EFFECT OF POST-HARVEST AFLATOXIN CONTAMINATION REDUCING ACTIVITIES ON GROUNDNUT MARKETING IN NORTHERN REGION OF GHANA

By

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DECLARATION

I, Magdalene Aidoo, do hereby declare that this submission is my own work towards the MPhil (Agricultural Economics) and to the best of my knowledge, it does not contain material previously published by another person nor material which has been accepted for the award of any degree of the university except where due acknowledgement has been made in the text.

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ABSTRACT

The main objective of this study was to examine the cost of aflatoxin reducing activities on net revenue in groundnut production and marketing in the Northern Region of Ghana. A total of 165 respondents comprising 75 producers, 60 retailers and 30 wholesalers were selected through a multi-stage sampling approach in Tamale Metropolis, Savelugu Nanton and Tolon-Kumbugu Districts for the study. Data for 2012 crop year and trading information from wholesalers and retailers as well as their level of awareness regarding aflatoxin contamination in groundnuts were examined using descriptive statistics. Enterprise budget was used to examine the costs involved in producing quality groundnuts which in effect reduces aflatoxin contamination. A multiple regression model in the log-linear functional form was employed to examine the relationship between the cost of drying, sorting and storage on one hand and net revenue on the other hand.

The study revealed that producers' awareness of aflatoxin contamination and the health effect in animals and humans was higher than the awareness of the traders. Aflatoxin awareness level among retailers was found to depend on educational level and years of experience. From the study groundnut production and marketing are profitable in the Northern region. Although sorting was generally found to reduce the net revenue of producers and traders, the net revenue of retailers in Tamale was higher for sorting their groundnuts than for their counterparts in the other two districts. Results from the regression analysis showed that, the costs of sorting had a significant negative effect on the net revenue obtained by producers. Drying and sorting costs had a negative influence on the net revenue obtained by producers and retailers. However, storage cost had a positive relationship with net revenue received by producers and retailers whiles it had a negative influence on wholesalers net revenue. The study recommends awareness creation especially on the health and economic effects of aflatoxin contamination through public education. Such education and sensitization should also focus on proper pre and post-harvest activities which can reduce contamination and lead to the supply of quality groundnuts. There should also be conscious effort by market actors to segment the groundnut market to allow for premium price to compensate actors for the extra cost incurred in embarking on aflatoxin reducing activities.

DEDICATION

This work is dedicated to the ALMIGHTY GOD for his divine protection and guidance throughout my journey to achieve this work. I am most grateful to GOD. It is also dedicated to my family and Dr. S.C. Fialor for their immeasurable support and encouragement.

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LIST OF ACRONYMS

AF	Aflatoxin
AFB2	Aflatoxin B2
AFB1	Aflatoxin B1
AFG1	Aflatoxin G1
AFMI	Aflatoxin M1
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organisation Statistics
GDP	Gross Domestic Product
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
MoFA	Ministry of Food and Agriculture
WHO	World Health Organisation
GSS	Ghana Statistical Service

CHAPTER ONE INTRODUCTION

1.0 Background

Groundnut *(Arachis hypogaea L.*) is an important legume in Ghana with an annual production of 530887 tons in 2010 (FAOSTAT, 2011). Groundnut is grown in all the agro-ecologies in Ghana, from the dry savannah regions to the moist forest but nearly 85% of the total national production comes from the three northern regions (Atuahene-Amankwa et.al., 1990).

As at 2010, the total area of groundnut production was over 25million hectares and yield of 37.64 million metric tons. Developing countries in Asia, South America and Africa who grow groundnuts as food and cash crop, account for 97% of the area of production and 95% of total production (www.cgiar.com2011/08/15).

Though groundnut is considered a minor crop and makes no significant contribution to exports in Ghana, it is an important oilseed and a valuable source of protein for humans and animals. Apart from its protein sources, it also has medicinal properties for treating hemophilia, stomatitis and acne. The haulm is used as a fodder and the cake in formulating animal feed. Like other legumes, groundnuts roots have the potential to fix nitrogen in the soil.

One major constraint of groundnut production and marketing is the mold that develops on the kernel during storage which is due to pre and post-harvest conditions. This moldiness makes the groundnut unsafe for consumption since it may contain high levels of aflatoxin (AtuaheneAmankwa et.al, 1990). This is also confirmed by Awuah and Kpodo (1996) that moldy, damaged and broken nuts have high level of aflatoxin.

"Aflatoxins are naturally occurring mycotoxins that are produced by species of fungus: *Aspergillus flavus* and *parasiticus".* They were first detected in 1960 in England, where 100 turkeys died as a result of its contamination and has become a global issue since then (Atawodi et al., 1994).

Aflatoxins are toxics which are normally found in foods (Salunkhe et al., 1992). Aflatoxins have carcinogenic and immunosuppressant potency (liver cancer and hepatitis A and B), which affect both humans and animals (William et al., 2004).

Aflatoxins thrive well in humid and warm temperate areas. Most of the contamination occurs at the pre and post-harvest stages due to poor harvesting, improper drying, poor processing and improper storing (Jolly et al., 2006; Hell et al., 2000).

According to Burlingame and Pineiro (2007), aflatoxins contamination of groundnut is a great factor in determining quality of groundnuts since it can cause significant losses for countries that export groundnuts. As a result of this, most countries set regulatory standards to limit the level of aflatoxins in groundnut.

However in many developing countries, the practice to ensure good quality groundnut with low levels of aflatoxins, is to embark on certain pre harvest and post- harvest activities since they have been found to reduce the level of contamination in groundnuts.

Although these activities are not deliberate activities for reducing the level of aflatoxins in groundnut, they end up achieving that to some extent because it is assumed that good quality groundnuts have low levels of aflatoxins.These activities come at a cost, and it is not certain whether consumers will pay a price for the resulting high quality groundnut or whether the returns are proportional to the cost incurred.

This study therefore aimed to analyze the cost effect of activities that tend to reduce aflatoxin contamination in groundnut production and marketing.

1.1 Problem Statement

Groundnut is an important crop in Ghana since it is a major source of protein for humans and animals and a source of livelihood for producers, traders and processors. The consumption of groundnut and groundnut products has received some attention in recent years due to food safety concerns. Food safety is concerned with, among others, the potential hazards associated with food that can affect human health. The potential hazards associated with food include naturally occurring mycotoxins which periodically cause severe intoxications.

Aflatoxin contamination has been associated with groundnut over the years. Cardwell et al., (2004) report that, the annual loss in corn, groundnut and wheat crops in Africa due to mycotoxin contamination was estimated to be over $750 million in 2004. According FAOSTAT (2011), there has been a decline in Ghana's groundnut export since 2000 due to food safety standards including aflatoxins.

Aflatoxins, which are also found in foods like maize and rice reduce the quality and quantity of groundnuts and can cause serious health problems to animals and humans when consumed (Salunkhe et al., 1992). In view of this, all efforts aimed at reducing aflatoxin levels in groundnut and other foods are recommended by public health experts.

Several activities such as proper drying, sorting and proper storage need to be undertaken to reduce the level of aflatoxin by the market participant at each stage of marketing. These activities involve

costs. The cost of activities performed by market actors represents a financial risk since there is some probability that consumers may not be willing to pay premium price for quality groundnut. When consumers or buyers do not pay premium price for quality nuts, it is likely to discourage the supply of quality (aflatoxin-free) groundnut to promote human and animal health.

Currently, some producers and traders invest time and financial resources to undertake aflatoxin reducing activities in order to supply quality groundnuts to the final consumer. A greater proportion of producers and traders, however, do not carry out these activities. Since the groundnut market is not segmented and products are not differentiated along quality lines, all actors face similar or the same price. It is therefore not clear whether drying, sorting and storage and other quality enhancing activities are rewarding enough, at least financially. The purpose of this study was to evaluate the costs associated with quality enhancing activities and how these costs affect the net revenue obtained by producers and traders in the groundnut value chain.

1.2 Research Questions

The following questions were addressed in the study:

1. Are groundnut value chain actors aware of Aflatoxin contamination?
2. What activities are performed by groundnut market participants to improve groundnut quality?
3. What costs are associated with performing each of the quality enhancing activities?
4. How do costs associated with groundnut quality enhancing activities affect net revenue of producers and traders?

1.3 Objectives

The main objective of this study was to examine the effects of aflatoxin contamination reducing activities on the profitability of groundnut production and marketing in the Northern Region of Ghana.

The specific objectives were to:

1. Determine the socio- economic characteristics of respondents.
2. Determine aflatoxin knowledge and awareness of respondents.
3. Identify the main activities performed by groundnut market participants to improve the quality of groundnuts at each stage of the marketing chain.
4. Estimate the costs associated with the activities aimed at improving groundnut quality.
5. Compare the net returns that accrue to market participants for handling value-added and non-value added groundnut.
6. Examine the factors that influence net revenue obtained by each market participant.

1.4. Hypotheses

The following hypotheses were tested in the study:

- There is no significant difference between the profits of producers who sort groundnuts before sale and those who do not sort.

- The costs of drying, sorting and storage negatively influence net returns obtained by market participants.

1.5 Justification

The issue of aflatoxin contamination has become a global issue and important to producers, marketers, process and consumers because of its implication on the quality and quantity of groundnuts produced and marketed. According to FAO (2002), developing countries are unable to sell large quantities of groundnuts produced on the international market because of Aflatoxins contamination which do not meet the safety regulations.Also, because of its effect on the health of those who consume it, it is important to undertake research that can provide estimates of the cost associated with quality improvement activities. Such information could be useful to participants in the market chain, policy makers and non-governmental organizations that aim to address food safety, farmer's development, and health issues of both consumers and other1stakeholders in the groundnut marketing chain.

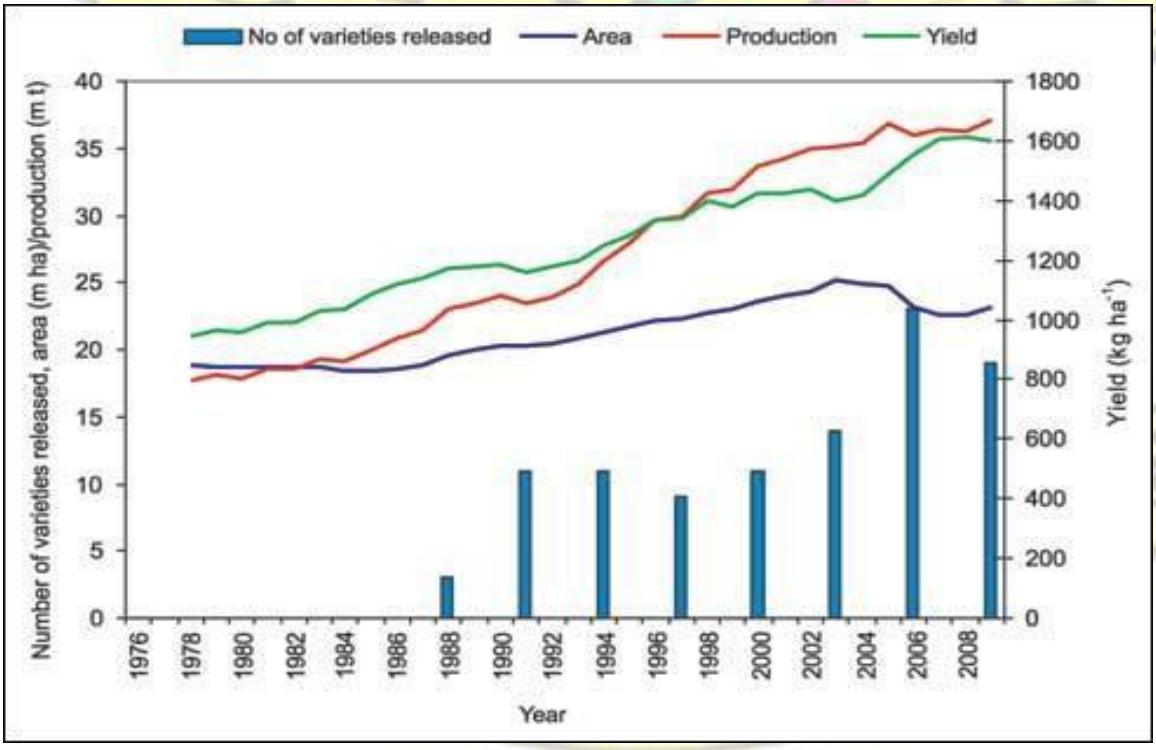
CHAPTER TWO

LITERATURE REVIEW

2.1 Global Groundnut Production

Groundnut is an annual leguminous crop which is rated the 13th most important food crop and the world's 4th most important source of edible oil (Taru et al., 2010). Groundnut seeds contain high quality edible oil (50%), easily digestible protein (25%) and carbohydrates (20%). Figure 1.1 below shows the production area and yield of groundnut in the world from 1978 to 2008 (FAOSTAT, 2011).

Figure2.1: Three-year moving average for groundnut area, production and pod yield; and number of varieties released (3-year total) globally.



Source: FAOSTAT, 2011

According to FAOSTAT (2011), major groundnut producers in the world are: China, India, Nigeria, USA and Myanmar. Developing countries in Asia, Africa and south America accounts for 97% of the global groundnut area and 95% of the global production *(http//www.icrisat.org/crop-groundnut.htm 01/05/2015).* Groundnuts thrive well in areas with an average rainfall of 600 to 1,200 mm and mean daily temperatures are more than 20^{o}C (Weiss, 2000).

With market demand of peanut expected to increase due to growing population and urbanization, African countries have the potential of increasing peanut output and consumption, and possibly export to neighbouring countries (FAO, 2002).

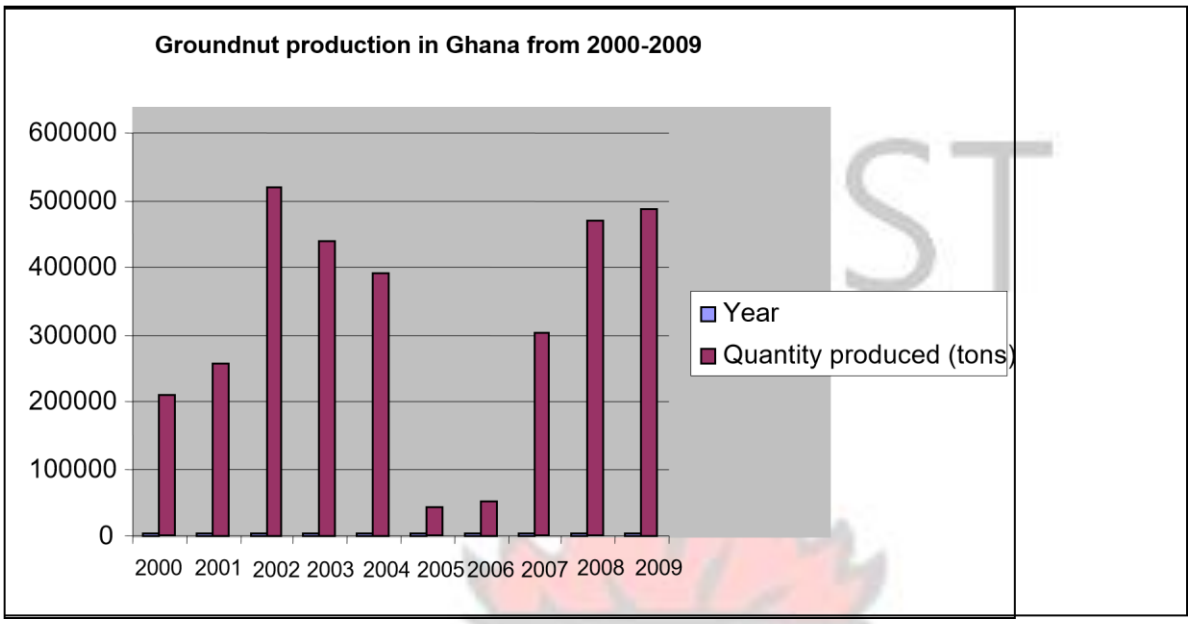
2.2 Groundnut Production in Ghana

In Ghana, groundnut is among the major staple crops produced. It is the most widely cultivated legume in Ghana and it features prominently in the cropping system of the Savanna and Forest Savanna transitional agro-ecological zones (Asafo-Adjei et al., 1998).

Groundnut production is concentrated in the northern regions of Ghana. Tsibey et al., (2001) noted that more than 90% of farmers in the northern communities cultivate groundnut. Below is the statistics for Ghana's groundnut production from 2001-2009 (Fig.2.2).

From figure 2.2, it can be observed that production increased from 2000 to 2002, declined from 2002 to 2005 and increased again to 2009.

Fig 2.2: Trend of groundnut production in Ghana.



Source: FAO, 2011

Almost half of the production of groundnuts is concentrated in the Northern region of Ghana which is made up of three separate administrative regions (Northern, Upper East and West regions) which altogether account for 94% of groundnuts production in Ghana. The region is located in the Guinea Savannah agro-ecological zone. The rainy season is mono-modal, starting in April/May and ending in September/October with an annual rainfall varying between 900 and 1,100 mm (FAOSTAT 2011).

2.3 Importance of groundnut as a food crop

According to CGIAR (2000), about one third groundnut produced globally is eaten and twothirds are crushed for the oil. Groundnut is an important food crop in Ghana. Groundnut is an important source of protein and high quality cooking oil for both humans and animals in most developing countries especially Ghana (Awuah, 2000). It can be consumed raw or roasted. It serves as a

major source of vegetable protein and is used extensively in many dishes. Groundnut is a valuable source of E, K, and B vitamins, thiamine B1, P, Ca, and Mg (Schilling and Gibbon, 2002).The oil is regarded as an excellent aperients' or a mild laxative and emollient which softens the skin *(http://www.cgiar.org/impact/research/groundnut.html 2011/08/15).*

Groundnut also has medicinal purposes and can be used to treat hemophilia, inherited blood disease, which causes hemorrhage, nose bleeding and in cases of excessive bleeding during menstruation in women. Chewing fresh groundnuts with a pinch of salt strengthens the gums, cures stomatitis, and kills harmful bacteria. A teaspoon of refined groundnut oil mixed with equal quantity of lime juice may be applied daily on the face before going to bed. It keeps the face fresh. Its regular use nourishes the skin and prevents acne also *(http://www.naaritoday.com/health/homermidies/groundnut.html2011/08/15).*

The groundnut plant has the ability to fix high amounts of atmospheric nitrogen and thus enhancing the sustainability of farming systems in Ghana. According to Marfo et. al., (1999) its haulm is used as fodder, the cake in formulating animal feed and also provides employment for rural women.

2.4. Food safety

Food safety according to Spencer (2003) in "Economics of Food Safety in Developing Countries" refers to the potential hazards associated with food that can cause ill-health in humans. Some of these hazards are naturally-occurring (for example aflatoxin in groundnuts), whilst others occur through contamination (for example pesticide residue in fruit).

According to studies done in some African countries, aflatoxin levels were high especially in

Children who were malnourished from protein insufficiency (*kwashiorkor).* Due to the effects of aflatoxin contamination, regulatory standards are set by many countries to restrict exposure of groundnuts to the toxic effect. These acceptable levels in some countries are presented in table 2.1 below.

Table 2.1: Aflatoxin standards in some selected countries.

Country	Aflatoxin Type	Maximum permissible level (ppb)	
		Foodstuffs	Livestock feed
Belgium	B_1	5	20
France	B_1	1	20
Germany	B_1	2	20
Ireland	B_1	5	20
Italy	B_1	5	20
The Netherlands	B_1	0	20
Sweden	B_1 B_2 G_1 G_2	5	10
UK	B_1 B_2 G_1 G_2	4	20
USA	B_1 B_2 G_1 G_2	20	20

Source: Freeman et al., 1999

These regulations require special attention in order to produce groundnuts safe for consumption and also for international market. In Kenya, Uganda and India, the maximum tolerable limits of aflatoxin level as reported by Okello et al., (2010) were 10ppb for Kenya and Uganda whiles India was 30ppb.

In Ghana, about 5 to 15 per cent of groundnuts were sorted out and discarded because it was contaminated with aflatoxin making it unsafe for human and animal consumption according to Awuah et al., (2009).

2.5 Aflatoxin in groundnut production

"Mycotoxins are chemical substances naturally produced by fungi that contaminate crops, either during the cropping season or in storage. Worldwide, substantial quantities of food grains are

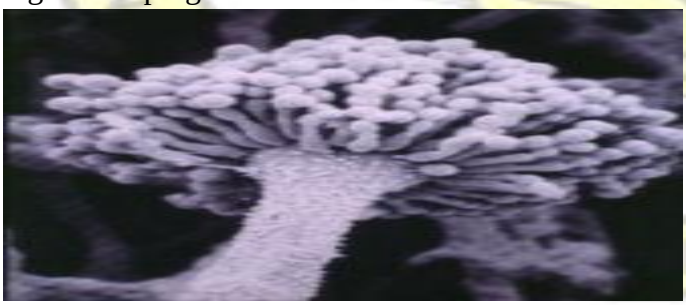
affected by Mycotoxins each year: maize 16 million tons, rice 12 million t, groundnut 1.8 million tons, sorghum and millet 378,000t, copra 3.7 million t, soybean 2.3 million tons.

In the semi-arid tropics, a number of crops are often contaminated by mycotoxins – groundnut, maize, cottonseed, sorghum, millet, rice, Brazil nuts, pecans, pistachio nuts, spices (particularly chillies), walnuts and products made from these crops

(http:www.icrisat.org/Aflatoxin/Aflatoxin.asp. 2011/08/15)

Aspergillus flavus and *Aspergillus parasiticus* are the main type of mycotoxins that affects groundnuts.There are four types of toxic substances produced by *Aspergillus flavus* and *Aspergillus parasiticus* are B1, B2, G1, G2 **.** These four different types of aflatoxins according to Hell (2003) are produced in varying amounts and proportions depending chiefly on the genetic capabilities of the fungus. Aflatoxins have toxigenic, carcinogenic, mutagenic potential (Keenan and Savage, 1994) in the order AFB1 > AFGI > AFB2 > AFG2 (ICRISAT, 2000). Aflatoxin occurrence depends on drought stress and rainfall, suitability of crop genotype for its climate, insect damage, and other agricultural practices like pre and post- harvest activities of the crop (Wu and Khlangwiset, 2010).

Fig 2.3: Aspergillus flavus seen under an electronic microscope



(Source:http://www.ansci.cornell.edu/plants/toxicagents/aflatoxin/aflatoxin.html#Introduction 2011/08/10).

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2.6 Aflatoxin Knowledge and Awareness

Aflatoxins cannot be seen with the naked eye. However, Awuah et al., (2009) stated that broken, shriveled and damaged nuts have high levels of aflatoxin although clean nuts cannot be said to be aflatoxin free. Awareness about aflatoxins among producers, traders, governmental agencies and individuals is very important for reducing aflatoxin contamination as stated by Wu and Khlangwiset (2010). In Ghana, there have been attempts to educate groundnut producers and consumers on proper post-harvest handling and storage practices to reduce AF contaminations in groundnut (Awuah, 2000; Ellis, 2000).

Jolly et al., (2009) also examined the effect of policy decisions on awareness and knowledge of aflatoxin, among policy makers in improving food safety through improved groundnut handling after post- harvest in Ghana.

A similar study was also conducted in Benin by the same authors where producers behavior, knowledge, awareness, and attitude toward adopting hygienic and postharvest activities to reduce contamination of aflatoxin in groundnuts using the Health Belief Model (HBM). The knowledge and awareness of aflatoxin contamination is very vital in mitigating aflatoxin. An early study by Bearwood (1964), reported that 90% of groundnuts sampled in Accra market were highly contaminated with aflatoxin. This was later confirmed by Awuah and Kpodo (1996) when groundnuts sampled in 21 markets in Ghana had high levels of Aflatoxin.

A study in Nigeria to investigate the knowledge of aflatoxin contamination in groundnut and the risk of its ingestion among health workers in Ibadan reported that 80.6% of the health workers interviewed had a good knowledge on Aflatoxin contamination in groundnut but its health consequences was lacking (Ilesanmi and Ilesanmi, 2011). The authors revealed a positive significant association with awareness of aflatoxin.

Although reports on aflatoxin contamination in Ghana and other African countries are available (Awuah et al., 2009), however, 92.3% of producers in Ejura-Sekyeredumase district of Ashanti region surprisingly had not heard what aflatoxin was but 76.8% sorted their groundnuts and very few agriculturist and health workers were aware of health effects even though they were aware of aflatoxin contamination in groundnuts (Jolly et al., 2009).

Florkowski and Kollavalli (2013) reported that aflatoxin awareness is low among producers and traders and even well-educated consumers (Florkowski and Sarpong, 2012)

Similarly a study conducted in Malawi to analyze the occurrence and distribution of aflatoxin contamination assessed farmers' awareness of aflatoxin in groundnuts and the results showed that about 65% of respondents were aware of the aflatoxin contamination in groundnuts *(http://oar.icrisat.org/7380/1/Aflatoxins.pdf 28/05/2015*).

Knowledge and awareness of Aflatoxins are usually determined using the likert scale. A Likert scale is a method of assigning quantitative value to qualitative data in statistical analysis. In a study by Ephrem (2014) to examine Perception about aflatoxin Contamination in Groundnut, perceptions of Aflatoxin in groundnut were measured using a 5-point Likert scale (strongly agree, agree, neutral, disagree and strongly disagree) and the results established that majority of the producers

(98.7%) and traders (93.3%) disagreed to the eight indices which promotes aflatoxin contamination in groundnuts.

Similarly, Jolly et al., (2006:2009) also used the five point scale in measuring the aflatoxin knowledge and awareness in Ghana and Benin. For the perception and awareness variables, respondents indicated how sure they were aware about each statement (definitely uncertain, somewhat certain, certain and definitely uncertain).

James et al., (2007) reported in a study done in Benin, Ghana and Togo that awareness rate among farmers were 20.8%, 26.7% among traders, 60.0% among poultry farmers and 25.2% among consumers. In 2006, Kaaya et al., also revealed that, wholesalers and retailers in Uganda lack awareness of aflatoxin health effects associated with groundnuts and this lack of awareness affects their decision to sort.

2.7 Effect of Aflatoxin contamination on health

Aflatoxins contamination since its occurrence according studies has gained much attention because it affects the health of those who consumes it. A report by Strosnider et al., (2006) indicated that "Aflatoxin is the most potent natural carcinogenic substance and has been linked with a higher prevalence of hepatocellular cancer in Africa". The WHO in 2008 reported "The primary disease associated with Aflatoxin intake is hepatocellular carcinoma (HCC, or liver cancer). This disease is the third-leading cause of cancer death globally with about 550,000– 600,000 new cases each year". East Asia and sub-Saharan Africa accounts for 83% of this death (Strosnider et al., 2006 and Kirk et al. 2006).

Basically the effects of aflatoxin on humans and animals have been categorized into two according to Wu (2010); acute aflatoxicosis and chronic aflatoxicosis. Acute aflatoxicosis occurs when

moderate to high levels of aflatoxins are consume whiles Chronic aflatoxicosis also occurs when low to moderate levels of aflatoxins are consumed.

This study further reported that, aflatoxin causes between 5 to 30 % of all liver cancer cases in the world and Africa accounts for 40%. This re-enforces an earlier study by William et al in 2004 where it was estimated that 5 billion people are potentially exposed to aflatoxin in the developing countries.

Aflatoxin has been a recurrent problem in Africa especially in Kenya where it was first detected in 1981. In 2004, there were 125 deaths out of 317 reported cases of aflatoxicosis with similar events repeating during 2005-2008 and 1n 2010, 10% of Kenyans maize harvest was terminated by aflatoxin and deaths reported (Liu and Wu, 2010).

Aflatoxin contamination inhibits growth and suppresses immune systems of animals and humans when they consume it (Khlangwiset et al. 2011). “There is a high risk of Hepatitis B and Hepatitis C carriers developing liver cancer when they are exposed to Aflatoxin” (Williams et al., 2004).

A study on chronic aflatoxin exposure in animals by Lubulwa et al., (1994) showed impaired reproductive efficiency, reduced feed conversion efficiency, increased mortality rates, reduced weight gain, anemia, and jaundice. In the case of laying hens, aflatoxicosis causes an enlarged fatty liver and lowered egg production.

Cardwell et al. (2001) also revealed that children especially in developing countries are more prone to high mycotoxin contamination in their diets. According to Lamplugh (1988), there is prenatal exposure of the foetus and apart from this; infants through breast milk are easily affected by these mycotoxins in some African regions. Therefore, analysing breast milk from lactating mothers has demonstrated postnatal consumption of various aflatoxins by breastfed infants. This is similar to the results by Tchana et al. (2010).

2.8. Factors influencing aflatoxin contamination in groundnut

Aflatoxin contamination of groundnuts is influenced by both biological and non-biological factors which facilitates the growth of the Aflatoxin fungi. The contamination can occur in any stage of production through to storage. The constraints to groundnut production include moldiness of kernels at storage but Atuahene-Amankwa et al., (1990) attributed this to the high kernel moisture due to unsatisfactory post-harvest pod handling and the humid conditions in the producing areas. Pre-harvest contamination primarily occurs under heat and drought stress most especially during the later growing stage when growth rate of the plant is in decline (Keenan and Savage, 1994).

Moisture is one of the factors that determine aflatoxin contamination in groundnut. It affects both the grade and storability and has a critical effect on mold growth and mycotoxin production. It is one of the most important considerations in determining whether aflatoxin will develop in groundnuts after harvest. Storage fungi grow at moisture contents in equilibrium with relative humidity ranging from 65-70 to 85-90 percent. A. flavus will only grow when the moisture content exceeds 9%, at 80-85% relative humidity and above.

Mestres et al., (2004), observed that "For peanuts the standard practice is drying of pods in the sun. Often pods are left in the field after uprooting for up to four weeks to partially dry prior to home drying. Achieving this through simple sun-drying under the high humidity conditions of many parts of Africa is difficult.

2.9. Methods of reducing aflatoxin contamination in groundnut

To reduce aflatoxin contamination of groundnut to improve health and incomes of producers and consumers, there must be activities to promote pre-harvest and post-harvest technologies that will minimize aflatoxin contamination of groundnuts. These pre-harvest and post-harvest activities are summarized in the sub-sections below.

2.9.1 Pre-harvest activities

Aflatoxin contamination of crops (including groundnuts) has been shown to take its roots from both pre harvest and post-harvest conditions. This contamination could occur in the field, during storage and in transit (Hell et al., 2008). ICRISAT (2000) identified three methods of aflatoxin management: "pre harvest management, post-harvest management and detoxification". Pre harvest management of aflatoxin according to ICRISAT (2000) is the best and most widely explored strategy. This is because *A. flavus* infests all affected crops before harvest.

2.9.1.1 Control by Cultural Practices

Cultural practices are basically preventive in nature and for effectiveness; cultural control must be designed taking prevailing environmental and agronomical factors into consideration (ICRISAT, 2000). In groundnut, Waliyar et al., (2002) recommended the adjustment of sowing and harvesting dates and gypsum application as effective in preventing aflatoxin contamination. They also recommended "application of lime, which reduces seed contamination by *A. flavus* by 47%, manure by 33%, crop residues by 24% and combination of manure and crop residues by 50%". Other cultural control measures are selection of the right cultivar which fits a particular growing season such that, maturity coincides with the end of the rainy season for adequate drying , optimum

plant population and irrigation in the last 4-6 weeks of crop growth to forestall pre harvest aflatoxin contamination of groundnuts.

2.9.1.2. Control through Breeding

According to Brown et al., (2003), several screening tools have been developed and used to facilitate corn breeding for developing germplasm resistant to fungal growth and/or aflatoxin contamination. The authors tested aflatoxin resistance in thirty-six maize inbred lines selected in West and Central Africa and in 2008, six tropical maize germplasm were registered. There have been several attempts to develop aflatoxin resistant germplasm in groundnuts and this has led to the development of elite resistant varieties released in Niger, Senegal and Burkina Faso (Upadhyaya et al., 2002). Guo et al., (2009) revealed new strategies that will enhance the groundnut plant to be resistant against fungal infection and restrict the growth of toxigenic fungi. Mehan (1989) identified the three types of resistance: "resistance to contamination (pod wall); resistance to seed contamination (seed coat); and resistance to aflatoxin production (cotyledons)". However, according to the author, use of resistant varieties should not be used in isolation but rather in concert with other cultural and crop handling procedures suitable for a particular agro ecological zone.

2.9.1.3 Biological Control

Cotty and Jaime-Garcia (2007) identified three basic types of biological control strategy for preharvest contamination.

1. The use of an agent that annihilates the pest;
2. An agent that secretes poisons that destroys the posts (atixigenic agents); and

3. The use of an agent that competes with the pest in its ecological niche.

In USA, afla-guard® and AF36® has been developed based on atoxigenic *Aspergillus flavus* strains to biologically control aflatoxin production in crop especially in the prevention of aflatoxin in groundnuts, maize and cotton seed (Dorner, 2009).

Pre harvest activities that are efficient in increasing yield tend to reduce the levels of aflatoxin contamination in groundnuts. Bruns (2003) noted that managing of aflatoxin is greatly influenced by controlling infection on the field.

2.9.2 Post-harvest activities

Post-harvest activities aimed at reducing the level of aflatoxin in groundnut include drying, sorting and storage. Based on previous studies by N'dede (2009), and Awuah and Kpodo (1996), variable drying, sorting and storing are reported as the most important factors that discourage aflatoxin production.

2.9.2.1 Drying

In Ghana, drying of groundnut is normally done either on the field or on the ground in the house. There are several strategies according to Hell et al., (2008), to increase efficiency of drying grains and reduce the contamination of the toxin even under poor condition such as drying on the mats, platforms and the field. Producers are advised to dry peanut immediately after harvest and most importantly, down to a moisture content of less than 8 per-cents by ICRISAT (2008). Awuah et al., (2009) reported that aflatoxin levels of kernels dried for 4weeks were very low and fall within the safe aflatoxin level for consumption. Therefore drying to a low moisture level

(below 8%) is very effective in reducing the level of aflatoxin in groundnut. Previous studies just show the desired drying method but no cost were associated with it except in Awuah et al., (2009) where the drying cost accounted for 23-27% of the post- harvest handling cost.

2.9.2.2 Sorting

A number of methods have been suggested for the reduction of aflatoxin in peanut. Among them are heat, mechanical, electronic and hand picking, chemical, density and flotation techniques, and manual sorting (Galvez et al., 2003).

In Ghana, sorting is normally done with the hand. Awuah and Kpodo (1996) and Hamid (1997) said mouldy, broken and shrivelled groundnuts usually have high levels of aflatoxin so must be sorted out to minimize the contamination of the groundnuts. This is not effective and time consuming as compared to the developed countries where mechanical sorters are used (Awuah et al., 2009). The authors revealed that, illiterate and producers with primary school education are involved in post-harvest activities and are more likely to sort their groundnuts. Aflatoxin contamination is optimal in regions with high temperatures and in warm, humid climate. Sorting must be done to remove defective or contaminated nuts.

N'dede (2009) in Benin revealed that although sorting reduces the level of aflatoxin contamination in groundnut, it also reduces the net revenues of the producers and the market participants who sort. "Sorting can remove a major part of Aflatoxin contaminated units, but levels in contaminated commodities may also be reduced through food processing procedures that may involve processes such as washing, wet and dry milling, grain cleaning, de-hulling, roasting, baking, frying, and extrusion of cooking oil" Fandohan et al. (2008).

2.9.2.3 Storage

Storage is considered as one of the most important post-harvest activities that can reduce the level of aflatoxin in groundnut. “Grain crops may be attacked by fungi in the field which can then develop rapidly during storage when conditions are suitable for producing mycotoxin” according to Turner et al., (2003).

Presently there are efforts to market improved hermetic storage bags in Africa, based on triple bagging developed for cowpea which has been or is being tested for other commodities. Efforts to evaluate effectiveness of this technology in controlling aflatoxin have not been conclusive. Storage is an important activity in agriculture because it reduces losses at post-harvest stage and also gives opportunity to sellers and producers to increase their net revenue as a result of price increase.

According to Kaaya et al. (2005), storage is also one of the post-harvest activities that reduce aflatoxin contamination. They further reported that length of storage greatly influence the conditions that favours aflatoxin production especially in Kumi and Mayuge districts in Kenya, where groundnuts which were stored for longer months had a high level of aflatoxin. It is therefore believe that the length of storage affects the quality and enhances contamination of aflatoxin.

2.10 Determination of aflatoxin (AF) level

There are various tests to detect the presence of aflatoxin in groundnut. These may include VICAM and ELISA. “VICAM is an aflatoxin test that produces numerical results using monoclonal antibody-based affinity chromatography. The test can isolate aflatoxin β1, β2, ğ1, and ğ2 from feeds, foods, grains, and nuts, and from dairy products” (N’dede, 2009) and Enzyme Linked

Immuno-sorbent Assay (ELISA) is “convenient for simultaneous determination of contaminants in a large number of samples with relatively low cost and short time.

Reddy et al., (2001) in India used the ‘indirect competitive ELISA to determine the level of aflatoxin in selected foods (chillies) and feed (maize and groundnut) for poultry because commercial kits to estimate Aflatoxin by immunological methods are expensive, and there are problems associated with their importation. Hence, efforts were made to produce at ICRISAT the good quality antiserum that is a basic requirement for ELISA”. In order to quantify the levels of aflatoxin in Korea, Chun et al. (2006) used high performance liquid chromatography (HPLC) as a monitoring scheme.

These tests are not performed in this work to determine the aflatoxin levels in groundnuts. However, mouldy, damaged and broken nuts which have been tested to have high levels of aflatoxin were used as a proxy for aflatoxin contamination (Awuah et al., 2009).

2.11 Effects of aflatoxin contamination on groundnut

Aflatoxins in groundnuts, and for that matter all crops can have direct economic effect resulting from loss of produce or market value as well as indirect economic effect from loss of animals, increased costs of veterinary and human health care services, cost of food–borne surveillance and food monitoring (Table 2.2).

Table 2.2: Examples of Economic Losses Associated with aflatoxin (and other mycotoxins) contamination

Bearer	Economic losses and costs

Primary Producer	• Outright food and feed loss • Less income from contaminated food • Reduced productivity of livestock
Intermediary	• Less income from products refused, condemned or sold at a discount • Potential loss of market • Increased storage, transport and packing cost • Increased costs due to surveillance and control
National/ Government	• Lower forex from reduced exports • Increased costs due to surveillance and control • Increased costs of shipment, sampling and analysis of products for export • Increased need of expenditures in human health and livestock care services • Increased costs of training, communication and extension programs
Consumer (humans or livestock)	• Impaired health and productive capacity • Possible higher medical and veterinary costs
International level	• Loss of market value or market • Trade distortions

(Adapted from Jemmali, 1987)

Economic losses according to Okello et al., (2010), may reach 100% depending on the market when the entire produce is rejected if aflatoxin levels exceed the accepted standards. It is estimated that Africa loses over $670 million annually due to requirements for European Union for all food exports and over billions of dollars are lost by farmers and traders due to aflatoxin contamination (Otsuki et al., 2001; Guo et al., 2009).

Contamination of aflatoxin in groundnut is identified as “a major constraint to groundnut trade in

Africa" (Lubulwa et al., 1994). According to Latha et al. (2007), "aflatoxin reduces peanut quality and poses economic and trade problems at almost all stages of peanut marketing, especially during export". A large percentage of the peanuts produced are contaminated with aflatoxin at post-harvest.

Aflatoxin contamination affects the quality and quantity of groundnuts produced and marketed as well as the health of humans and animals. Report from Shephard (2003), confirms that aflatoxin contamination is a recurrent problem especially in Africa and it is an important factor to international trade**.**

Burlingame and Pineiro (2007) also stated that aflatoxin contamination of peanuts is a great factor determining the quality of peanuts and causes significant financial losses both for producers and exporting countries.

2.12 Profitability analysis in groundnuts

Marketing margin is one of the important tools used for analyzing the performance of a marketing system. It is simply the difference between the price received by a producers and what consumers pay for the final product (Olukosi and Isitor, 1990). Alabi et al., (2013), Adinya, 2009 and other studies report that groundnut production and marketing is a profitable business using the gross margin analysis.

In Ghana, groundnuts are mainly stored unshelled by farm households who shell appropriate quantities for market as and when there is need for cash for family requirements. There are several participants in the chain as is the case of other major grains. A wide range of research has been done in relation to profitability of agricultural produce.

Olukosi and Erhabor (1988) also state that farm budgetary analysis enable the estimation of the total costs as well as total revenue accrued to the enterprise within a specific production period. There are basically two types of enterprise budgeting; total and partial budgeting. A total budgeting is used when contemplating a complete re-organization of the entire farm business, while partial farm budget is used when the action intends to be implemented does not affect the whole farm (Adinya, 2009). Similarly, Awuah et al., (2009), N'dede et al., (2012 and 2013) also revealed that groundnut production and marketing is a profitable business.

2.13 Effect of post- harvest aflatoxin reducing activities on net revenue

Okello et al., (2010) reported that Aflatoxin contamination makes groundnut unacceptable for marketing and causes financial loss to producers or traders. Turner et al., (2005) described a "postharvest intervention package to reduce aflatoxin s in groundnuts that was tested in Guinea. The package consisted of education on hand-sorting nuts, natural-fiber mats for drying the nuts, education on proper sun drying, natural-fiber bags for storage, wooden pallets on which to store bags, and insecticides applied to storage floors". A lot of studies have been done in relation to postharvest activities on aflatoxin contamination in groundnut but very few studies have attempted to examine the cost effectiveness of these activities and how they affect net returns.

A study by N'Dede et al., (2012) analyzed the effect of sorting, drying and storage including other production cost on the net revenue. Their study reported that, the cost sorting and storage had a negative influence whiles cost of drying had a positive influence on the net revenue of producers. A 10% increase in the cost of sorting and storage reduces the net revenue of the producers by $0.85/kg and $0.30/kg respectively whiles drying cost increase their net revenue by

$4.46/kg. The authors added that, the effect of drying cost on net revenue resulted from effective drying of the groundnuts before sale. The same authors in: Economic analysis of aflatoxin contamination in marketing of groundnut in Benin revealed a negative relationship between purchasing price and the cost of sorting and the net revenue of traders. The net revenue of traders decreased by $7.53/kg and $2.28/kg when there was 10% increase in purchasing price and sorting cost increase. It has also been confirmed that groundnuts stored for more than six months have low quality attracting lower price which eventually reflects in the net revenue Hell et al., (2000).

2.14 Other factors that affect net revenue

Most studies use the multiple regression to assess the effect of factors such as age, gender, farm size, educational level, labour, quantity of seeds and fertilizers on the output or yield (Awoke 2003, Taru et al., 2008, and Jolly et al., 2009). Net revenue could vary from one actor to the other depending on the number of marketing activities as well as the final selling price of the product. Agwu (2009), in a study on the determinants of profitability among plantain marketers in Abia State, Nigeria reported that the coefficient of number of years of experience of the traders was positive and significant at 10% indicating that as the number years in business increases, so does the profitability of wholesalers.

After analyzing round potato marketing in Tanzania, Mwakaje and Nyunza (2012) outlined the factors influencing producer's income as education, access to market information, household size, production cost, farm size, years of experience, volumes handled and selling price. The regression analysis of these factors on producers income revealed that, selling volumes (quantity handled) were positively significant whiles the others factors negatively affected farm income.

Bagamba (1998) also found out that farm size and years of experience had a significant effect on farm income when education, farm size, years of experience, on and off farm income, age ,gender, distance, extension services and number of cattle owned by farmer were regressed on farmers income in studying the profitability of banana.

An assessment of gari marketing in South West Nigeria by Afolabi (2009) identified purchasing cost, transportation, marketing experience, labour cost and cost of storage as the factors influencing revenue. The results of the study indicated that cost of storage accounted for 0.25% of the total cost which negatively influences net revenue.

Farm size, production costs, farm location, interaction between production costs and farm gate price as well as the interaction between the varieties used and fertilizer applied were significantly related to gross margins of sorghum by Erbaugh et al., (2008). However, contrary to this, results showed that farm size negatively influenced gross margins. Imoudu (1992) also showed that farm size and labour were the significant determinants of maize output and profitability in Ondo– State.

A study by Agwu and Ibeabuchi (2011) in Socio-economic analysis of wholesale rice marketers in Abia state, Nigeria revealed that income, years of experience, educational attainment of the traders and sex of the traders were major determinants of profitability in the enterprise.

In a study by Nwaru et al (2011) on Socioeconomic Determinants of Profit in Wholesale and Retail Banana marketing in Umuahia Agricultural Zone of Abia State, Nigeria, the coefficient of the quantity of bananas handled and the selling price by a retail marketer was significantly related to profitability at the 10% and 1% levels respectively. As the quantity handled and the selling price increase profits also increase. The quantity of bananas that a marketer handles defines his scale of

business operation. Ceteris paribus, the higher this scale, the higher the marketing profit because of possible economies of scale.

From the above studies, it can be observed that, there are some common factors that influence the profitability of these enterprises. However, some of these factors were specific in affecting the profitability of specific enterprises.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This section presents information on the identification and selection of the study area, the population and the sample size, sampling technique, type and source of data and analytical tools for data analysis.

3.2 Study area

Groundnut production in Ghana is concentrated in the Northern region of Ghana which is made up of Northern, Upper East and West regions. These regions account for 94% of groundnuts production in Ghana. The region is located in the Guinea Savannah agro-ecological zone. The rainy season is mono-modal, starting in April/May and ending in September/October with an annual rainfall varying between 900 and 1,100 mm (FAO 2012).

The study was undertaken in three districts in the Northern region of Ghana namely, Tolon-Kumbugu, Savelugu-Nanton and Tamale Metropolis. The districts were selected based on the evidence of dominance of groundnut amongst the food crops grown in these districts compared to other districts in the region (GSS, 2008).

3.2.1 Tamale metropolis

The Tamale Metropolis is located in the central part of the Northern Region which lies between latitude 9.16° and 9.34° north and longitudes 00.36°and 00.57° and situated 180meters above sea level. It has a population size of 537,986 people with a land size of 38,352 hectares. The Metropolis experiences one single rainy season starting from April/May to September/October with a mean annual rainfall of 1100mm. The rainfall duration highly restricts staple crop

production. The dry season is usually from November to March which is mostly influenced by North Easterly (Harmattan) winds. Almost 60% of the people are engaged in agriculture with the crops normally grown in this district are maize, rice, sorghum, cowpea, groundnuts, soya bean, yam and cassava. Tamale metropolis lies within the Guinea Savanna belt of Northern Ghana. The main soil types are clay, sand and laterite. The introduction of subsidies by government and non-governmental agencies (NGOs) has increased production of staple industrial crops (ghanadistricts.com 5/6/2012).

3.2.2 Tolon Kumbungu

The District lies between latitude 10-20 north and longitude 10 to 50 west, shares border with West Mamprusi District in the North, West Gonja district in the West and South and the East with Savelugu/Nanton District and the Tamale Municipal Assembly The district has a land size of 2400km^2 with which 70% is mainly used for agricultural purposes. The district is home to key agricultural institutions as University of Development Studies (UDS), Animal Research Institute (ARI), the Savanna Agricultural Research Institute (SARI) and other relevant NGOs which assists in agricultural activity in the district (ghanadistricts.com 5/6/2012).

3.2.3 Savelugu-Nanton

The Savelugu-Nanton district "covers a total land area of 1790.70 sq. km. It shares boundaries with West Mamprusi in the North, Karaga to the East, Tolon/Kumbungu in the West and Tamale Metropolitan Assembly to the South. The area receives an annual rainfall averaging 600mm, considered enough for a single farming season. The annual rainfall pattern is erratic at the

beginning of the raining season, starting in April, intensifying as the season advances raising the average from 600mm to 1000mm. Temperatures are usually high, averaging 34ºC.

The maximum temperature could rise as high as 42ºC and the minimum as low as 16ºC. The low temperatures are experienced from December to late February, during which the North-East Trade winds (harmattan) greatly influence the District. The generally high temperatures as well as the low humidity brought about by the dry harmattan winds favor high rates of evaporation and transpiration, leading to water deficiencies (ghanadistricts.com 5/6/2012).

3.3 Sampling technique

For the purpose of this study a multi-stage sampling procedure was used in the data collection. Firstly, three districts; Tamale metropolis, Savelugu Nanton and Tolon Kumbugu were purposively selected. Twelve communities were randomly selected from a list prepared by the author with guidance from agricultural extension agents. The selected communities included
Tamale, Gbalali, Kapayili and Wovuduma for Tamale metropolis; Diare, Savelugu, Nanton and Gushie for Savelugu Nanton district and Tolon, Tingoli, Kpalsogu and Tivigoli for the Tolon Kumbugu district. The selection of these communities is based on the dominance of groundnut production and their contribution to the districts groundnut production and the country at large (GSS, 2008). The traders were sampled both in the market through simple random and in the community through snowball sampling. The market is the community market. In all seventy five groundnut farmers (twenty five in each district), thirty wholesalers (ten selected from each district) and sixty retailers (twenty from each district) were selected for the study. The assumption is that there are more producers and retailers than wholesalers who deal with larger quantities.

3.4. Data collection

Primary data was used for the study and was collected by administering structured questions to respondents. Information on socio-economic characteristics as age, gender, education, occupation and years of experience was sourced from respondents. Also data on respondent knowledge of aflatoxin contamination in groundnuts, production and marketing costs were collected. Secondary information on the districts and communities, population and its size and groundnut producers and traders were collected. Relevant information on groundnut production and marketing, aflatoxin occurrence, health and economic effect on groundnut, prevention strategies and its costs was also sourced from the internet and related published studies. This information was very helpful and useful for the literature review in this study.

3.5 Data analysis

Data collected from the survey was analysed using Statistical Package for Social Scientists (SPSSv16).

Descriptive analytical tools such as the frequency tables, arithmetic means, median, standard deviation, and simple proportion were used to summarize the demographics of the respondents as well the activities employed to reduce aflatoxin contamination.

The Likert scale was used to evaluate actors' knowledge and awareness of aflatoxin in groundnut. A five point likert scale (strongly aware, aware, somewhat aware, not aware and strongly not aware) was used to describe the awareness and knowledge of aflatoxin contamination in groundnut, knowledge of the health effects in animals and humans, specific disease associated with ingestion aflatoxin contaminated groundnuts and knowledge of discolored groundnuts being

harmful when eaten. Chi-square test of independence was used to explore associations between demographic variables and aflatoxin awareness and knowledge.

Enterprise budget was prepared to determine the profitability of groundnut production and marketing. The Net Revenue (NR) of producers and traders in the study area was estimated using the expression;

NR=TR-TC

where;

TR= Q*P

TC= TFC+TVC

NR is the Net revenue,

TR represents Total Revenue,

TC represents Total Cost,

TFC represents the total fixed cost

TVC represent the total variable cost

Q represents Quantity of groundnut and

P represents unit Price of groundnut.

Marketing margin is one of the important tools used for analysing the performance of a market system. It is simply the difference between the price received by a producers and what consumers pay for the final product (Olukosi and Isitor ,1990). Alabi et al., (2013), Adinya, 2009 and other studies reported groundnut production and marketing is a profitable business using the gross margin analysis.

Gross margin which equals the difference between what the consumers pay and the farm gate price per unit of the food produce (Kohls and Uhl, 1990) was estimated with the formula:

Gross margin = Total Revenue - Total Variable Cost

The variable costs for the producers include the average cost of ploughing, seed cost, planting, weeding, harvesting, drying, sorting, storing, transportation, market rate and cost of sacks.

The fixed cost includes the average of repairs and maintenance and depreciation.

The depreciation was calculated using the straight line method.

A multiple regression model specified in the log-linear form was employed to examine the relationship between the costs of aflatoxin reducing activities and profitability (net revenue).

This is because the price of the groundnut is not continues as reported by Hell et. al., (2000) and Jolly et.al., (2009) that after Storage period of six months groundnuts attracts lower prices as a result of deterioration. This makes simple linear specification of the model not appropriate.

The empirical model was specified as;

$$\ln Y_1 = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5$$

$$+ \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 \ln X_8 + \varepsilon$$

Where;

Y is the net revenue for the chain actors (producers, retailers and wholesalers)

β_0 is the constant $\beta_1 - \beta_8$ are the coefficients of the explanatory variables to be estimated

Ln is the natural logarithm and

$X_1 - X_8$ are the explanatory variables.

The definitions of the variables and their *a priori* expectations are presented in Table 3.1 Table 3:1 Definition of variables and *a priori* expectations

Variable	Definition	A prior expectation

X_1	Land size planted to groundnut (in acres)	+
X_2	Quantity harvested Per acre (measured in 100kg bags)	+
X_3	Years of experience of respondents	+
X_4	Cost of drying 100Kg bag	-
X_5	Cost of sorting groundnuts	-
X_6	Cost of storing groundnuts	-
X_7	Quantity handled by trader (100kg bags)	+
X_8	Purchasing cost per unit (GHC/100Kg bag)	-
ε	Error term	

Three different models were estimated for the key actors; one each for producers, retailers and wholesalers. Land area cultivated and quantity harvested were used only in the producers' model. Quantity of produce handled and purchasing price were also used only in the traders' models. The student t-test was used to statistically test the difference between the means of the net revenue obtained by producers from selling sorted and unsorted groundnut.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Introduction

This chapter constitutes the analysis for the study. It aims at establishing the relationship between the activities undertaken in reducing the level of aflatoxin, their cost and benefits and the financial risks associated with these activities.

4.1 Socio-economic characteristics of respondents

This comprises the age, gender, educational level, occupation and the years of experience in occupation of the target respondents.

The demographic characteristics of the respondents are summarized in Table 4.1. About 67% and 50% of producers and traders (retailers and wholesalers) which constitute the majority of the respondents were between the ages of 41 and 60 years. None of the respondents interviewed was below the age of 20 years and very few of producers and wholesalers (12% and 16.7%) were above 60 years. The mean ages were 49, 44 and 47 years for the producers, retailers and wholesalers respectively. This is consistent with the studies by Asa (2003), and Jolly et al., (2007) that people within the age group of 41-60 are economically active than the older ones since groundnut production is labour intensive.

Production (81.3%) and wholesaling (90%) of groundnuts were dominated by males whiles retailing (73.3%) was dominated by females (Table 4.1). More men are engaged in groundnut production than women because of the nature of groundnut production and the fact that women are left with marketing and household activities. This result is synonymous to the results of Kaaye et al., (2006), Adinya (2007) and Jolly et al., (2009) except for males dominating wholesaling.

Educational level was grouped into four, primary, secondary, tertiary and no education (Table 4.1). More than 65% of all the respondents had no education at the study area. However, 30% of both retailers and wholesalers as well as 25.3% of producers had primary education. Only 3.3% of the retailers had a tertiary education. High level of education is very important in agricultural production especially adopting new agricultural practices hence high illiteracy level is a disadvantage (Agwu et al., 2008).

From the survey, all the wholesalers and producers (100%) in the study areas had wholesaling and farming as their main occupation whereas majority of the retailers (83.3%) had retailing as their main occupation with a few (16.7%) having farming as their secondary occupation.

Majority of the respondents (producers 49.3%, retailers 80% and wholesalers 60%) have spent 10 years in groundnut production and marketing. Only 13.3% of the producers and wholesalers as well as 6.7% of retailers interviewed have had more than 20 years' experience. The average years spent by respondents in groundnut production and marketing are 12.7(producers), 9.7(retailers) and 11.7(wholesalers) respectively.

With the area of land for cultivation, 65.3% of the producers at the study area cultivates on a two acre land whiles 32% cultivates between 3-5 acres. Only about 3% cultivates more than five acres and above. Majority of the producers (56%) had an average output of between 11 and 20 bags of groundnuts with 4% having an average of 30 bags and above.

Table 4.1: Summary of socio-economic characteristics of respondents

VARIABLE	PRODUCERS		RETAILERS		WHOLESALERS	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage

AGE						
1-20yrs						
21-40yrs	16	21.3	30	50	10	33.3
41-60yrs	50	66.7	30	50	15	50
Above 60	9	12	0	0	5	16.7
Mean	49		44		47	
GENDER						
Male	62	82.7	16	26.7	27	90
Female	13	17.3	44	73.3	3	10
EDUC.LEVEL						
Primary	19	25.3	18	30	9	30
Secondary	7	9.3	2	3.3	1	3.3
Tertiary	0	0	2	3.3	0	0
No education	49	65.3	38	63.3	20	66.7
OCCUPATION						
Farming	75	100	10	16.7	30	100
Trading	0	0	50	83.3	0	0
NO OF YRS IN OCCUPATION						
1-10yrs	37	49.3	48	80	18	60
11-20yrs	28	37.3	8	13.3	8	26.7
Above 20 yrs	10	13.3	4	6.7	4	13.3
Mean	12.6		9.7		11.7	
LANDSIZE						
1-2 acres	49	65.3				
3-5 acres	24	32				
Above 5 acres	2	2.7				
Mean	2.2					
OUTPUT (BAGS						
1-10 (100KG)	21	28				
11-20 (100KG)	42	56				
21-30 (100KG)	9	12				
Above30(100KG)	3	4				
Mean	19.5					
QUANTITYHANDLED						
Retailers						
1-3 bags			34	56.7		
4-6bags Mean			26	43.3		
wholesalers			3.3			
1-50bags						
51-100bags						
101-150bags					9	30
151-200bags					11	36.7
Above 200bags					8	26.7
Mean					1	3.3
					1	3.3

					87.3	

Source: Field data: 2012

Retailers and wholesalers constitute the traders at the study area. Retailers handled small quantities as compared to the wholesalers who handle large quantities. About 60% of the retailers handles a maximum of three bags whiles the 40% handles up to six 100kg bags of groundnuts. Majority of the wholesalers (36.7%) handled between 51-100 bags whiles only 3.3% handles more than 200 bags of groundnuts. Averagely, retailers at the study area handled

3.3 bags of groundnut whiles 87.3 bags were recorded for the wholesalers per one month period.

4.2 Aflatoxin knowledge and awareness

Aflatoxins are caused by fungus and so cannot be seen with the naked eyes. However, producers and traders can identify aflatoxins in groundnut by the mouldy, shrivelled, discoloured nature of the nuts as indicated by Awuah et al., (2009). Knowledge and awareness of aflatoxin contamination is important for producers and traders to designing strategies for the management of aflatoxin contamination.

From Table 4.2, 30.7% and 33.3% of the producers and retailers were aware and strongly aware of aflatoxin contamination in groundnut whereas only about 37% of the wholesalers were somewhat aware of it. Most of the producers (29.3%) and wholesalers (60%) were not and

somewhat aware of discolored grains being harmful when eaten but 3.3% of the retailers was strongly aware of that. With respect to the health effects of ingestion aflatoxin contaminated groundnuts on both animals and humans, most of the respondents were not aware except for the producers who were aware in both animals (25.3%) and humans (33.3%).

Table 4.2 presents information on the knowledge and awareness level of producers and traders of groundnut about aflatoxin.

Table 4.2: Aflatoxin knowledge and awareness of respondents

VARIABLE	Producers		Retailers		Wholesalers	
	Frequency	%	Frequency	%	Frequency	%
Aflatoxin contamination in groundnut						
Strongly not aware	9	12.0	4	6.7	8	26.7
Not aware	11	14.7	10	16.7	5	16.7
Somewhat aware	11	14.7	16	26.7	11	36.7
Aware	23	30.7	10	16.7	2	6.7
Strongly aware	21	28.0	20	33.3	4	13.3
Aflatoxin has adverse Health effect in animals						
Strongly not aware	14	18.7	16	26.7	20	66.7
Not aware	17	22.7	22	36.7	4	13.3
Somewhat aware	16	21.3	12	20.0	5	16.7
Aware	19	25.3	0	0	1	3.3
Strongly aware	9	12.0	10	16.7		
Aflatoxin has adverse Health effect in humans						
Strongly not aware	5	6.7	6	10.0	20	66.7
Not aware	23	30.7	24	40.0	3	10.0
Somewhat aware	6	8.0	14	23.3	4	13.3
Aware	25	33.3	6	10.0	3	10.0
Strongly aware	16	21.3	10	16.7		
Discolored grains are harmful when eaten						
Strongly not aware	10	13.3	6	10.0	1	3.3
Not aware	22	29.3	18	30.0	6	20.0
Somewhat aware	10	13.3	16	26.7	18	60.0
Aware	15	20.0	18	30.0	4	13.3
Strongly aware	18	24.0	2	3.3	1	3.3

Damaged and broken nuts do spoil others in storage						
Strongly not aware	26	34.7	18	30.0	3	10.0
Not aware	8	10.7	18	30.0	16	53.3
Somewhat aware	10	13.3	6	10.0	1	3.3
Aware	22	29.3	12	20.0	5	16.7
Strongly aware	9	12.0	6	10.0	5	16.7
Sorted Groundnut Sell at higher Price						
Strongly not aware	5	6.7	12	20.0	4	13.3
Not aware	12	16.0	14	23.3	19	63.3
Somewhat aware	4	5.3	10	16.7	1	3.3
Aware	23	30.7	18	30.0	4	13.3
Strongly aware	31	41.3	6	10.0	2	6.7
Groundnuts stored on wooden platform are sold at better price						
Strongly not aware	18	24.0	12	20.0	14	46.7
Not aware	21	28.0	14	23.3	7	23.3
Somewhat aware	10	13.3	10	16.7	3	10.0
Aware	20	26.7	18	30.0	4	13.3
Strongly aware	6	8.0	6	10.0	2	6.7

Source: Field data: 2012

About 35% of the producers were strongly not aware of damaged and broken nuts spoiling others in storage whiles 53% of wholesalers were also not aware of it and only 3.3% of the retailers and wholesalers were strongly aware that discolored nuts are harmful when eaten. Majority of the producers (41.3%) were strongly aware that sorted nuts sells at a higher price whiles 23.3% and 63.3% of retailers and wholesalers were not aware. About 47% of the wholesalers were strongly not aware that, better prices are offered to groundnuts which are stored on wooden platforms before sale.

The results from the study with respect to aflatoxin knowledge and awareness are different from previous study by Jolly et al., (2006), where awareness of aflatoxin contamination was low. They reported that 92.3% of the producers in Ejura-Sekyeredumasi had not heard about aflatoxin. In 2009, Awuah et al., also revealed that knowledge of the health implication of aflatoxin contamination among agriculturist and health workers in Ghana was low although they were aware

of its contamination. Also Jolly et al., (2009) report that about 73% and 67.3% of producers were aware of aflatoxin in crops and in groundnuts. The authors stated that 43.4% and 39% of producers were aware of aflatoxin contamination in humans and animals respectively. Also, James et al., (2007) reported a low level of aflatoxin awareness in a study done in Benin, Ghana and Togo. They further revealed that awareness rate among farmers were 20.8%, 26.7% among traders, 60.0% among poultry farmers and 25.2% among consumers

Table 4.3 provides the results of a chi square test of independence between aflatoxin awareness and knowledge level on one hand and demographic characteristics of producers on the other hand.

Table 4.3 Factors Influencing Aflatoxin awareness in Groundnut of producers

VARIABLE	Strongly not aware	Not aware	Somewhat aware	Aware	Strongly aware	Pearson χ^2 (p, df)
GENDER						7.086
Male	8.1	12.9	16.1	32.2	30.6	p(.131)
Female	30.8	23	7.7	23	15.4	df(4)
AGE			5.6			14.920
21-40yrs	27.8	5.6	16.7	38.9	22.2	p(.061) df
41-60yrs	6.3	20.8	22.2	22.9	33.3	(8)
Above 60 years	11	0		55.6	11.1	
EDUCATIONAL LEVEL						
No education	10	16	16	32	26	6.229
Primary	22.7	13.6 0	9.1	18.2	36.4	(.622)
Secondary	28.6		14.3	42.9	14.3	df (8)
Tertiary						
YEARS OF EXPERIENCE						
1-10 years	8.3	11.1	16.7	36.1	27.8	15.322
11-20 years	7.1	25	14.3	17.9	35.7	p(.053) df
Above 20 years	36.4	0	9.1	45.5	9.1	(8)

Source: Field data: 2012

The results from the chi-square analysis show that, none of the socio-demographic characteristics of producers and wholesalers has any significant influence on the awareness of aflatoxin contamination in groundnut at a 5% significant level. Majority of the producers who were males

(32.2%) were aware of aflatoxin awareness whiles the female producers (30.6%) were strongly unaware although awareness did not depend on their gender (X^2=7.086, p=.131). Producers with the age group above 60 years (55.6%) and those with more than 20 years of experience (45.5%) in groundnut production as well as those with secondary education were aware of aflatoxin contamination in groundnut.

There is a similarity with the results of Jolly et al., (2009) where aflatoxin awareness in groundnut was not influenced by age, gender and education; they found a significant relationship between producers' level of education and their perception of the seriousness of aflatoxin contamination. However, those with higher educational background were more aware of aflatoxin contamination in groundnut. With the years of experience, Jolly et al., in 2007 reported a significant relationship between gender and the number of years and the knowledge of aflatoxin contamination in groundnuts which is different from the result of this study with respect to producers. They also reported that, males had a greater awareness of aflatoxin risks and producers with more than 20 years of experience were aware of aflatoxin contamination in groundnuts.

Table 4.4: Factors Influencing Aflatoxin awareness in Groundnut of Retailers

	Strongly not aware	Not aware	Somewhat aware	Aware	Strongly aware	Pearson χ^2 (p, df)
GENDER						17.381 p(.002), df(4)
Male	11.1	0	55.6	0	33.3	
Female	4.8	23.8	14.3	23.8	33.3	
AGE						.800
21-40yrs	6.7	13.3	26.7	20	33.3	p(.938), df(4)
41-60yrs	6.7	20	26.7	13.3	33.3	
EDUCATIONAL LEVEL						
No education	10.3	0	41	15.4	33.3	45.965
Primary	0	44.4	0	11.1	44.4	(.000),df(12)
Secondary	0	0	0	100	0	
Tertiary	0	100	0	0	0	
YEARS OF EXPERIENCE						
1-10 years	9.1	22.7	18.2	22.7	27.3	31.200
11-20 years	0	0	80	0	20	p(.000),d(6)
Above 20 years	0	0	0	0	100	

Source: field data: 2012

The results of the chi-square test in Table 4.4 affirmed the null hypothesis of independence between gender, education and years of experience of retailers on one hand and their knowledge and awareness level of aflatoxin contamination on the other. However, the test results show that aflatoxin knowledge and awareness among retailers are dependent on gender (X^2=17.381, p=.002), educational level (X^2=45.965, p=0.000) and experience level (X^2=31.200, p=.000). Majority of the male retailers were somewhat sure of aflatoxin contamination in groundnuts whiles 33.3% of the females were strongly aware of it. All retailers with tertiary education were not aware. 100% of the retailers with secondary education were aware of aflatoxin contamination in groundnuts.

The results also revealed that wholesaler's knowledge and awareness of aflatoxin contamination in groundnut is not influenced by the age, gender, level of education and the number of years spent in the groundnut business (Table 4.5). Most of the female wholesalers (66.7%) were strongly not aware of aflatoxin contamination whiles the males (40.5%) were somewhat aware of it. There was no statistical dependency in the levels of awareness among the age groups (X^2=13.120, p=.108), the wholesalers between 21-40 years were strongly aware (30%), those between 41-60 years and above 60 years were 53% and 60% were somewhat aware of aflatoxins in groundnut. Similarly, awareness of aflatoxin in groundnuts did not depend on wholesalers educational level (X^2=12.698, p=.123) and years of experience (X^2=4.730, p=.786).

Table 4.5: Factors Influencing Aflatoxin awareness in Groundnut of Wholesalers

	Strongly not aware	Not aware	Somewhat aware	Aware	Strongly aware	Pearson χ^2 (p,df)
GENDER						5.000
Male	22.2	18.5	40.7	7.4	11.1	p(.287),df(4)
Female	66.7	0	0	0	33.3	

AGE 21-40yrs 41-60yrs Above 60 years	30 26.7 20	20 13.3 20	0 53.3 60	20 0 0	30 6.7 0	13.120 p(.108),df(8)
EDUCATIONAL LEVEL No education Primary Secondary Tertiary	20 44.4 0	20 11.1 0	50 11.1 0	5 11.1 0	5 22.2 100	12.698 (.123),df(8)
YEARS OF EXPERIENCE 1-10 years 11-20 years Above 20 years	33.3 12.5 25	11.1 25 25	27.8 50 50	11.1 0 0	16.7 12.5 0	4.730 p(.786),df(8)

Source: Field data: 2012

4.3 Activities performed to improve groundnut quality (reduce aflatoxin level)

Aflatoxin contamination of crops (including groundnuts) has been shown to take its roots from harvest conditions. This contamination could occur in the field, during storage and in transit (Hell et al., 2008). To reduce aflatoxin contamination of groundnut to improve health and incomes of producers and consumers, some pre-harvest and post-harvest activities are undertaken by value chain actors. Table 4.6 provides the distribution of respondents according to post harvest activities carried out to improve quality and reduce aflatoxin level.

Table 4.6: Post harvest activities aimed at reducing aflatoxin contamination

ACTIVITIES	PRODUCERS		R :TAILERS		WHOLESALERS	
	YES (%)	NO (%)	YES (%)	NO (%)	YES (%)	NO (%)
Early harvesting	36 (48)	39 (52)	0	0	0	0
Drying of pods on the field	29 (38.7)	46 (61.3)	0	0	0	0
Sun drying of pods in the house	50 (66.7)	25 (33.3)	8 (13.3)	52 (86.7)	5 (16.7)	25 (83.3)

Sorting before drying	29 (38.7)	46 (61.3)	0	0	0	0
Sorting after drying	30 (69.3)	45 (30.7)	30 (50)	30 (50)	0	0
Sorting to remove damaged discolored pods	30 (40)	45 (60)	22 (36.7)	38 (63.3)	0	0
Sorting to remove broken pods	20 (26.7)	55 (73.3)	14 (23.3)	46 (76.7)	0	0
Sorting to remove stones and foreign materials	18 (24)	57 (76)	28 (46.7)	32 (53.3)	0	0
Storage of dry pods	56 (74.7)	19 (25.3)	48 (80)	12 (20)	30 (100)	0
Storing at dry clean places	56 (64)	19 (25.3)	38 (63.3)	22 (36.7)	30 (100)	0
Storage in structures that prevent leakage	48 (90.7)	7 (9.3)	48 (80)	12 (20)	28 (93.30	2 (6.7)

Source: Field data: 2012

4.3.1. Drying

From the table above, only 48% of the producers harvest their pods early whiles 66.7% dry in the house, about 39% dries on the field. Producers have the option of either selling the fresh groundnut immediately after harvest or sell later after drying and storage. About 33% of the producers who do sun dry groundnuts can possibly sell in the fresh state. The length of drying actually depends on the intensity of the sun. Majority of producers (60%) dry within 7days in the house. Only 28% of them dry within two weeks with 12% drying within three days depending upon the intensity of the sun (Table 4.7). None of the producers interviewed was found to dry their groundnuts beyond two weeks.

Very few of the retailers (13.3%) and wholesaler (16.7%) dry their pods before selling.

About 80% of the retailers store at a dry place free from leakage. Only 6.7% of the wholesalers had problems with leakages at their storage place and this can facilitate the production of toxins.

The length of drying as mentioned before depends on the intensity of the sun. Traders dry their pods for a maximum of three days (Table 4.7).

Table 4.7: Groundnut drying period by respondents

DRYING PERIOD	PRODUCER		RETAILERS		WHOLESALERS	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
3days	13	17.3	8	100	5	100
1week	46	61.3	0	0	0	0
2weeks	16	21.3	0	0	0	0
Beyond 2 weeks	0	0	0	0	0	0

Source: Field data: 2012

4.3.2 Sorting

Sorting is a very important activity in reducing aflatoxins in groundnut. Broken, discolored and shriveled nuts are found to have high levels of aflatoxin (Awuah et al., 1996). In Ghana, sorting is mainly done by handpicking.

About 40% of the producers sort to remove damaged nuts whiles 27% and 24% sort to remove broken and foreign materials. None of the traders sort before drying. Normally sorting and drying are done together. Half (50%) of the retailers interviewed sort their pods whiles the wholesalers do not sort. Out of the retailers who sort, 36.7% sort to remove damaged discolored pods, 23.3% sort to remove broken pods and 46.7% to remove stones and foreign materials.

This result is similar to a previous study by Kaaya et al., (2006) in: Peanut aflatoxin levels on farms and in markets of Uganda who reported that, very few wholesalers carry out further drying and even do not try at all when they have limited time or when groundnuts are scarce and

of high demand. Sorting among traders are normally done by retailers than wholesalers and they sort purposely to remove mouldy, discolored, broken and shriveled kernels, which according to studies have high levels of aflatoxins and foreign materials.

4.3.3 Storage

Storage is one of the post-harvest activities that reduce aflatoxin contamination. The table below (Table 4.10) gives the information on storage for producers and trades.

Table 4.8: Storage activities for participants.

ACTIVITIES	PRODUCERS		RETAILERS		WHOLESALERS	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Store						
Yes	56	74.7	48	80	30	100
No	19	25.3	12	20	0	0
Access to long term storage						
Yes	63	84	36	75	17	56.7
No	12	16	12	25	13	43.3
Own storage facility						
Yes	56	74.7	40	83.3	26	86.7
No	19	25.3	8	16.7	4	13.3
Store groundnut with other crops						
Yes	56	74.7	33	68.75	16	53.3
No	19	25.3	15	31.25	14	46.7
Storage period						
1 month	14	18.7	44	73.3	8	26.7
1-3month	27	36	16	26.7	8	26.7
3-6month	34	45.3	0	0	14	46.7

Source: Field data: 2012

From the table above, majority of the farmers (74.7%), retailers (68.75%) and all the wholesalers (53.3%) store their groundnuts for some time before sale. Most of respondents interviewed had

access to storage facilities which are owned by them. Very few of them have access to long term storage facility which is rented. Majority responded that storing of groundnuts is done together with other crops such as maize and sorghum.

Out of the 56 producers who store groundnut in Table 4.8, only 12.5% stored in structures that leaked. However, all of them stored at clean dry place. Since aflatoxin contamination is facilitated by humidity producers who store in leaked structures are prone to aflatoxin contamination. With the storage periods of participants, all participants who store groundnuts store for a maximum of six months. However, majority of the retailers stores within a one month period whiles most of the producers and wholesalers stored up to six months.

4.4 Cost associated with quality improving activities

In improving the quality of groundnuts, some activities such as drying, sorting and storage which come with a cost are performed by the participants. These activities in effect reduce aflatoxin contamination in groundnuts. Table 4.9 to Table 4.11 summarize the costs associated with the activities (drying, sorting and storage) aimed at improving quality of 100Kg bag of groundnuts by producers and traders.

Table 4.9: Cost of drying, sorting and storage for 100kg bag of groundnut for producers

VARIABLE	TOLON		SAVELUGU		TAMALE	
	SORT	DO NOT SORT	SORT	DO NOT SORT	SORT	DO NOT SORT
DRYING						
Unit price for drying 100kg bag (GH₵)	2.2	2.53	2.03	2.73	2.3	2.33
Total labour cost of drying (GH₵)	2.2	2.53	2.03	2.73	2.3	2.33
Losses during drying(GH₵)	0.9	1.33	1.23	2	1.5	2.07
Total cost of drying (GH₵)	3.1	3.86	3.26	4.73	3.8	4.4

SORTING						
Man-days for sorting 100kg bag	1	0	1	0	1	0
Unit price per day (GH₵)	3.8	0	3.4	0	4	0
Total labour cost of sorting (GH₵)	3.8	0	3.4	0	4	0
Losses during sorting(GH₵)	0.87	0	0.62	0	0.97	0
Total cost of sorting (GH₵)	4.67	0	4.02	0	4.97	0
STORAGE						
Unit cost of storage for 100kg bag (GH)	0.84	0.6	0.15	0.2	0.14	0.1
Total storage cost (GH₵)	0.84	0.6	0.15	0.2	0.14	0.1

Source: Field data: 2012

Drying of the pods depended on the intensity of the sun at the time of drying. From the table above, the cost of drying 100kg bag was higher in Savelugu (GH₵4.73) than in Tamale and Tolon although they recorded the least losses of groundnut during drying.

Sorting is time consuming and normally done with the hand. Producers in Tamale had the highest sorting cost per 100kg bag. Savelugu producers had the least costs of sorting of GH₵3.03. The producers alluded that, drying is effectively done to avoid spoilage in storage and so the losses in storage are transferred to other participants in the marketing chain (traders or consumers).

Table 4.10: Cost of drying, sorting and storage for 100kg bag of groundnut for retailers

VARIABLE	TOLON		SAVELUGU		TAMALE	
	SORT	DO NOT SORT	SORT	DO NOT SORT	SORT	DO NOT SORT
DRYING						
Unit price for drying100kg (GH₵)	0.9	1.1	1.5	0.5	1.7	0.7
Total labour cost of drying (GH₵)	0.9	1.1	1.5	0.5	1.7	0.7
Losses during drying(GH₵)	0.4	0.45	0.35	0.2	0.5	0.3
Total cost of drying (GH₵)	1.3	1.55	1.85	0.7	2.2	1.0
SORTING						
Man-days for sorting	1	0	1	0	1	0
Unit price per day (GH₵)	4.6	0	4.5	0	4.5	0
Total labour cost of sorting (GH₵)	4.6	0	4.5	0	4.5	0
Losses during sorting(GH₵)	1.78	0	1.8	0	1.4	0
Total cost of sorting (GH₵)						

	6.38	0	6.3	0	5.9	0
STORAGE						
Unit cost of storage(GH₵)	2.4	2.2	2.3	1.8	2.1	2.8
Total storage cost (GH₵)	2.4	2.2	2.3	1.8	2.1	2.8

Source: Field data: 2012

From Table 4.10, retailers in Tamale had the highest drying cost of GH₵ 2.2 and the least cost of sorting per 100kg bag of groundnut. About GH₵ 6.5 was spent by retailers in Tolon and Savelugu in sorting 100kg bag of groundnut whiles GH₵ 2.8 was the storing cost of retailers in Tamale who do not sort groundnuts.

Wholesalers did not undertake sorting but drying and storage. Wholesalers in Tolon incurred the highest drying cost whiles those in Savelugu had the highest storage cost. This is presented in the table below.

Table 4.11: Cost of drying, sorting and storage for 100kg bag of groundnut for wholesalers

VARIABLE	TOLON	SAVELUGU	TAMALE
	SORT	SORT	SORT
DRYING			
Unit price for drying 100kg bag (GH₵)	1.52	1.4	1.2
Total labour cost of drying (GH₵)	1.52	1.4	1.2
Losses during drying(GH₵)	0.7	0.5	0.8
Total cost of drying (GH₵)	2.6	1.9	2
SORTING			
Man-days for sorting 100kg bag	0	0	0
Unit price per day (GH₵)	0	0	0
Total labour cost of sorting (GH₵)	0	0	0
Losses during sorting(GH₵)	0	0	0
Total cost of sorting (GH₵)	0	0	0

STORAGE			
Unit cost of storage for 100kg bag (GH₵)	0.36	0.47	0.35
Total storage cost (GH₵)	0.36	0.47	0.35

Source: Field data: 2012

4.5 Enterprise budget for participants

This section shows the profitability analysis producer and traders using the enterprise budget and gross margin analysis.

4.5.1 Enterprise budgets for producers

Table 4.12 shows the enterprise budget for groundnut producers detailing out costs and benefits associated with producing groundnuts on an acre of land. The total average cost for drying, sorting and storage used for the enterprise budget is summarized in Table 4.9. From the table above, producers obtained higher net revenue when they decided not to sort before selling their groundnuts across the districts. Ploughing was the highest production cost for those who sort and those who do not sort groundnuts in the various districts.

Table 4.12: Cost and benefit analysis for producers for handling 100kg bag of groundnut

VARIABLE	TOLON		SAVELUGU		TAMALE		ALL
	SORT	DO NOT SORT	SORT	DO NOT SORT	SORT	DO NOT SORT	
Unit price (100kg)	39.7	38.9	40	40.2	40.5	39.4	39.41
Number of bags per acre	6.5	7.15	7.03	6.8	6.7	7.4	7
Revenue (GH₵)	258.05	278.135	281.2	273.36	271.35	291.56	275.87
Variable costs (GH₵)							
Production cost:							
Seeds	13.1	13.4	12.3	14.9	16.3	14.2	14.08
Plowing	25	25	23.8	24	28.7	27.8	25.69

Planting	15.4	12.37	21.3	13.8	14.6	11.7	14.42
Weeding	18.9	17.5	28.6	18.9	21.1	21.7	20.78
Harvesting	15.6	17.4	19.5	21.3	23.6	26	20.79
Total production cost	88	85.67	105.5	92.9	104.3	101.4	95.76
Drying	20.15	26.31	22.91	32.16	25.46	32.56	27.78
Sorting	30.36	0	28.26	0	33.3	0	12.12
Storage	5.46	4.29	10.19	1.36	9.65	0.67	0.33
Other costs (GH₵/100kg):							
Transportation	1.7	1.3	1.25	1.2	0.59	0.2	1.02
Sacks	6.45	7.15	7.03	6.8	6.7	7.4	7
Market rate	0.76	0.91	0.48	1.1	0.75	0.35	0.74
Total variable cost	152.88	125.63	175.62	135.52	180.75	142.58	144.75
Income above variable cost	105.17	152.505	105.58	137.84	90.6	148.98	31.12
Fixed costs (GH₵)							
Depreciation	1.46	3.14	4.9	3.2	1.9	2.16	2.81
Total fixed cost	1.46	3.14	4.9	3.2	1.9	2.16	2.81
Total cost	154.34	128.77	180.52	138.72	182.65	144.74	147.56
Net revenue per acre	103.71	149.365	100.68	134.64	88.7	146.82	128.31
Net revenue per 100kg bag	15.96	20.89	14.32	19.8	13.24	19.84	18.33

Source: Field data: 2012

Other production costs include planting, seed, weeding and harvesting. Producers in Tolon (GH₵152.505) recorded the highest gross margin whiles producers in Tamale recorded the least with GH₵ 90.6. In all, producers obtain net revenue of GH₵ 128.31 per acre of groundnuts. Drying costs constituted 19.2% of the total variable costs whiles sorting and storage accounted for 8.4% and 0.23% respectively.

Among the producers in the districts, the cost of sorting increase the total cost from GH₵ 123.98 to GH₵ 153.34 and reduce the net revenue from GH₵ 134.07 to GH₵ 103.71 in Tolon. In Savelugu, costs of sorting increase the total cost from GH₵ 152.26 to GH₵ 180.52 and reduced the net revenue from GH₵128.94 to GH₵ 100.6. In Tamale also sorting cost increase the total cost

from GH₵ 149.35 to GH₵ 182.65 and reduces the net from GH₵122 to GH₵88.70. Producers in Savelugu recorded the highest net revenue of GH₵ 134.64 for selling unsorted groundnuts whiles producers in Tolon also recorded GH₵ 103.71 for selling sorted nuts.This result is similar to previous studies that sorting reduces the quantity of groundnuts produced and marketed thereby reducing net revenue (Awuah et. al.,2009; Awuah and Kpodo,1996 and N'Dede, 2009). Estimated cost and benefit analysis for producers by N'dede et al., (2013) reported that the net revenue of producers decreases as they decide to sort. They further stressed that sorting reduces yield by 5% and increase labour costs which in turn reduces the net revenue of producers.

None of the producers interviewed store groundnut with chemicals. Savelugu producers who sort recorded the highest storage cost of GH₵1.4 which is about 1.2% of the total variable cost.

For producers who do not sort their groundnuts before sale, cost of drying accounted for 20.9% in Tolon, 23.7% in Savelugu and 22.8% in Tamale of the total variable cost. Cost of storage on the other hand also constituted 3.4%, 1% and 0.5% of the total variable cost in Tolon, Savelugu and Tamale respectively. With respect to producers handling 100kg bag of groundnuts, producers in Tolon had highest net revenue of GH₵ 20.89 for not sorting GH₵15.96 for sale of sorted nuts.

4.5.2 Enterprise budget for traders

The traders consist of the retailers and wholesalers in the study area.

4.5.2.1 Retailers

There are two categories of retailers in the study area, those who sort their groundnuts before selling and those who do not sort. The total average cost for drying, sorting and storage used for the enterprise budget is summarized in Table 4.10.

In handling 100kg bag of groundnuts, retailers in Tolon (₵45.81) and Savelugu (₵51.87) who sort groundnuts had lower net revenue than those who do not sort. However, retailers in Tamale (GH₵54.95) who sorted groundnuts had higher net revenue than those who do not sort.

Table 4.13: Cost and benefit analysis for retailers for handling 100kg bag of groundnut.

VARIABLE	TOLON		SAVELUGU		TAMALE		ALL
	SORT	DO NOT SORT	SORT	DO NOT SORT	SORT	DO NOT SORT	
Revenue (₵)	202	188	200	194	212	196	198.67
Purchasing cost per100kg(₵)	142.8	130	138.2	136.8	140.6	136.8	137.37
Transportation (₵)	1.28	0.91	1	1.12	0.78	1.24	1.05
Loading (₵)	0.7	0.45	0.5	0.52	0.54	0.6	0.54
Drying (₵)	1.6	1.55	1.85	0.7	2.2	1	1.48
Sorting (₵)	6.4	0	6.29	0	5.9	0	3.11
Storage (₵)	2.4	2.8	2.3	1.8	2.1	2.8	2.27
Market rate	1.17	1.28	1.38	3.85	2.8	0.95	1.61
Total variable cost	156.35	136.99	151.52	144.79	154.92	143.39	147.43
Income above variable cost	45.65	51.01	48.48	49.21	57.08	52.61	51.24
Fixed costs (GH₵)							
Rental (GH₵)	2.24	2.24	2.94	2.35	4.23	4.5	3.08
Total fixed cost (GH₵)	2.24	2.24	2.94	2.2	4.23	4.5	3.08
Total cost (GH₵)	158.59	139.23	154.46	146.99	159.15	147.89	150.51
Net revenue (GH₵)	43.41	48.77	45.54	47.01	52.85	48.11	48.16

Source: Field data: 2012

In all, retailers receive net revenue of GH₵48.16 for handling a 100kg bag of groundnut. The cost of drying, sorting and storage accounted for 2.07%, 1.51% and 0.98% respectively. The study further revealed that, cost of sorting which is the highest variable cost aside the purchasing cost, for the three different districts, accounted for 4.04%, 4.07% and 3.7% of the total cost in Tolon, Savelugu and Tamale. The cost of sorting in Tolon increased the total cost from GH₵152.59 to GH₵158.59 and reduced the net revenue from GH₵ 49.81 to GH₵48.77. In Savelugu the cost of sorting also increased the total cost from GH₵148.17 to GH₵154.46 and reduced the

net revenue from GH₵ 51.83 to GH₵45.54. However, in Tamale, the net revenue of retailers who sell sorted groundnut obtained higher net revenue than when they decide to sell unsorted nuts. This is quite inconsistent with other findings in literature (N'dede et al., 2012). Reason can be that, the prices received by retailers are high enough to offset the cost incurred during sorting. The gross margins for retailers in Tamale were higher for both those who sort and those who do not sort.

4.5.2.2: Enterprise budget for wholesalers

Table 4.16 shows the enterprise budget of wholesalers handling 100kg bag of groundnuts. The results from the table indicate that, wholesalers in Tolon had the highest net revenue of GH₵26.68 on 100kg than wholesalers in Savelugu (GH₵23.78) and Tamale (GH₵22.08). Apart from the purchasing cost which is the highest variable cost for all the wholesalers, transportation cost was higher as compared to the other variable cost such as loading, drying, sorting, storage, market rate and the renting of the structures. In all, wholesalers handling a 100kg bag obtained net revenue of GH₵23.81. Drying and Storage costs accounted for 1.1% and 0.23% respectively.

The total average cost for drying, sorting and storage used for the enterprise budget is summarized in Table 4.11

Table 4.14: Costs and benefit analysis for wholesalers

	TOLON	SAVELUGU	TAMALE	ALL
Revenue (100kg)	194	191	190	191.67
Purchasing cost per 100kg	163	159	161	161
Transportation (GH₵)	1	4.2	3.5	2.9
Loading (GH₵)	0.46	0.48	0.6	0.5
Drying (GH₵)	1.6	1.9	2	1.83
Sorting (GH₵)	0	0	0	0
Storage (GH₵)	0.36	0.47	0.35	0.39

Market rate (GH₵)	0.3	0.27	0.28	0.28
Total variable cost (GH₵)	166.36	165.85	167.38	166.9
Income above variable cost	27.64	25.15	22.62	24.77
Fixed costs (GH₵)				
Rental (GH₵)	0.96	1.37	0.54	0.96
Total fixed cost (GH₵)	0.96	1.37	2.94	0.96
Total cost (GH₵)	167.32	167.22	167.92	167.86
Net revenue (GH₵)	26.68	23.78	22.08	23.81

Source: Field data: 2012

All the wholesalers had access to long term storage facilities which most of the rent especially those who sell in the markets.

The gross margin (income above variable cost) of retailers GH₵51.24 was higher for handling 100kg bag than wholesalers (GH₵24.77) and producers (GH₵ 31.12).

The results for both wholesalers and retailers indicate that groundnut marketing is profitable. This result is consistent with Adinya (2009), Jolly et al. (2009), and N'dede (2009) and also of Hamidu et al., 2006 who stressed that groundnut marketing is a profitable business.

Result from the overall test for significant difference between the means of the net revenue from sorted and unsorted groundnuts of producers revealed no statistical significant difference between the net revenue of sorted groundnuts and unsorted groundnut t(73)=-.371,p=.712. This is summarized in table 4.15 below.

Table 4.15: Independent Samples Test

	Levene's Test for Equality of Variances	t-test for Equality of Means	
			95% Confidence Interval of the

		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Difference Lower	Difference Upper
Net Revenue	Equal variances assumed	.928	.339	-.371	73	.712	-18.09093	48.74745	-115.24446	79.06260
	Equal variances not assumed			-.348	48.941	.729	-18.09093	51.92245	-122.43617	86.25432

4.6 Effects of costs of quality enhancing activities on net revenue

Based on previous studies that aflatoxin contamination of groundnuts affect the quality and quantity of groundnuts produced and marketed and hence the net revenue, a log-linear regression model was used to establish the relationship between the cost of reducing aflatoxin contamination in groundnuts and the net revenue of groundnut actors. Table 4.17 provides information on the regression analysis of producers and traders.

Results from the regression analysis showed that, the costs sorting had a significant negative influence on the net revenue obtained by producers. Cost of sorting was significant at 1% producers. A 10% increase in sorting cost reduces the net revenue obtained by producers by 3.68%. There was no significant influence of the costs of drying and storage. However, a 10% increase in the cost of drying reduces the net revenue by 1.27% whiles the cost of storage increases the net revenue by 0.48%. This is quite different from the results of N'Dede et al., (2013); in aflatoxin and peanut production risks and net incomes. Their results showed a significant positive relationship between drying and net revenue as well as a negative influence of sorting and storage on producer's net revenue. A one standard deviation increase in the cost of sorting and storage reduces the net revenue of the producers by 0.085 and 0.030 standard deviation respectively whiles drying cost

increase their net revenue by 0.446. The authors added that, the effect of drying cost on net revenue resulted from effective drying of the groundnuts before sale.

Table 4.16: Determinants of net revenue obtained by producers, retailers and wholesalers

	Coefficients	Standard error	t-statistics	P>|t|
PRODUCERS				
lnExperience	-.124	0.154	-.806	0.423
lnselling price	1.619	0.790 0.095	2.050	0.044**
lnSorting Cost	-0.368	0.056 0.204	-3.872	0.000***
lnStorage cost	0.048	0.135	0.868	0.388
lnDrying Cost	-0.127		-0.622	0.536
lnQuantity harvested	1.165		8.613	0.000***
F (d.f)	17.386***(6)			
R^2	0.605			
Adjusted R^2	0.571			
RETAILERS				
lnQuantity handled	.929	.111	8.347	0.000***
lnPurchasing cost	-2.717	0.596 0.027	-4.560	0.000***
lnDrying	-0.017	0.129	-0.630	0.535 0.325
lnSorting	-0.129	0.065	-1.002	0.629 0.95
lnStorage	0.032	0.071	0.490	
lnExperience	-0.004		-0.057	
F (d.f)	26.451***(6)			
R^2	0.873			
Adjusted R^2	0.840			
WHOLESALERS				
lnQuantity handled	1.248	0.055 1.183	0.145	8.612
lnPurchasing cost	-1.013	0.034 0.069	8.612	0.000***
lnDrying	-0.002	0.201	-0.054	0.957 0.783
ln Storage	-0.019		-0.279	0.753
ln Experience	-0.064		-0.318	
F (d.f)	22.313***(5)			
R^2	0.823			
Adjusted R^2	0.786			

Source: Field Data, 2012, *, **, ***, indicates significance at 10%, 5% and 1% respectively.

Other variable costs such as selling and quantity harvested had a significant positive relationship with net revenue. As the quantity and selling price increases, net revenue also increases, ceteris paribus. A 10% increase in the selling price per unit will result in 16.19% increase in the net

revenue for producers. Also, a 10% increase in the quantity harvested results in about 11.65% increases in the net profit.

There was a negative relationship between the costs of drying and sorting on one hand and net revenue on the other hand of the retailers. The profit obtained by retailers' decreases by 0.17% and 1.29% when the cost of drying and sorting increases by 10% respectively. Also the cost of storage (10% increment) also increases net revenue by 0.32%. This is inconsistent with a study by Afolabi (2009) who indicated that cost of storage accounted for 0.25% of the total cost which negatively influences net revenue.

Quantity handled by retailers was significantly and positively related to net revenue. The net revenue increases by 9.29% when the quantity handled increase by 10%. There was a significantly negative relationship between purchasing price and net revenue of retailers. As the purchasing cost increases by 10%, net revenue also decreases by 27.17%. The cost of drying and storage negatively influences the net revenue of wholesalers. Profit of the wholesalers decreases by 0.02% and 0.19% with a 10% increase in the cost of drying and storage respectively.

N'dede et al., (2012) in: Economic analysis of aflatoxin contamination in marketing of groundnut in Benin also revealed a negative relationship between purchasing price and the cost of sorting and the net revenue of traders. The net revenue of traders decreased by 7.53 and 2.28 standard deviation when there was a one standard deviation increase in purchasing price and sorting cost increase. The regression results on the cost of storage are quite different from previous studies which have shown a negative relationship between the cost of storage and net revenue. This is an indication

of market actors getting premium price which are commensurate with the cost. Reasons can also be attributed to the fact that groundnuts were not stored up to six months since studies by Hell et al., (2000) and Jolly et al., (2009) revealed that groundnuts stored for more than six months have low quality hence attract lower prices.

Awuah and Kpodo (1996) and Hamid (1997) said mouldy, broken and shrivelled groundnuts usually have high levels of aflatoxin so must be sorted out to minimize the contamination of the groundnuts. This reduces the quantity produced and marketed as well as the net revenue.

Nwaru et al., (2011) in Socioeconomic Determinants of Profit in Wholesale and Retail Banana marketing in Umuahia Agricultural Zone of Abia State, Nigeria, also found a similar result. They stressed that the quantity of bananas that a marketer handles defines his scale of business operation. Ceteris paribus, the higher this scale, the higher the marketing profit because of possible economies of scale.

The result is also similar to Bassey et al., (2015) in analysis of fresh fish market who stressed that Storage and purchasing cost were negatively significant at 5% and 10% on the net revenue of fish marketers.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter entails the conclusions and recommendations based on the survey conducted from the study area.

5.1 Summary

In summary, more than half of the respondents were aware of aflatoxin contamination in groundnut but awareness of the wholesalers were lower compared to the retailers and producers.

Awareness of aflatoxin contamination in groundnut was not dependent on the socio economic characteristics (age, gender, education and years of experience) of respondents except for retailers where education and years of experience were significant at 1%.The cost of the aflatoxin contamination reducing activities increased the total cost thereby reducing the net revenue obtained by the producers and traders.

The enterprise budget revealed that, groundnut production and marketing is a profitable business. Net revenue of producers and retailers who sort before sale is lower than when they decide not to sort. However, retailers in Tamale who sold sorted groundnuts obtained higher net revenue than those who did not sort.

The cost of aflatoxin reducing activities (drying and sorting) negatively influences net revenue except for the cost of storage which had a positive influence on the net revenue for producers and retailers. The net revenue obtained by wholesalers was negatively influenced by drying cost and positively influenced by the cost of storage.

5.2 Conclusion

This study entails the effects of the cost of activities associated with the reduction of aflatoxins in groundnut. It compares the costs and benefits of producers and marketers who undertake activities such as sorting, drying and storage to improve the quality of the nuts thereby reducing aflatoxin contamination in the groundnuts. The study also examined the socio economic factors that

influence the knowledge of aflatoxin awareness of producers and traders in the study area as well as the effects of these activities on the net revenue of producers and marketers who undertake these quality enhancing activities.

The descriptive statistics revealed that most of the respondents in the study area were in the economic active age (41-60 years). Production in the study area was dominated by males (82.7%) whiles trading activities were dominated by female except for wholesaling (90) which was dominated by males. Majority of the producers and had no education with very few of the retailers (3.3%) having tertiary education. With experience in production and trading, most of the producers and traders had ten years of experience. None of the respondents had more than twenty of experience in either production or marketing of groundnuts. Producers had an average farm size of 2.2 acres with an average output of 19.5 100kg bag. Retailers and wholesalers handled an average bag (100kg) of 3.3 and 87.3 respectively although most of them handle between 1-3 bags (retailers) and 51-100 bags (wholesalers).

Generally the knowledge of aflatoxin contamination in groundnut for producers and retailers is quite high than the wholesalers. More than half of the respondents were aware of aflatoxin contamination in groundnuts which is different from a previous who revealed that, up to 90% of farmers, processors and consumers were not aware of aflatoxin (Jolly et al., 2006; Awuah et al., 2009 and James et al., 2007).

However, general health effects on animals and humans were low by traders. Stomach ache is the disease most respondents thought could be the specific disease associated with the aflatoxin contamination when consumed but studies on health effect of aflatoxin revealed that, aflatoxin is most potent natural carcinogenic substance and has been linked with a higher prevalence of hepatocellular cancer (Strosnider et al., 2006; WHO, 2008 and Wu, 2010).

The knowledge and awareness of aflatoxin contamination in groundnut was not dependent on the socio-economic characteristics (age, gender, education, and years of experience) of respondents except for retailers where education and years of experience were significant at 1%. This result was consistent with findings from related studies by Jolly et al., (2009).

The study also revealed that less than 50% of the producers harvest early and dry pods on the field. About 67% of the producers 13% of retailers and 16.7% of the wholesalers dry in the house. Post-harvest activities aimed at reducing aflatoxin contamination included early harvesting, drying pods on the field and house, sorting before and after drying, sorting to remove damaged. Length of drying of pods whether on the field or at home is greatly influenced by the intensity of the sun. Most of the producer for one week whiles traders dry for a maximum of three days.

Sorting is mainly done by hand picking. Sorting reduces the quantity of groundnuts produced and marketed. From the literature, consuming contaminated groundnut by aflatoxin is harmful to the health of those who consume it; be they humans or animals. Likewise the contamination of other nuts by aflatoxin in storage, most of the respondents are sure that, aflatoxins contaminate other nuts when stored together.

Groundnut production and marketing is a profitable business. The enterprise budgets revealed that, net revenue of the producers and retailers who sort groundnuts before sale is lower than when they decide not to sort. Cost of sorting, drying and storage increases the total costs thereby reducing net revenue all things being equal. Retailers in Tamale however had a different report in that, the retailers who sold sorted nuts obtained higher revenue than the retailers who did not sort. This can be as result of the retailers having high prices for producing quality groundnuts. This result differs from previous studies where sorting affect quantity of groundnuts marketed hence reducing net revenue (N'dede et al., 2012; Awuah et al., 2009 and Kaaya et al., 2006).

Results from the regression analysis showed that, the costs of sorting, quantity harvested and selling price had a significant negative influence on the net revenue obtained by producers. However, storage cost had positive relationship with net revenue received by retailers and producer's whiles drying cost had a negative influence. A 10% increase in sorting cost reduces the net revenue by 3.68%. Other variables such as experience also showed a negative relation on net revenue. As the years of experience increase by 10%, net revenue also decreases by 1.24% revenue. Drying and sorting costs had a negative influence on retailer's net revenue whiles storage cost had a positive influence. A 10% increase in the storage cost of retailers increases their net revenue by 0.32%. Net revenue obtained by wholesalers was negatively influenced by the cost of drying by 0.02% and 0.19% respectively when these costs increase by 10%. Other cost like purchasing cost showed a significant negative effect on net revenue of the traders whiles quantity handled had a positive significant effect. As the quantity handled by traders increase, all things being equal, net revenue also increased. This is similar to a study by Nwaru et al., (2011) and Mwakaje and Nyunza (2012), who revealed the quantity handled and profits are positively related.

The regression result also reported a negative effect on net revenue obtained by traders which is not consistent with previous studies (Agwu, 2009) where there was a significant and positive relationship between experience and net revenue.

5.3 Recommendation

The Ministry of Food and Agriculture (MoFA) together with the Ministry of Health (MoH) should embark on awareness creation especially on the health and economic effects of aflatoxin contamination through public education.

There must also be education and sensitization on proper pre-harvest and post-harvest activities which can reduce contamination and lead to the supply of quality groundnuts since awareness of aflatoxin contamination was dependent on education.

There should also be conscious effort by market actors to segment the groundnut market on the basis of quality to allow for premium price to compensate actors for the extra cost incurred in embarking on aflatoxin reducing activities. To this end, proper labeling of sorted and high quality groundnut should be explored.

In order to restrict exposure to aflatoxins contamination, appropriate policy must be formulated by decision makers emphasizing on the health implication of its ingestion.

Safety regulations must be set to limit the average concentration of aflatoxins on groundnut and groundnut products.

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APPENDIX: QUESTIONNAIRES

EFFECT OF POST-HARVEST AFLATOXIN CONTAMINATION REDUCING ACTIVITIES ON GROUNDNUT MARKETING IN NORTHERN REGION OF GHANA

PRODUCERS

A. BACKGROUND INFORMATION

1. Location: …… Qn Code No. …….

2. Sex: 1. Male…../ 2. Female ……./ Age…….

3. Household size? 1. Males (above 18yrs)… 2. Females…/ 3. Children (below 18yrs)……

4. Main Occupation (in terms of income): 1……../. 2. Other occupation ……../

5. Number of years in main occupation 1……../ 2……/

6. Source(s) of income for household 1. ……../ 2. ……./ 3. ….……/

B. AFLATOXIN KNOWLEDGE AND AWARENESS

Answer the question by circling the most appropriate answer.

1=strongly not aware 2=not aware, 3=somewhat aware, 4= aware, 5=strongly aware

7. Are you aware of aflatoxin contamination of groundnuts? 1 2 3 4 5

8. Are you aware of aflatoxin contamination of maize? 1 2 3 4 5

9. Are you aware of health effects of aflatoxin to animals? 1 2 3 4 5

10. Are you are aware of the health effects of aflatoxin on human? 1 2 3 4 5

11. Explain the health effects: _____

What is your opinion on the following: (Qn 12-16)

1=no/not sure, 2=may be, 3=somewhat sure, 4= sure, 5=fully sure

12. Damaged and broken nuts do not spoil the others in storage.1 2 3 4 5

13. Discolored grains are harmful when eaten 1 2 3 4 5

14. Damaged and broken grains spoil the others in storage. 1 2 3 4 5

15. Do you think sorted groundnuts sell at a higher price than unsorted ones? 1 2 3 4 5

16. Do you think groundnuts stored in bags on wooden platforms in the room are sold at a better price per bag than those stored in bags on the floor? 1 2 3 4 5

17. Do you discuss aflatoxin with your neighbors? 1= yes 2=no

18. If yes, at what time? _____

C. PRODUCTION INFORMATION

19. Do you own or hire the land you cultivate? 1. Own / / 2. Hire / / 3. Other (specify)……/

20. If hired how much do you pay for the season?...../

21. How do you grow your groundnut? 1. Pure stand / / 2. Intercrop / / 3. Other (specify)

……

22. If intercrop what are the other crops? 1. Maize / / 2. Sorghum / / 3.Millet / / 4. Cowpea / / 5. Other (specify)……

23. What is the amount of land used for producing groundnuts?.....acres.

24. For how long have you been cultivating on this piece of land?.....years

25. How often do you cultivate on this land? 1. Yearly / / 2. Once in two years / / 3.Other (specify)…….

26. Where do you get your planting seeds from? 1. Previous harvest /__/ 2. MoFA-certified /__/ 3. Other (specify)…….

27. How much do you spend on seeds per acre if not from previous harvest?.....

28. Which cultivar of groundnut do you grow? 1. F-Mix /__/ 2.Chinese /__/ 3. Valencia /__/ 4.Manipinta /__/ 5. Other (specify)…….

29. Why do you grow this cultivar? 1. High yield /__/ 2. Disease and Pest resistant /__/ 3.Consumer preference /__/ 4.Other /__/ specify……..

30. Which of these methods do you use to prepare the land before planting? 1. bullock/donkey plough /__/ 2. Tractor plough /__/ 3.Slash and burn /__/ 4. Other/__/ specify……..

31. Which of these do you practice when planting groundnuts? 1. Use of Planters /__/ 2. Manual (hand) planting /__/ 3. Other /__/ specify……

Table 1: Pesticides, herbicides and fertilizer used for production

	Type	Quantity used	Cost involved
Pesticides			
Herbicides			
Fertilizer			

32. What is your total production in bags of unshelled groundnuts? ...../

33. What are the problems you face in cultivating groundnuts? 1. Land /__/ 2. Capital /__/ 3. Pest and Diseases /__/ 4.Marketing /__/ 5. Other/__/specify……

1=not necessarily, 2=as often as I can, 3=always

34. I plant at the onset of rain 1 2 3

35. I look out abnormal-looking seeds during planting. 1 2 3

36. I apply pesticides to the crops when they are in the field 1 2 3

37. I harvest when the ground is dry 1 2 3

38. I am careful about damaged pods during harvesting.1 2 3

39. Which method do you use in harvesting groundnuts? 1. Manual/hand-pulling /__/ 2. Mechanical /__/ 3.Other /__/ specify……..

40. Which method do you use to shell groundnuts after harvesting? 1. Sheller /__/ 2. Manual (hand) shelling /__/ 3. Other/__/specify……

41. Do you hire labor for any activity in producing the groundnuts? 1. Yes /…./ 2. No/…../ 42. if yes complete the table below for a one acre farm size

Labour activity	1.Hired 2. Family	Num. of days	Costs involved
Ploughing			
Planting			
Weeding			

Application of fertilizer			
Application of pesticides			
Application of herbicides			
Harvesting			

D. SORTING INFORMATION

43. Do you sort out groundnuts before sale? 1. Yes/__/ 2. No /__/

44. Why do you sort groundnuts? 1. Attraction of customers /__/ 2.Attraction of higher price/__/

3. Ensure good quality/__/ 4. Other (specify)……

45. Do you sort out groundnuts before consumption? 1. Yes/__/ 2. No /__/

46. If Yes, is it for 1. Taste…. 2. Health reasons…… or 3. Other …….. ?

47. What method do you use in sorting? 1. Handpicking (manual) /__/ 2. Colour sorting machine /__/ 3. Other /__/ specify.....

48. Who does the sorting? 1. Women 2. Men 3.Men and women 4.Children 5. The whole family (Number …W, ….M ….Children)

49. How long (hours) does it take to sort one maxi bag of shelled groundnut by 1. One woman, 2.One man…… 3. One man and woman……..

50. What is the quantity you lose in sorting a 100kg bag?

51. What is the cost of the quantity you loosed from sorting?

52. With your knowledge of local market conditions do you think it is profitable to sort groundnuts before sale? 1. Yes ……./ 2. No. ……./

53. How much is unsorted groundnuts (shelled) sold per 50kg bag? …….cedis

54. How much is sorted groundnuts (shelled) sold per 50kg bag? …….cedis

55. Does sorted groundnut takes longer time to sell?1. Yes…./2. No……/ 3. Can't say…../ 56. What other activities do you do apart from sorting to improve the quality of groundnut?

i).....ii)..... iii)…….. iv…….

57. What are some of the challenges you faced in sorting your groundnut?

E. STORAGE INFORMATION

58. Do you dry your groundnuts before storing? 1. yes / / 2. no / /

59. How do you dry your groundnuts? 1. Mechanical dryer / / 2. On the ground / / 3. On tarpaulins / / 4. Other (specify)…….

59b. cost of drying 100kg bag……

60. In what form do you store harvested groundnut? 1. Shelled /__/ 2. Unshelled /___/

61. Where do you store your groundnuts? 1. Own storehouse / / 2. Community storehouse / / 3. House / / 4.farm / / 5. Other (specify)…….

62. How do you store the groundnuts? 1. In bags/ / 2. Baskets / / 3. Other (specify)…….

63. Do you think that adherence to MoFA recommended practices will help reduce fungal infestation in groundnuts?

64. For how many months do you think groundnuts should be stored before sale?

65. Why do you think so? …….

66. What do you do to prevent groundnut from developing mould?.....

67. What are some of the challenges you faced in storing your groundnut?

F. MARKETING INFORMATION

68. In which form do you sell groundnut? 1. Fresh /__/ 2. Roasted /__/ 3. Paste /__/ 4. Groundnut oil /__/ 5. 'kulikuli'/__/

69. Who are your customers 1.processors / / 2.Wholesalers / / 3.Retailers / / 4. Consumers / / 5. Anybody /__/ 6. Institutions (eg. schools, hospitals) /__/ 7. Others (specify) /____/

70. Where do you sell your groundnuts? 1.Market/ / 2. Farm gate/ / 3. house/ / 4. other(specify)……

71. If market what are the cost involved transporting it to the market……

72. Do you any market rate in the market before you sell? 1. yes / / 2. no / /

73. If yes how much do you pay? .....

74. Of the quantity you harvested, how much did you:

A. sell……at a price…….?

B. barter?……

C. retained for planting?…….

D. retained for consumption?……..

E. loose due to spoilage?

75. What quantity do you sell per season on the average?

……..

76. What are some of the challenges you faced in marketing your groundnut?

G.EQUIPMENTS AND MACHINERY

77. The table below specifies the type of machinery used, indicate if owned or hired and the cost involved.

Equipments	1.owned 2. Hired	quantity	No. of years	cost involved
Tractor				
Truck				
Cutlass				
Hoes				
Backpack Sprayer				
Weighing scales				
Bagging machines				
Storage facility				
Drying machines				
Other (specify)				

TRADERS

A. BACKGROUND INFORMATION

1. Location: ……Qn. Code....……

2. Sex: 1. Male…../ 2. Female ……./ Age……..

3. Household size? 1. Males (above 18yrs)… 2. Females…/ 3. Children (below 18yrs)……

4. Main Occupation (in terms of time spent/year): 1……../. 2. Other occupation ……../

5. Number of years in main occupation 1……./ 2……/

6. Source(s) of income for household 1. ……../ 2. ……./ 3. ….……/

B. AFLATOXIN KNOWLEDGE AND AWARENESS

Answer the question by circling the most appropriate answer.

1=strongly not aware 2=not aware, 3=somewhat aware, 4= aware, 5=strongly aware

7. Are you aware of aflatoxin contamination of

   groundnuts? 1 2 3 4 5

8. Are you aware of aflatoxin contamination of

   maize? 1 2 3 4 5

9. Are you aware of health effects of aflatoxin

to animals?

10. Are you are aware of the health effects of

aflatoxin on human? 1 2 3 4 5

11. Explain the health effects: _____

What is your opinion on the following: (Qn 12-16)

12. Damaged and broken nuts do not spoil the

others in storage. 1 2 3 4 5

13. Discoloured grains are harmful when eaten 1 2 3 4 5

14. Damaged and broken grains spoil the others in storage.

1 2 3 4 5

15.Do you think sorted groundnuts sell at a higher price than unsorted ones? 1 2 3 4 5

16.Do you think groundnuts stored in bags on wooden platforms in the room are sold at a better price per bag than those stored in bags on the floor? 1 2 3 4 5

17. Can you identify spoilage in any of the above food items you consume? /____/

(1=Yes, 2=No)

18. How much of your food is usually spoilt? /____/ %

(1=handful, 2= a bucketful, 3=more than a bucket full

19. What do you do with food items you consider to be spoilt? _____

Any other information _____

C. MARKET INFORMATION

22. What kind of trader are you? 1. Wholesaler / / 2. Retailer / / 3. Others (specify)……

20. How many years have you been trading? ……..

21. Is trading your only source of income? 1. yes / / 2. no / /

22. If no what are the other sources?

I.....

II. ……

III. ……..

23. Is groundnut the only commodity you trade in? 1. yes / / 2. no / /

24. If no what other commodity do you sell?.

I. .....II……III…….....

25. Where do you purchase your groundnuts? 1. Farmers / / 2. Wholesalers/ /3. Retailers / / 4. Other / / (specify) ……

26. Who are your customers? 1. Consumers / / 2. Other(specify).....

27. In which form do you purchase your groundnut? 1. Fresh / / 2. Shelled / / 3. Unshelled / / 4. Other/ / specify……

28. Where do you purchase your groundnut? 1. Farm gate/ / 2. Market / / 3. Other (specify)……..

29. In what unit do you normally buy the groundnuts? 1. olonka / / 2. Basket / / 3.50kg bag/ / 4. 100kg bag / / 5. other (specify)……..

30. What is the quantity of groundnuts you last purchased? ... …… 31. What is the cost of the quantity you purchased during the last season?

.....

32. How do you transport your purchased groundnut? 1. Truck / / 2. Ox cart/donkey / / 3. Wheelbarrow / / 4. Head pan / / 5. Other (specify)…….

33. What is the cost involved in sending it to its destination including on and off loading?.....

34. Where do you sell your groundnuts? 1. Market / / 2. Neighbouring villages/ / 3. Other (specify)……..……..

35. If the market how much do you pay for the place?.....

36. How much tax do you pay for the year?.....

37. How much do you pay as a market rate daily? ……

38. To whom do you sell your groundnuts to? 1. Processors / / 2. Retailers / / 3. Consumers / / 4. Other (specify)……..

39. At what unit do you sell your groundnuts? 1. 50kg bag / / 2. 100kg bag / / 3. Other (specify) .....

40. How much do you sell per this unit?.....

41. How many days do you use to sell the groundnuts you purchase?.....

D. SORTING INFORMATION

41. Do you sort the groundnuts before selling? 1.yes / / 2. No / /

42. Why do you sort groundnuts? 1. Remove damaged discoloured nuts /__/ 2. Remove broken nuts /__/ 3. Remove stones and foreign materials /__/ 4. High prices 5. Other (specify)……

43. What method do you use in sorting? 1. Handpicking (manual) /__/ 2. Colour sorting machine /__/ 3. Other /__/ specify.....

44. Who normally do the sorting? 1. Hired labour ( ) 2. Family labour ( )

45. What is the cost involved in sorting a 100kg bag of groundnuts if labour is hired?

46. What is the quantity you lose in sorting a 100kg bag?

47. What is the cost of the quantity you loosed from sorting?

48. What are some of the benefits you get from sorting out bad nuts? 1. High price...../ 2. Sale of produce promptly ...../ 3.Loyal customers...../ 4. Others ...../

49. What are the costs or disadvantages you face for sorting out bad nuts? 1. High cost .....cedis/bag) 2. Absence of labour for other activities,...../ 3. Low profit...../

D. STORAGE INFORMATION

50. Do you dry the groundnuts before storing them?1. Yes / / 2. No / /

51a. Why do you dry your groundnuts before selling? .....

51b. cost of drying 100kg bag

52. Do you store some of the groundnuts you sell? 1. Yes / / 2. No / /

53. Do you have access to long term storage facilities? 1. Yes / / 2. No / /

54. Do you own or rent a storage facility? 1. own / / 2. rent / /

55. What is the capacity of the storage facility?.....

56. Do you store the groundnuts with any other crops? 1. Yes / / 2. No / /

57. If yes what are the other crops? .....

58. Do these crops affect the groundnuts in anyway? ..... 59. If yes complete the table below

Method of storage	Cost of storage/bag	Quantity stored	Period of storage(days)	quantity lost/bag due to storage
TOTAL STORAGE COST				

Answer by circling the most appropriate answer.

1=no, I do not plan to do so in the near future, 2=no, I am planning to do so in the near future,

3=no, I am planning to soon, 4=yes, I did it last time, 5=yes, I do it all the time

60. I buy thoroughly sorted groundnuts 1 2 3 4 5

61. I sort my grain/nuts before selling.	1	2	3	4	5
62. I store my grain/nuts in a dry place.	1	2	3	4	5
63. I discard the spoiled nuts	1	2	3	4	5
64. I use the spoiled nuts to make oil.	1	2	3	4	5
65. I use the spoiled grain/nuts to feed animals.	1	2	3	4	5
66. I inspect the products thoroughly before buying	1	2	3	4	5
67. I consider the source of the products before buying.	1	2	3	4	5
68. I store my products in disinfected area.	1	2	3	4	5

The following questions are designed to solicit your personal opinion. Please provide answers to the best of your ability about your food purchases and storage.

69. What are the problems you face in marketing your groundnut?

.....