension Office

Table 2: Access to Public extension service

Distance from Public extension office	Frequency	Percent
Within 1 km	21	10.4
Within 2 km	62	30.7
Beyond 2 km	119	58.9
Total	202	100.0

It was noted that 58.9% of the farmers were beyond 2 kilometres from ward extension offices while 30.7% were within 2 kilometers and 10.4% of the interviewed farmers were within 1 kilometer.

According to studies by Yazan, Nyariki, Wasonga, and Ekaya, (2012) access to extension services showed positive and significant influence on the per capita daily income and that the households with access to technical advice and information realized higher production and more income than those that did not access extension services.

Sources of Knowledge on About Aflatoxin

Table 3: Various Sources of Information about Aflatoxin

Source of Information	Frequency	Percentage
Public Extension Officer	96	46
Private Extension Officers, NGO's, Churches, Agro-Vet	90	44.6
Other Farmers	150	74.3
ICT (Radio/TV/Internet	155	76.7

The table above shows how various farmers obtained information about aflatoxin. Where 46% of respondents received information from public extension officers, 44.6% received information from private extension officers, NGO's, churches and agrovet while 74.3% got information from the other farmers while 76.7% received information from ICT (Radio, TV, Internet). This is attributed to the popularity of the local radio stations which have influenced the locals it the type of information they receive and the actions they take on daily lives. These farmers are able to share the information with other farmers in their daily interactions explaining why others farmers also have a high percentage as source of information.

Pre- harvest Practices Preventing Aflatoxin Contamination

Table 4: Pre-harvest Practices Farmers belief can Prevent Aflatoxin Contamination

Pre-harvest practices	Frequency	Percentage
Early land preparation	60	29.7
Early planting	59	29.2
Early weeding	59	29.2
Crop rotation	64	31.7
Approved maize variety	76	37.6

The study sought to know whether farmers belief whether pre harvest practices prevent aflatoxin contamination. Among the respondents 29.7% belief early land preparation can prevent aflatoxin contamination while 29.2 % of respondents belief early planting and weeding can prevent aflatoxin contamination. Those who belief crop rotation can prevent aflatoxin where 31.7% as 37.6% believed buying approved maize variety can prevent. Many farmers could not associate pre harvest practices with aflatoxin contamination since they belief maize is affected by aflatoxin after harvest and poor handling of maize after harvesting.

Post- harvest Practices Preventing Aflatoxin Contamination

Table 5: Post-harvest Practices Farmers belief can Prevent Aflatoxin Contamination

Post-harvest Practices	Frequency	Percentage
Timely harvesting	174	86.1
Proper drying	180	89.1
Drying maize on canvas	166	82.2
Sorting maize before storage	179	88.6
Good storage facility	174	86.1
Moisture testing	146	72.3

Timely harvesting and Good storage facility had 86.1% each of respondents believing can prevent aflatoxin contamination while proper drying had the highest percentage of 89.1 having the belief that it can prevent aflatoxin contamination. Drying maize on canvas had 82.2%, sorting maize before storage had 88.6%, of the respondents as moisture testing had the lowest percentage of 72.3.

Farmers can easily associate proper handling post- harvest practices with the prevention of aflatoxin contamination, this could be due to the fact that the farmers can see the maize and see effects of maize exposure to moisture.

Source of Knowledge on Pre-harvest Practices

Table 6: Source of Knowledge on Pre-harvest Practices

Information Source	Frequency	Percent
Public extension	44	21.8
Private extension,ngo,church,agrovet	42	20.8
Other farmers	62	30.7
ICT(Radio,TV,Internet)	54	26.7
Total	202	100.0

Table 6 shows the various sources in which farmers receive knowledge on the pre-harvest practices. Respondents who have received knowledge from public extension officers accounted for 21.8% while 20.8% obtained knowledge from private extension, NGO's, church or agrovet. Majority of the respondents (30.7%) received knowledge from other farmers while 26.8% obtained information from ICT (Radio, TV, Internet).

Source of Knowledge on Post-harvest Practices

Kumar, Kalita, & Smith. (2017). indicated that more than one-third of food is lost every year in the postharvest operations. In Ethiopia, data on losses at different stages in the postharvest system are limited. (Mohammed, A. & Tadesse, A. (2018)

Table 7*:* Source of Knowledge on Post-harvest Practices

Information Source	Frequency	Percent
Public extension	33	16.3
Private extension,ngo,church,agrovet	36	17.8
Other farmers	88	43.6
ICT(Radio,TV,Internet)	45	22.3
Total	202	100.0

Table 7 shows the various sources in which farmers receive knowledge on the post-harvest practices. 16.3% of the respondents receive knowledge from public extension officers while 17.8% obtained knowledge from private extension, NGO's, church or agrovet. Majority of the respondents which was 43.6% received knowledge from other farmers while 22.8% obtained information from ICT (Radio, TV, Internet).

Source of Skills on Pre-harvest Practices

Table 8: Source of Skills on Pre-harvest Practices

Information Source	Frequency	Percent
Public extension	37	18.3
Private extension,ngo,church,agrovet	37	18.3
Other farmers	82	40.6
ICT(Radio,TV,Internet)	46	22.8
Total	202	100.0

The results in Table 8 show that only 18.3 percent of the farmers acquired skills from both public extension and private extension, NGO's, Church and agrovets skills. Acquisition of skills is highest from other farmers at 40.6 percent while from ICT (radio, TV, Internet) is at 22.8 percent. Farmers normally have merry-go-round meetings which facilitate resolving of members problems, sharing of ideas and building of trust amongst members. Through these meetings farmers are able to discuss among other issues the problem of aflatoxin once a case is reported. Nguyen (2002) asserts that regular group meetings that involve everybody to provide information and solve members' problems are important to the sustainability of farmers.

Source of Skills on Post-harvest Practices

Table 9: Source of Skills on Post-harvest Practices

Source of information	Frequency	Percent
Public extension	41	20.3
Private extension,ngo,church,agrovet	28	13.9
Other farmers	66	32.7
ICT(Radio,TV,Internet)	67	33.2
Total	202	100.0

The farmers were asked ways by which they obtain skills on post-harvest practices. The results were as presented in Table 9. Most of the respondents (33.2 percent) gave priority to ICT (radio, TV, Internet) followed closely by 32.7 percent who said obtained information from other farmers. Source of skills from public accounted

for 20.3 percent while 13.9 percent received skills from private extension, NGO's, church and agrovet.

CONCLUSION

It was concluded that from the existing sources of information about aflatoxin prevention, ICT (radio, TV, Internet) was strongly ranked by farmers especially local radio stations *(Athiani FM, Mbaitu FM and County FM)* to obtain any new knowledge about agriculture including information on aflatoxin. These stations have programs paid for by seed and Agro-based companies where vital information is given to the farmers through these programs. The women also had women groups called *Mukilye* where they meet to do

merry go rounds as well as discussing issues affecting then agriculture being one of them. This explains why other farmers ranked second source of information about aflatoxin. Famers do not greatly obtain information from Public and Private extension officers due the government policy that the supply of extension services be demand driven, requiring that farmers must request the services they want from the government extension officers, this idea keeps off most farmers from the extension officers and again as very few extension officers are present to man the areas (Ministry of Agriculture, 2011)

RECOMMENDATION

On basis of the results and conclusion from the study the following recommendations were forwarded.

1. The government should to change the policy that services of extension services be demand driven requiring farmers must request for services but also initiate programs to involve farmers in extension work.
2. Increased funding on the public extension officers to facilitate them and be in a position to easily visit farmers in their farms
3. More use of local media especially radio and television to increase passing of information to the farmers which seems to the very influential source in decision on activities they do in their farms.
4. Encouraging formation of farmers groups and actively involve extension officers to improve sharing of information on agricultural production.

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