Vol.15(2), pp. 95-101 April-June 2023
DOI: 10.5897/JAERD2022.1365
Articles Number: 97D2EFB70747
ISSN: 2141-2170

http://www.academicjournals.org/JAERD

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Journal of Agricultural Extension and Rural Development

Full Length Research Paper

Economic costs of aflatoxin contamination in Meru and Tharaka Nithi counties of Kenya

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Received 27 December, 2022; Accepted 16 February, 2023

Aflatoxin resulting from the consumption of contaminated cereals has always been a concern in Kenya. The purpose of this study was to determine the economic costs of aflatoxin contamination in Meru and Tharaka Nithi counties in Kenya. A multi-stage cluster sampling using the Kenya National Bureau of Statistics (KNBS) design was used to select clusters and households. Once clusters were identified, households were selected from each cluster using a stratified random sampling method. Questionnaires were developed and pretested to determine their validity and reliability. Majority of the surveyed households associated aflatoxin contamination with an increased cost of farming, and lack of market rejection of their products by the market and brokers. Finally, an increased need for veterinary intervention was also associated with contamination. It was therefore concluded that access to the market remains a challenge to most farmers and this can only be corrected if aflatoxin is managed.

Key words: Aflatoxin, socio economic.

INTRODUCTION

Aflatoxins (AF) are poisonous substances produced by certain kinds of fungi (molds) such as *Aspergillus flavus* and *Aspergillus parasiticus* that occur naturally all over the world. They can contaminate food crops and pose a serious health threat to both humans and livestock (WHO, 2018). Picture 1 shows maize comb contaminated with aflatoxin. It has been estimated that more than 5 billion people from developing countries are at risk of chronic exposure to AF (Wu et al., 2011). Besides health impact, aflatoxins impose a significant economic burden with the Food and Agriculture Organization (FAO) reporting that approximately 25% of the world's food is being destroyed annually and food worth US$ 750 billion is wasted or lost throughout the supply chain (FAO).

Aflatoxin affects many of Africa's dietary staples such as maize, rice, and cassava, and continues to be a big burden to many countries which are anchored on agriculture. In sub-Saharan Africa, one of the world's poorest and most food-insecure regions, the World Bank (2011) estimates that a 1% reduction in post-harvest losses could lead to estimated economic gains of US$ 40 million each year. Such economic gain would mostly

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Picture 1. Maize contaminated with Aflatoxin.
Source: iita.org (2023).

benefit those upstream of the food supply chain who are small-scale farmers. Empowerment of farmers and consumers through the provision of information and training on aflatoxins is an important step in the recovery and reduction of resultant economic losses and financial burdens imposed on the world's most vulnerable people, especially those in rural areas.

Aflatoxin in Kenya

The first case of AF was reported in 1961 when 16,000 turkeys died from ingesting contaminated feeds while in Kenya an outbreak in humans was reported in 1981 with Machakos, Makueni, and Kitui counties being the worst hit areas (Marechera and Ndwiga, 2015). A more devastating aflatoxin outbreak in Kenya happened in 2004 where 127 lives were lost (Marechera and Ndwiga, 2015). Since 2004, aflatoxin contamination along the maize value chain has been reported almost on a yearly basis (Nkonge, 2016). Between 2005 and 2008, there were 72 fatalities in Kenya's Eastern region with 16 of these fatalities occurring in Igembe District in Meru County (Ministry of Agriculture, 2016). In 2010, 10% of the maize harvest was declared unfit for human or animal consumption leading to an estimated $ 1.15 billion and significant adverse effects on farmers, traders, millers, and consumers (Nkonge, 2016). In 2013 about 60,000 bags of maize that were harvested in Hola Agriculture Scheme were declared unfit, leading to an estimated loss of almost USD 50 million (Omondi, 2019). Clearly, aflatoxins are not only having health ramifications, but also substantial economic costs to households in Kenya.

Aflatoxin, food security, and socioeconomic impacts

Aflatoxin (AF) is a developmental challenge to Africa, posing a triple menace to public health, food, and nutrition security, and trade and economy (N'dede et al., 2012; PACA, 2015). N'dede et al. (2012) noted that AF is a potent carcinogenic toxin that causes millions of dollars of financial losses to the African continent. Aflatoxin contamination can affect the agricultural sector output generally and specifically the major pillars of food security: availability, access, utilization, and stability (PACA, 2013).

Aflatoxin contamination of foods consumed by humans and animals is a major threat to food security, health, and livelihoods. Compared to other food crops, maize is the most cultivated mainly for subsistence and is a source of income for many farmers in Kenya (Njeru et al., 2019). Unfortunately, aflatoxin is commonly found in maize and is a popular staple food in most Kenyan households, the ramifications of the contamination are widely felt (FAOSTA, 2014; Sirma et al., 2016; Mutiga et al., 2015; Cardwell, 2000). The consumption of staple foods is the economical way to feed households, and therefore not likely to go away, besides most households depend on their surplus produce for extra income. It cuts associated food costs of feeding households not only in rural areas but also in the nation. Therefore, the consumption of maize in Kenya as a local staple food will continue and so are the economic costs associated with the contamination of this staple food.

According to Agriculture Trade (2016), the economic impact of AF on livestock production includes mortality and reductions in productivity, weight gain, feed efficiency, poor fertility, and reduction in the ability of livestock to resist disease. Further, there are financial losses that may result due to poor quality of meat, milk, and egg produced due to livestock consumption of contaminated feed (Agriculture Trade, 2016). To exemplify this, 5% of the maize and peanuts produced in the Philippines and Thailand are discarded and the cost that is associated with contamination in these countries is in excess of 367 million USD (Agriculture Trade, 2016). In the United States (US) alone, it is estimated that the loss due to aflatoxin contamination may exceed 500 million USD (Grubisha and Cotty, 2015).

The cost of contamination includes health that leads to loss of labor, increased health expenses, loss to farmers and traders due to condemned produce, decreased animal production, and high cost of decontamination (Grace et al., 2016; Guardian article, 2004; Wagacha and Muthomi, 2008). When agricultural products are contaminated, directly the availability of the product is reduced. Further, the farmer earns less from the same due to product rejection and the low price they are likely to fetch in the market (PACA, 2013). The produce is also likely to be denied access to the international markets which are very sensitive to agricultural products (Grace et al., 2016; Njeru et al., 2019). The result of this to the farmers is that their income is reduced and their purchasing power eroded. Hence, they are unable to buy food for the family or pay for better health services, or education.

The direct impact of aflatoxin on the economy is a result of reduction in marketable volume, loss in value in the national market, losses incurred from livestock disease, consequential morbidity, and mortality. In the international arena, produce that does not meet aflatoxin standards is either rejected at the point of entry, rejected in channels of distribution, assigned a reduced price, diverted to non-humans, or worse taken to uses that do not generate any money (PACA, 2013). Mutegi et al. (2018) raised a concern that grain traders may find loopholes where they may divert the rejected grains toward manufacturing animal feed.

N'dede et al. (2012), in their study of economic risks of AF in the marketing of peanuts in Benin, found that 31.7% of the respondents sell spoiled nuts at a lower price while 68% just discard them. In Kenya, a similar predicament always faces the farmers and retailers whenever there is an aflatoxin outbreak. During an AF alert in 2009, for instance, the prices of maize dropped by half from 1800 Kenyan shillings to 900 Kenyan shillings in Kitui County (Marechera and Ndwiga, 2015). Further, at least 2.3 million bags of maize were found unfit for human and livestock consumption or trade during the AF outbreak in the period between 2004 and 2006 (Marechera and Ndwiga, 2015). This is a clear indication of possible reduced income as a result of AF contamination of agricultural produce. Total economic loss due to AF exposure in Tanzania had a median of 332,500,000 USD in the year 2014/2015 according to PACA (2015). The case was similar for Malawi which due to AF the domestic market had a net loss of 1.85 and 0.01% of the informal regional market (PACA, 2013).

The presence of aflatoxin in parts of Kenya has not been in question as revealed by Njeru et al. (2019). Consequently, the economic costs of this phenomenon cannot be ruled out given that most parts of the country grow cereals. Unfortunately, the focus on health, contamination levels, and mitigation strategies appears to have overshadowed research into the associated economic cost of aflatoxins. There is not much documented in regard to the economic cost of aflatoxin. This study sought to identify the economic costs associated with aflatoxin contamination in foods and animal feeds in Meru and Tharaka Nithi counties in the upper Eastern Kenya region.

METHODOLOGY

Study design

This was a cross-sectional, descriptive, and correlational study. It utilized the Kenya National Bureau of Statistics cluster design. The KNBS sampling design is based on household-level surveys. This utilized the national sampling frame where clusters were drawn through a stratified sampling probability proportionate methodology. The 30 by 30 cluster sampling procedure was followed. This study purposively selected two counties based on empirical evidence of aflatoxin contamination of staple foods in these counties. Each county will be stratified into rural and urban strata.

County selection

For purposes of objective data collection two counties were purposively selected because of high levels of aflatoxin contamination in staple foods. The counties of Tharaka-Nithi and Meru were identified for the aforementioned reason; the counties are as shown in Figure 1. For each county cluster sampling was done independently using a two-stage sample design. Households were then sampled systematically from the listing as the sampling for second stage selection. A household-level questionnaire was administered in all sampled households. Field assistants were trained, through demonstrations and other means, to be familiar with the questionnaire. The study and target populations comprised household representatives. It included all adults (above 18 years of age) who are household heads or their representatives within the study area. The study sought to evaluate the socioeconomic impact of aflatoxin contamination of staple food, and crops at the household, community, and market levels.

RESULTS

The study had a total of 718 households out of which 488 were from Meru county while 230 were from Tharaka Nithi county shown in Table 1. The majority of the respondents were self-employed (73%), while homemakers came second with 27% and third were causal workers with 20%. In the two counties of study, males lead as being the head of the household with 78% while females recorded 22%. A majority (68%) of the respondents had primary education across the two counties while only 1.6% had bachelor's level and above.

Common foods that are consumed in Meru were found to be staples (66%) and legumes (69%). The two are mainly sourced from the farm with only 23 and 21%, respectively coming from the market. A slightly different

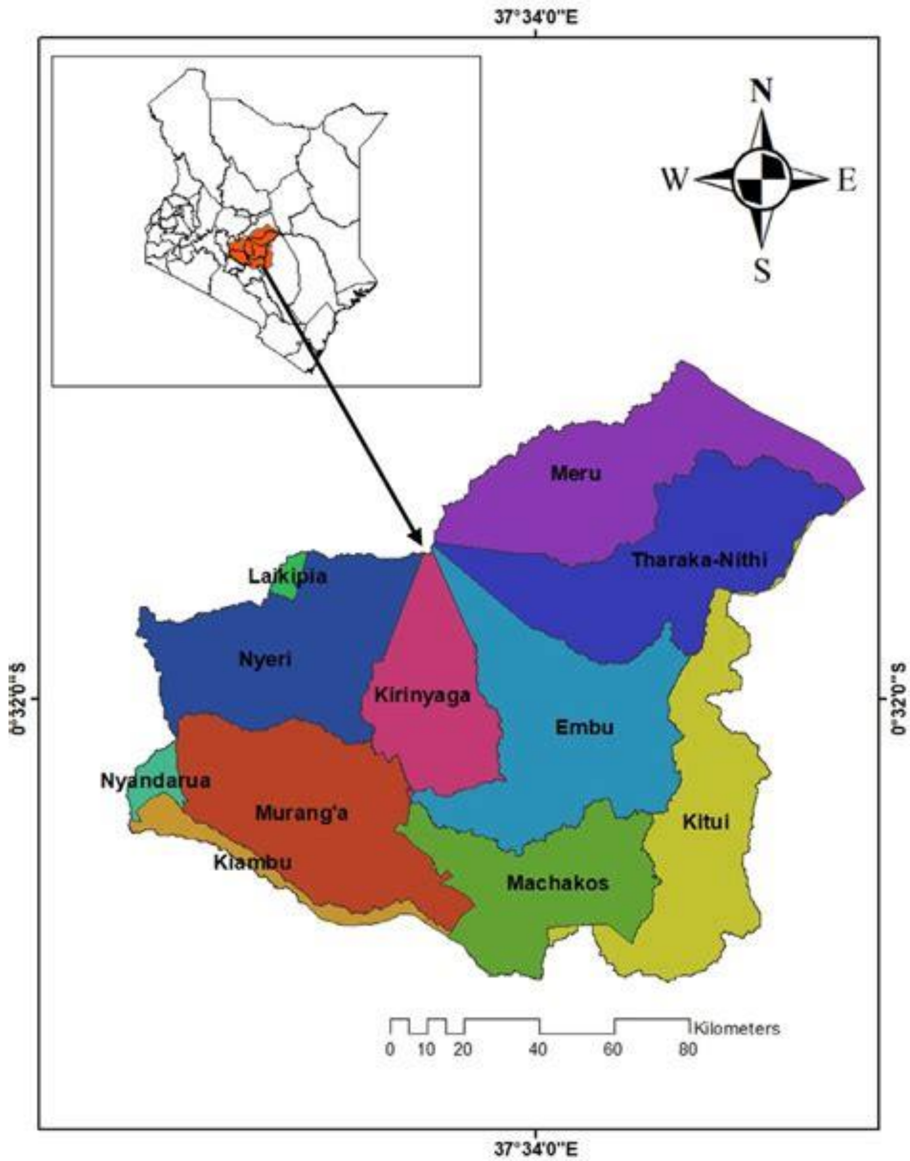

Figure 1. Map of Kenya with 47 counties.
Source: Research Gate Net (2023).

Table 1. Distribution of households in the two counties.

Variable	County		Total
	Meru	Tharaka Nithi	
Frequency	488	230	718
Percent	68	32	100

Data collected by authors during 2019-2022.

pattern was noted in Tharaka Nithi, in terms of regularly consumed food, where dairy food and staple group came first with 34% followed by legumes with 30%. Again, the main source of this food in Tharaka Nithi was identified as households' farms. It was noted from this study that most of the fruits consumed by the households were coming from the markets in the two counties. Maize was identified as the most commonly grown crop in the two

Table 2. Types of food crops grown.

Crop	County			
	Meru		Tharaka Nithi	
	Frequency	Percentage	Frequency	Percentage
Maize	471	66	219	31
Cassava	140	20	72	10
Millet	10	1	90	13
Sorghum	71	10	75	10
Cowpeas	137	19	115	16
Vegetables	206	29	103	14

The percentages are based on the total number of households (718), that participated in the study.

Table 3. Economic impact of aflatoxin contamination.

Variable	No (%)	Yes (%)
Animal fed from aflatoxin contaminated feeds register decreased performance	50.3	49.7
Animal fed from aflatoxin contaminated feeds witness reproductive disorders	52.8	47.2
Animal fed from aflatoxin contaminated feeds require increased veterinary interventions	46.1	53.9
Animal fed from aflatoxin contaminated feeds experience poor fertility	50.3	49.7
Animal fed from aflatoxin contaminated feeds experience reduced ability to resist disease	50.8	49.2
Animal fed from aflatoxin contaminated feeds are likely to result to poor quality products	46.8	53.2
Whenever there are high levels of aflatoxin, the cost of farming normally goes up	28.5	71.5
There is no market for aflatoxin contaminated produce	14.4	85.6
Aflatoxin contaminated produce are rejected by the brokers and the market	17.3	82.7

Data collected by authors in 2019-2022.

counties by 97% of the respondents as depicted in Table 2.

Majorly, the study sought to identify the economic impacts of aflatoxin contamination in the region. The responses are highlighted in Table 3. The majority (71%) of the surveyed households associated aflatoxin contamination with an increased cost of farming. Lack of market for the produce was associated with aflatoxin contamination by 85%, similarly, 82% cited rejection of their produce by the market and brokers due to contamination. Economic impacts of aflatoxin relating to animals that were identified in this study include 49% of the households pointed out the possibility of animal registering reduced performance, 47% noted the possibility of animal reproductive disorders, 53% pointed likely hood of increased veterinary interventions, while 49% of the households indicated poor fertility as likely impact of aflatoxin contamination. Quality of produce from contaminated crops or animals fed with such was also listed as something that respondents have witnessed and are concerned with 53% agreeing. The possibility of reduced disease resistance by livestock was pointed out by 49% of the households as an aspect that is likely to result from aflatoxin contamination.

DISCUSSION

The focus of the study was on the economic costs of aflatoxin contamination in the region. The study revealed that there were several such costs, which can be categorized into two: crops related and livestock-related. The study revealed that most of the households were headed by males across the two counties; this is in line with patriarchal arrangements that are common in Kenya. This finding suggests that the majority of the households' heads have attained primary education, and therefore can be considered literate, they have no knowledge about aflatoxin and are not able to identify its contamination. This was contrary to other research that has been done in other counties, where the awareness level was very high (Malusha et al., 2015). This is a big gap that needs to be filled. Unfortunately, this study revealed that very few farmers are using practices that would lower or control the contamination. The study revealed that the living room and kitchen as the main storage facility and the ventilation of these two areas are definitely wanting and could not be hoped to stop the spread of contamination. Equally, the choice of packaging materials used by the households was found to be inappropriate as the majority used sisal and nylon bags and only a handful (4% in Meru and 2% in Tharaka Nithi) were using the recommended hermetic bags. This could be related to the high cost of hermetic bags compared to other packaging options, this is what Wu (2015) was pointing out, that unless the practices are sustainable adoption of the same is not likely.

The findings revealed several economic costs. The majority of the households (85%) did agree that their produces do lack market due to contamination while 82% agreed that such produce gets rejected. These findings are in agreement with those of PACA (2018) which pointed out that in Gambia, there is a 2% economic loss of international trade due to aflatoxin contamination. The current study findings identified the increased cost of farming as another economic impact, 71% of the household cited this as an impact. Clearly, in as much as the study found some mitigation strategies such as hermetic bags, farmers indicated that these were very expensive measures and this was confirmed by the fact that the majority of the households were using nylon bags as their preferred preservation method after harvesting. This was in line with Wu's (2015) argument about the need for sustainable practices.

While it is applaudable that some households sort out the affected crops, this was found not to be accompanied by proper disposal practices since most of these crops were used as animal feeds while others were thrown away with the likelihood of contaminating the soil. This very practice was found in the Western part of Kenya by Njeru et al. (2019), their study further identified that rotten maize was being used to brew local liquor, which posed a health hazard to residents. When affected crops are fed to the animals, households end up consuming milk, meat, and eggs from the very animals with high chances of them being contaminated. This is the same case when contaminated crops are thrown away, they affect the soil and the cycle continues. Mutegi et al. (2018) noted that lack of knowledge and options for the disposal of contaminated grain at the household level leads to the grain being fed to animals. These were common practices in both Meru and Tharaka Nithi as revealed by the study. The end results of this as confirmed by current findings are the possibility of livestock reporting reduced performance, poor quality products from both crops and livestock, the need for more veterinary intervention as animals' disease resistance capability reduces, and more and more reproductive disorders get witnessed. All these impacts add to the cost of farming and at the same time reduce the final price the produce can fetch or even make them miss out on markets.

Conclusions

From the study, it can be concluded that there are economic costs that result from aflatoxin contamination in the two regions and that the households have been affected negatively. The study findings, which were also collaborated by the focus groups of county officials from different departments indicated that the cost of farming was high due to aflatoxin contamination. This was due to the fact that from soil treatment all the way to post-harvest practices, farmers are required to do extra and incur extra costs in their bid to reduce or protect their crop and harvest from contamination. It can also be concluded that there is limited market access by farmers because of the contamination, farmers reported their produce being turned away by brokers and buyers due to contamination. This explains why the National Cereals and Produce Board is no longer active in the region. There is also a loss of income from livestock resulting from feeding aflatoxin-contaminated feedstuffs, e.g., higher mortality rates. Finally, households need to be informed on the proper methods of disposing of crops suspected of being contaminated, as the current practices are only enhancing the vicious cycle from crops to animals to human beings.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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