The Role of Women in Post-Harvest Handling of Peanuts: The Case of Reducing Aflatoxin Along the Supply Chain in Ghana

by

Akua Adu-Gyamfi

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Approved by

Michelle R.Worosz, Chair, Associate Professor of Rural Sociology
Conner Bailey, Professor of Rural Sociology
Arianne Gaetano, Assistant Professor Sociology

Abstract

Peanuts are an important food and cash crop for rural farmers in Ghana. However, contamination of peanuts by aflatoxins, which have been linked to food poisoning and health related problems such as liver cancer and malnutrition in children, poses a threat to the country's public health sector. Contamination typically occurs during post-harvest operations like drying, sorting, processing and storage where women play a major role. This role positions the women as the main controllers of aflatoxin contamination and food safety. This study determines factors that influence supply chain participants awareness of aflatoxin and post-harvest handling practices. Based on face-to-face interviews with participants in the peanut supply chain, this thesis addresses factors affecting chain actors' involvement in post-harvest activities and their awareness of aflatoxin contamination. This thesis finds that socio-demographic factors such as age, household income, and household size significantly influence women's role in peanut post-harvest handling activities. Further results show that agricultural training was a significant determinant of awareness of aflatoxin and womens' role in ensuring food safety in peanut post-harvest along the supply chain.

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CHAPTER 1: INTRODUCTION

Worldwide peanut production is about 34.4 million metric tons per year, with China, India and the U.S being the leading producers (World Peanut 2009). A total of approximately 1.25 million tons of peanut is exported worldwide. The leading peanut exporters are the U.S., Argentina and China. Countries such as India, Vietnam and several African countries periodically enter the world market depending upon their crop quality and world market demand (Revoredo and Fletcher 2009). In Africa, peanut serves as an important staple food and cash crop for most rural farmers.

Peanut seeds are reported to be a nutritional source of niacin, zinc, iron, riboflavin, thiamine and potassium (Okello et al. 2010). Peanuts contain protein (23-25% content), fat (40-50%), oil (40-52% content), and (10-20%) carbohydrates (Savage and Keenan 1994). In addition it is also a great source of plant protein for households who cannot afford animal protein. Peanut are consumed raw, roasted and processed into peanut butter, crushed, and mixed with traditional dishes in many parts of Africa.

Women in rural Africa are the main stakeholders in peanut production at the subsistence level as a way to provide food for their households (Wemin and Geob 2004). Their involvement is mostly during harvesting and post-harvest handling activities such as drying, storage and sorting of peanuts. In addition they are involved in marketing of peanut as a way to earn income. However, in rural Africa the peanut industry faces a major problem known as aflatoxin contamination.

Aflatoxins impede export of peanuts from Africa on the international markets and it is also a known carcinogen associated with liver cancer (Jolly et al. 2007). The bulk of aflatoxin contamination occurs during post-harvest handling activities and marketing of peanut where the majority of workers are women. Very little is known about womens' activities during post-harvest handling in the peanut supply chain in Ghana. Some believe their contribution to the peanut supply chain is highly understated and not well documented (Swantz 1985; Amu 2004; Kayaa and Christie 2007). This thesis investigates women's work in peanut post-harvest handling activities (drying, sorting, storage and processing) and marketing in Ghana. By learning about their work in post harvest handling we will understand where it might be possible to reduce aflatoxin contamination along the peanut supply chain. The following objectives are addressed in this study.

- To determine the factors influencing supply chain actors' awareness of aflatoxin contamination in peanut.
- To determine the factors affecting supply chain actors' decision to dry, sort and store peanut.
- To determine if supply chain actors are financially compensated during post-harvest activities.

These objectives were met by conducting a face-to face survey with women stakeholders along the supply chain in Ghana. Logistic regression was used to examine selected factors assumed to influence participants' awareness of aflatoxin contamination in peanut and their decision to sort, dry and store peanuts.

Women in Agriculture in Africa

Agriculture provides employment and livelihood for most people in Africa (Olawepo and Fatulu 2012). The African Development Bank (2009) estimated about 70 percent of people in Africa are employed through diverse agricultural systems. Boserup (1970) discusses three types of agricultural systems: female, male, and mixed farming. Female farming systems are practiced in some countries in Africa and Latin America and in certain areas of India. It is characterized by slash and burn agriculture, communal land ownership, and the use of the hoe. Except for land clearing, most of the farm work in this system is done by women. Such women tend to be economically independent and mobile. Production surpluses are traded to supplement subsistence earnings and to support themselves and their children.

Boserup (1970) further described male farming system as mainly based on land ownership, the use of draft animals and the plow. In this system, field labor is done almost entirely by men and is supplemented by hired labor. If women contribute to this type of farming at all it is during harvesting or post-harvest handling. Thus, women tend to be excluded from major income earning activities. Consequently, they become dependent on men for economic support.

Mixed farming, which follows and shares many of the characteristics of male farming systems, emerged as result of increasing human populations. Mixed farming requires year-round intensive cultivation and multiple cropping, facilitated with irrigation and technology. Labor demand is high, and despite social norms, women are drawn into such tasks as weeding, transplanting, harvesting and post-harvest activities (Boserup 1970).

Boserup (1970) reported that female farming systems have disappeared due to the introduction of cash crops. This has resulted in a shift from female oriented farm activities to male dominated ones. This trend dates back to colonial times when European administrators and technical advisers introduced cash crops and modern agricultural technologies into existing farming systems. Farm harvests greatly increased as well as the amount of labor required on farms. As a result of this, the plow replaced the hoe in female agricultural systems. Using the plow required a lot of strength and mobility and therefore became a job for men. Men, therefore, took credit for developing a highly productive export-oriented farming sector while women were left behind in the traditional low-yielding subsistence farming sector. As a consequence, women lost control over farming, as well as the economic autonomy derived from farming. Women farmers are less likely than men to use modern inputs such as improved seeds, fertilizers, pest control measures and mechanical tools (Saito 1994). Finally, women have less education and less access to extension services, which also reduces their chances to gain access to information and the use of other agricultural inputs such as land, credit and fertilizer. Saito and Surling (1993) reported that inadequate information about improved agricultural technologies was one of the constraints in agricultural production. Women do not have adequate access to agricultural information and innovation. These factors also prevent women from adopting new technologies as readily as men in the performance of their agricultural activities (FAO 2011).

Buvinic and Mehra's (1990) research on women in agriculture largely supported Boserup's (1970) insights in terms of variations in women's participation in different farming systems. However, their analysis on the less visible activities of women (e.g., domestic production, seasonal wage labor) showed that women make greater contributions to agriculture than those postulated by Boserup. It has been well noted in recent years that women make substantial contributions to food production and agricultural labor, even when they are secluded or in male-dominated farming systems. In Africa, women in agriculture comprise approximately 70 percent of agricultural workers and 80 percent of food processors (Rahman 2010; Banwo 2011; Olawepo and Fatulu 2012).

Traditional division of farm work exists by sex and is subject to socioeconomic and agro-ecological variations. Women are particularly active in growing food for subsistence, in weeding, post-harvest storage and processing, small-scale marketing of agricultural produce, and the care of livestock (Buvinic and Mehra 1990). Spieldoch (2007) reports that 80 percent of foodstuffs for household consumption and for sale in sub-Saharan Africa are provided by women. Men grow cash crops for sale in local, national, and international markets. In many parts of Africa, for instance, where women's participation in farm work is traditional and well recognized, and female farming systems in a sense still exist, there are female crops (e.g., peanuts, maize, cassava and other roots and tubers) and male crops (e.g.,sheabutter and cotton) (Buvinic and Mehra 1990). Bosurep found that women in general are more involved in farming activities and spend more hours per week working on farms (Bosurep 1970). Women’s contribution to farming work varies even more widely depending on the specific crop and activity.

Division of farm tasks is more rigid where cultural norms are strongly adhered to. It breaks down easily in response to changes in demand for farm wage labor and household labor. Rural poverty and the shortage of farm labor expand women's participation into male ascribed farm tasks. Presvelou (1979) also reported that, women in Africa perform their agricultural duties in addition to their domestic and reproductive responsibilities.

Little attention has been paid to revenue generated from home gardens and backyard farming which often contribute an important share of the household budget (Creevey 1986). Women face a serious gender gap in accessing productive resources (Klasen and Lamanna 2009). Women control less land than men and the land they control mostly has low-yielding potential for food crops (Holmes and Jones 2009). About 85 percent of all agricultural lands in Africa are jointly owned by families or individually owned by the men (FAO 2006). The U.N (2009) reported that access to land and control over its use are the basis for food and income production in rural areas, and more broadly, household well-being. In addition, it was noted that, lack of direct control of land places boundaries on women's productive roles and diminish their power and influence in the household (Meizen-Dick et al. 1997)**.**

Women in Peanut Production

In Africa, peanut yields are traditionally low due to a combination of unreliable rains, little technology available to small scale farmers in the form of mechanization and agrichemicals, pests and diseases, poor seed varieties (i.e., easily attacked by pests), and increased subsistence cultivation on marginal land due to rising commercial use and increase in population (Reynaud et al. 1989). Political instability and non-supportive small farm policies have also negatively impacted peanut production in Ghana. Because of these reasons, there has been an increased demand for women's support groups for home gardening and farming projects. Peanuts, originally grown by women in Africa as a way to supplement their families' diet, has now become a platform for women to earn cash income (Kenny and Katrina 2004). Access to cash increases women's empowerment and participation in the economy (ICRISAT 2001). Women have been found to value peanut harvests for many reasons, including:

- Profits from peanut harvest can be used to send children to school.
- The peanuts provide a high energy and protein food source for their children.
- The peanut oil can be used for cooking.
- Peanuts makes a high quality feed for cattle.

In Ghana, peanuts are farmed commercially and on a subsistence level. The highest level of production is in the Northern zone which is also the leading consumer of peanuts in Ghana (Jolly et al. 2009). More than ninety percent of farm families are involved in peanut production in the region (Tsigbey et al. 2003). Although trends in Ghana have been irregular since early 2000's, peanut production has recently recorded substantial increases. For instance, 2009 recorded the highest production in tonnes of peanuts in Ghana (Table 1.1). This is because of the introduction of high yielding peanut varieties, subsidized governmental inputs such as fertilizers and the gradual adoption of mechanization such as the use of tractors (Nin-Pratt et al. 2011).

Table 1.1 National Production of Peanuts, 2000-2009

Year	Area Cropped (ha)	Quantity (tonnes)
2000	218,000	209,000
2001	254,000	258,000
2002	384,000	520,000
2003	464,700	439,000
2004	431,667	389,649
2005	450,000	420,000
2006	480,000	520,000
2007	341,640	301,770
2008	350,660	470,100
2009	336,500	485,100

Source: FAOSTAT (C), FAO Statistics Division March, 2012.

Unfortunately, the peanuts produced and consumed and the excess traded in urban and rural markets tend to be poorly handled and stored prior to marketing. In Ghana, rural women who are involved in harvesting of peanuts tend to carry them on their heads, in sacks (Figure 1.1) or pans, from the farms to their homes. This may be very tedious especially in situations where the farm land is located further away from their homes. It also exposes peanuts to injury due to mishandling when transporting. In some cases, transportation such as tractor, cart, or motorcycle

(Figure 1.2) is used to bring the harvested nuts home. Drying is done immediately at home, and also done by women. Typically the nuts are dried in the sun by spreading them on the bare ground or on a prepared wooden surface above the ground. Individuals also carry the nuts in and out of storage and sort them either by color change or by sizes. Peanuts attacked by insects are also culled by women under trees or in front of their compounds, often sorting together in groups. In addition, women are entirely responsible for the storage of peanuts in sacks. This takes place in mixed-use storage rooms by groups of individuals. These storage houses are made of mud or clay and have poor ventilation. Furthermore, women are also involved in shelling the nuts. To make shelling easy, they sprinkle water on the peanuts before removing the shell, which can contribute to mold growth in storage especially when the nuts are not re-dried. Women's involvement in the above activities are relevant to our understanding of household security and food safety in Ghana (Balakrishnan et al. 1998).

Figure 1.1 Polythene sack for storing peanuts

Figure 1.2. A motorcycle also known as a “motorking” is used as a means of transporting peanuts.

According to the Food and Agricultural Organization (FAO) (1997), food security is defined as physical and economic access to sufficient, safe and nutritious food to meet dietary needs. Food safety is an integral part of food security. It is defined as protecting the food supply from microbial, chemical and physical hazards that may occur during all stages of food production so as to prevent foodborne illnesses. Because of insufficient access to food to meet demand on the African continent, the majority of people are only concerned with satisfying hunger and do not give due attention to the safety of food (FAO 1997), thus increasing the risk of exposure through ingestion of aflatoxin contaminated nuts in rural households. Moreover, women farmers in Ghana generally have low levels of education and training and thus have limited in knowledge and information on how to maintain safety in foods and reduce aflatoxin contamination along the supply chain (Amu 2004). Jolly et al. (2009) reported that women involved in peanut production are unaware of the implication of aflatoxin contamination on food safety. They also found significant difference between men and women with respect to the awareness to managing aflatoxin problems (Jolly et al. 2009).

Rationale and Significance of this Study

During my one year extension work with the Ministry of Food and Agriculture in Ghana, I noticed that women were marginalized and constrained in terms of agricultural production resources, such as fertilizer, tractors and improved seed varieties and most often produced lower yields. Most women were also illiterate and their only form of education was through infrequent farmer groups and contact with extension officers. It is, therefore, my hope that this research will not only increase my depth of knowledge but will provide some of the data necessary to design handling procedures and extension training that will reduce aflatoxin growth and spread.

Additionally, I hope this research will be useful to policy-makers in understanding and formulating policies that will help manage and mitigate aflatoxin contamination. In other words, understanding the role of women in post-harvest handling, drying, sorting, storage, processing and transportation of peanuts from farm to consumer will help to reduce aflatoxin contamination of peanuts in the agrifood system. Moreover, this research will add to existing literature on womens' role in peanut post-harvest handling and marketing.

The reminder of this chapter provides a background on aflatoxin including a review of the risk of aflatoxins to humans and in trade, the regulatory standards for aflatoxin in foods and feeds, and the factors affecting the growth of aflatoxin.

Background

History of Aflatoxins

Aflatoxins were discovered in 1960 when more than 100,000 young turkeys died in England. These deaths occurred over the course of only a few months from an apparently new disease that was termed "Turkey-X disease" (Asao et al. 1965). It was soon found that the mortality was not limited to turkeys. Ducklings and young pheasants were also affected. After a careful survey of the outbreaks, the disease was associated with Brazilian peanut meal. Intensive study of the feed revealed its toxic nature as it produced symptoms of Turkey-X disease when consumed by poultry and ducklings. Examination of the toxin suggested its origin from *A. flavus*, and thus was named "aflatoxin" (Guo et al. 2008). This outbreak stimulated scientific interest in, and gave rise to, modern mycotoxicology (Park et al. 1988; Pons and Goldblatt 1965). Research on aflatoxins led to a golden age of mycotoxin research during which several new mycotoxins were discovered (Bennett 2010). Other important mycotoxins produced by *Aspergillus* include *ochratoxin*, *patulin* and *fumigillin* (Bennett and Klich 2003; Cole and Cox 1981). Among all mycotoxins synthesized by fungal species, aflatoxins continue to receive major attention and are most intensely studied. They are the most potent hepatotoxic, carcinogenic metabolites (Diener et al. 1987).

What is Aflatoxin?

Thousands of mycotoxins have been identified, but only a few hundred are associated with food, and only a handful present significant food safety issues (Murphy et al. 2006). Among these mycotoxigenic fungi, *Aspergillus, Fusarium*, and *Penicillium* are predominant (Ciegler 1978). The fungi *Aspergillus flavus* and *A. parasiticus* produce molds called Aflatoxin (CAST 2003) which is reportedly the most important mycotoxigenic mold with regards to occurrence, toxicity and impact on human health and trade (Gnonlonfin et al. 2013). Aflatoxins affect many staples such as maize, sorghum, pulses, and peanuts that serve as the main foods for rural homes in West Africa and other parts of the developing world (Turner et al. 2005). There are four main aflatoxins commonly associated with pre- and post-harvest contamination of foods and feeds known as aflatoxins B1, B2, G1, and G2 (Brera et al. 2002). Since their discovery in 1960, aflatoxin has been the focus of enormous scientific interest and investigations in various part of the world (Shepherd 2008).

Aflatoxins are found in both air and soil; thus they infest agricultural commodities before harvest or they infest products stored under improper harvest and post-harvest conditions (FAO 1997). Aflatoxins persist to some extent in food even after the inactivation of the fungi by food processing methods, due to their significant chemical stability (Park et al. 1994; Yazdampah et al. 2005). Adebanjo (1993) also confirmed this in their research on corn-groundnut snacks when he found the snacks contained aflatoxins immediately after processing.

Risk of Aflatoxins on Humans

Aflatoxins are known to affect humans of all ages in Africa including the fetus, as aflatoxin has been detected in umbilical cord blood at birth (Lamplugh et al. 1988, De Vries et al. 1989). Evidence has also shown aflatoxin B1 in fetal liver (Wild et al. 1999), in breast milk (Wild et al. 1986; Lamplugh et al. 1988; Zarba et al. 1992; Jonsyn et al. 1995; El-Sayed et al. 2000) and in weaning food (Oyelami et al. 1996, Gong et al. 2002). Humans are at risk of exposure to aflatoxin through consumption of contaminated foods, particularly in African countries such as Ghana, where the lack of dietary diversity and a continuous ingestion of contaminated foods is a major issue (William et al. 2004). Gong et al. (2002) conducted a study on aflatoxin biomarkers in West Africa and found a higher exposure of humans of all ages to the toxin.

Aflatoxin is highly carcinogenic in all experimental animal species (Shepherd 2008). As a result the International Research Agency on cancer has classified aflatoxins as a possible carcinogenic problem in humans (IARC 1987). Wu and Khlangwiset (2009) reported aflatoxin

B1 as the most potent naturally occurring liver carcinogen known. High levels of exposure to aflatoxin can result in acute human poisoning leading to jaundice, edema, hemorrhage and, ultimately, death. Apart from these acute effects, many studies have reported aflatoxins as a known hepatotoxic (Jolly et al. 2007; Shepherd 2008). Data on hepatotoxicity in humans shows evidence of an association between aflatoxin exposure and liver cancer (Van Rensberg 1977; Gorelick et al. 1993; Wagacha & Muthomi 2008). In April 2004, an outbreak of acute hepatotoxicity was identified among people living in Kenya's eastern and central provinces that ended the lives of 120 people. Investigations revealed that the outbreak occurred as a result of aflatoxin poisoning from contaminated maize (corn). By July the number of deaths reached 125 making it one of the largest and most severe outbreaks of acute aflatoxicosis documented worldwide (Centers for Disease Control 2004).

Aflatoxin exposure is also associated with immune system disorders in adults and diminished weight and height in children (Jolly et al. 2013). Jiang et al. (2005) reported evidence among Ghanaian adults with reduced immunity and resistance to infection as a result of exposure to aflatoxin. Direct evidence for immune suppression caused by aflatoxin exposure has also been found in reduced levels among Gambian children (Turner et al. 2003). Similarly, over three decades of animal studies have shown aflatoxin to have immune suppressive impacts on animals. Furthermore, aflatoxin exposure causes stunted growth especially in children. This statement is supported by studies conducted in Benin and Togo where stunted growth was seen among children aged 9 months to 5 years as a result of being exposed to aflatoxin through consumption of aflatoxin contaminated foods during weaning (Gong et al. 2002). More recently, evidence has emerged that maternal aflatoxin exposure during pregnancy can also impact infant growth during the first year of life (Turner et al. 2005).

Regulatory Limits to Aflatoxin

Due to the toxic and carcinogenic nature of aflatoxins, it is important that humans protect themselves by limiting or regulating their ingestion. In 1965 the U.S Food and Drug Administration (FDA) enforced regulatory limits on the concentrations of aflatoxins in foods and feeds to 20 ppb (Wood 1992). For milk, the tolerance limit varies significantly from country to country and by mycotoxin type (Gilbert and Anklam 2002). For example, The European Union and Codex Alimentarius prescribe that the maximum level of aflatoxin M1 in liquid milk should not exceed 50 ppb (Codex Alimentarius Commission 2001). However, according to US regulations, the level of aflatoxin M1 in milk should not be higher than 500 ppb (Unusan 2006). The European Union set a limit for the safe level of aflatoxins in food and feed from African Countries at 4 ppb and 20 ppb depending on the product (FAO 2004; Murphy et al. 2006). In Ghana, peanut samples taken from market centres were reported to have higher levels of aflatoxin beyond the acceptable level in foods (Awuah and Kpodo, 1996). Similarly, Mintah and Hunter (1978) reported that 50-80% of peanut samples tested had aflatoxin content higher than the safe level recommended for foods. The peanut samples collected were from the Northern and Volta regions of Ghana. Another study that focused on maize in Ghana examined 15 samples to determine the presence of aflatoxin and level of contamination (Kpodo et al. 2000). The study revealed that 8 out of 15 samples tested positive to aflatoxin with levels higher than the 20 ppb acceptable in foods.

Effect of Aflatoxin on Trade

Many farmers in Sub-Saharan African countries traditionally export a variety of crops, from peanuts to cocoa. However, increasingly stringent food safety standards have pushed many smallholder farmers out of the market because quality testing is too expensive for them

(ICRISAT 2011). Several years ago, fear grew when new standards for safety were established in western countries for acceptable levels of aflatoxins in peanuts as this could lead to a loss of over $670 million in exports in African countries (Cardwell et al. 2004). The Council for Agricultural Science and Technology (CAST 2003) and Cardwell et al. (2004) estimated annual corn , peanuts and wheat crop losses in Africa due to mycotoxin contamination at over $750 million. Similarly, in Ghana export of peanut has decreased since 2000 and could be a result of food safety standards including aflatoxin contamination (Figure 1.2).

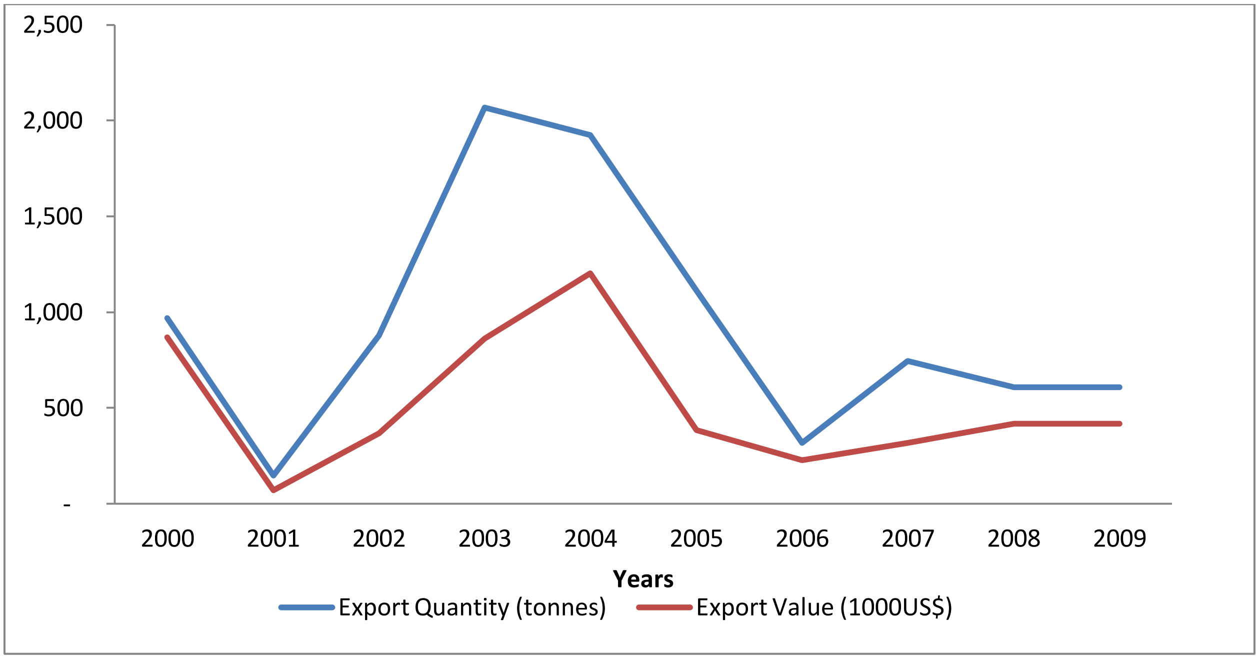

Figure 1.2. Export Quantity and Export Value of Ghanaian peanuts (inshell) between 2000 and 2009.
Source: FAOSTAT (C) FAO Statistics Division March, 2012.

Aflatoxin contamination also impacts the agricultural economy through the cost associated with monitoring and decontamination (Shane 1994). Cardwell et al. (2004) reported that regulatory enforcement, testing, and other control measures add an additional $466 million annually to the losses due to aflatoxin. Developing countries including Ghana are unable to sell large quantities of peanuts in the international market due to aflatoxin contamination (FAO 2004).

Factors Affecting Aflatoxin Formation

Aflatoxin contamination can occur at pre-harvest, especially when the crop is in the field, or at postharvest, when stored after harvest (Hurburgh et al. 2005; Kuchareck and Raid 2000; Wagacha and Muthomi 2008). Preharvest infection is more severe when high temperature and drought stress occur during the growth cycle (Beltrán and Isakeit 2004; Cotty and Jaime-García 2007). Insect damage is also recognized as a factor enhancing aflatoxin contamination preharvest. Insects act as vectors, facilitating spore entry into nuts and increasing infection by damaging the shells. When insect damaged crops are not culled out during post-harvest handling, aflatoxin contamination is likely to occur. Several agronomic and sociocultural factors or practices that take place at post-harvest also predispose peanuts to aflatoxin contamination. For example, contamination has been found to spread widely in storage under high temperatures and humidity (Reddy et al. 2007).

Aflatoxin fungi are native to tropical, warm, arid and semi-arid regions. Climatic factors such as drought stress and high soil temperatures, common in sub-Saharan Africa, are known to promote aflatoxin contamination because it induces cracking in pods which promotes fungi invasion (Rachaputi et al. 2002: Cotty and Jaime-Garcia 2007: Mutegi et al. 2009). It is also relevant to mention that climate changes alter in the quantity of aflatoxin producing fungi. However, the emphasis of this research is on post-harvest factors that contribute to aflatoxin and affect peanuts and peanut quality, because the bulk of aflatoxin contamination is known to occur during this stage. This project also focuses on the role of women in post-harvest because women farmers, processors and retailers are known to handle peanuts during post-harvest.

The next chapter presents the conceptual framework of this study including the socio-demographic factors that contribute to women's involvement in post-harvest handling activities, the factors that might affect women's decision during post-harvest handling, the factors affecting awareness of aflatoxin contamination, and the importance of considering the role of women when reducing aflatoxin along the supply chain. Chapter 3 details the methodology for this quantitative research project including the sampling and interview process, the method of the analysis, and the survey instrument that was used. The results of the analyses comparing the observed differences among supply chain actors sociodemographics, post-harvest handling activities, and awareness to aflatoxin in Ghana are presented in Chapter 4. The analysis of financial compensation for supply chain actors is also presented. Finally, the factors affecting supply chain actors' involvement in post-harvest activities in peanuts and awareness of aflatoxin contamination is presented. Chapter 5 draws conclusions from the findings and details how this work contributes to the existing literature.

CHAPTER 2: THEORY AND CONCEPTUAL FRAMEWORK

Conceptual Framework

The question of why women are involved in agricultural production, yet their roles are undervalued, stem from the existence of lineage systems (kinship) that exist especially in Africa. These lineage systems are believed to shape the roles of women in the households, as well as agriculture in Africa. More broadly to explain why the roles of women in agriculture are understated and not well documented, this thesis draws from the literature surrounding lineage systems (kinship), gender issues and decision-making in the households. It also draws on the concept of power, the socioeconomic factors that affect awareness of risk and the role of women in agriculture.

Gender roles are socially determined (Rosaldo and Lamphere 1974) and differ largely across cultures (Alesina and la Ferraral 2005). Ezumah et al. (1995) reports that the range of agricultural activities and crops cultivated and handled by women are dictated by cultural norms and lineage systems creating variations among different social groups. Lineage composes of extended families and clans. Lineage systems in Africa fall into two broad categories: patrilineal and matrilineal (Alesina and La Ferrara 2005). In Africa, traditional relations of kinship have affected the lives of people and ethnic groups by determining for example what land they could farm, whom they could marry, and their status in the communities. It also includes a network of responsibilities, privileges, and support in which individuals and families are expected to fill certain roles (Coser 1974). Though social and economic changes have begun to loosen the ties of traditional kinship, especially in the cities, these ties still play a large part in the everyday lives of many Africans (Coser 1974).

In patrilineal societies, social rank and property is passed in the male line from fathers to sons whereas in matrilineal societies, rank and property, although controlled by men (e.g., husbands, sons) are passed from generation to generation in the female line (Sarpong 2006). In patrilineal societies where the men have migrated to urban areas or where the men have died, women fill the head of the household position (female heads of households). A study conducted in Ghana by Antwi-Nsiah (1993) showed that in patrilineal households where men were present, the men dominated decision-making but in situations where the men were absent women dominated in decision making. These women are often at a disadvantage and are more likely to end up with less fertile, smaller acreage of land and resources that affect their agricultural productivity as well as their household work (Göler von Ravensberg et al. 1999). In addition they experience greater constraints and anxiety through control at a distance from extended family, they have less autonomy and decision-making power and an increase in work load (Brydon and Chant 1989).

Many West African families under any kinship system are nuclear, extended or polygamous (i.e., husband, wives and children) in nature. All these kinds of families exist within the context of a broader family community (e.g., grandparents, uncles and cousins). The head of such a community is usually a male and has greater power over the economic and social lives of community members (Coser 1974). Similarly the head of an individual household which is also usually a male has power within his household. Power within the household and in the African context is discussed further, below.

Power theory

In the understanding of power there are several distinct evolutions. It roots are Weberian and the original concept focused on authority and rule. Max Weber defined power as the probability that an actor within a social relationship will be in a position to carry out his will despite resistance. However, Robert Dahl (1961) discussed power within the boundaries of an actual community. According to Dahl, power is exercised in a community by a particular concrete individual. Finally, Gaventa's (1980) theory of power suggests that the purpose of power can be used as a way to prevent groups from participating in decision-making processes in the community.

Pollack (1994) and Bergstrom (1997) both reported that power exerted by each individual in a household plays a key role in understanding a wide array of behavioral choices. Household members derive power when they have control over economic resources. Economic resources have been treated in reference to income earning jobs of individuals in a household as a measure of their relative power (Duncan 2007). For example, in rural agricultural communities in Africa, males are predominately the bread winners in the household because men produce cash crops. This means men are in a better financial position than females to providing for the family. The control of money by the men also confers power on them in the households (Duncan 2007). Women on the other hand, mostly engage in subsistence agriculture that provides food for their household. Generally speaking, such activities are not as economically rewarding as cash crop production. The food that women grow is consumed, not exchanged on the market. So, it is neither public (visible) nor commodified. Producing surplus will then be a way of empowering women. For both men and women, earnings are tied to power and the level at which women can contribute to household decision-making is dependent on how much they earn (Ngome 2003).

In both patrilineal and matrilineal lineage systems, decision making power is culturally vested in males though females may have more influence in decision-making in matriarchal societies (Beckman 1983; Hollerbach 1983). The invisibility of women in agriculture has been attributed to patriarchal values that rigidly sustain powerful male supremacy (Safilios-Rothschild 1985). Generally, women earn decision-making power in the household by caring for its members. They do so by providing safe and nutritious foods. This food provisioning improves the nutritional status of household members (Thomas 1997; Kishor 2000; Smith et al. 2003). Balk (1994) and Hindin (2000) reported that the amount of influence a woman has in decision-making is a key indicator of her empowerment. Women's empowerment is a critical aspect of achieving gender equality. This includes increasing a woman's sense of self-worth, her decision-making power, her access to opportunities and resources, her power and control over her own life inside and outside the home, and her ability to affect change (Kabeer 1994). Ajani (2008) reports that gender inequality hinders a woman’s chances of employment, education, access to resources that affect her and her household’s food safety and security. Therefore, women’s inability to provide safe and nutritious foods for their family, in turn decreases their authority in decision-making. Given the traditionally limited role of women in decision-making processes at the household, village and national levels in most cultures, their needs, interests and constraints are often not reflected in policymaking processes and laws which are important for poverty reduction, food security and food safety (Ajani 2008).

In Ghana, especially in the communities chosen for this research, patrilineal system is the dominant practice. Women are relegated to the background in terms of decision-making in and around the households. Though the men contribute to household food and nutrition decisions (Baden 1994), the women in the study communities are solely responsible for food preparation and nutrition in their households. Furthermore the main tribal group in the study areas is Hausas, which is mostly Muslim. One of the most salient principles in Hausa society is the segregation of adults according to gender. This practice prevents women from engaging in extra-household income generating activities.

Women in Africa represent up to 70 percent of the rural poor (Ibnouf 2009). Typically, women living in poverty cannot provide safe and quality food for their households because they cannot afford to do so. Ibnouf (2009) found women can improve their household security and food safety by expanding their income generating activities. Women work for a combination of wage which includes payment in kind, under a variety of work arrangements as defined by the male or female farmer (Hurst, Termine and Marilee 2000). Doss (1999) also reported that hired labor may be paid in cash or in-kind. However, some women have gained some economic independence through remuneration for their labor on male cash crop farms (Kershaw 1976).

Socio-Demographic Factors Affecting Women's Role and Level of Awareness of Perception of Risk (Ingestion of Contaminated Food)

Certain variables such as age, education, household income and marital status have been shown to influence the division of labor and women's participation in agriculture (Sikod 2007; Damisa and Yohanna 2007; Enete and Amusa 2010). Damisa and Yohanna (2007) found out that the level of participation of women in farm management decisions increases with age. Older women are more likely to participate in farm decisions than younger ones. Enete and Amusa (2010) reported that experience most often comes with age, and in traditional societies, the older a woman gets, the more her opinion is respected and sought in decision-making. Moreover, experienced women farmers may be more versatile with regard to the production system and may therefore be better able to assess the risks involved in farming than inexperienced women (Enete and Amusa 2010). Awuah et al. (2009) reported that older women are more likely to be involved in post-harvest activities such as sorting peanuts for consumption at the household level in Ghana. He attributed this to the fact that women above 55 years (life expectancy age of women in Ghana) retire from active work and are involved in work that requires less physical energy like sorting.

Age has also been known to affect the seriousness of perceiving risk (risked associated with consumption of contaminated foods). A study by Krewski et al. (1994) reported that respondents in the higher age categories were more likely to rate consumption risks higher than those who were younger. Jolly et al. (2009) also found older age categories of peanut farmers to perceive a greater seriousness of risk associated with the consumption of aflatoxin contaminated peanuts than those in the younger categories. Lin (1995) also found that the importance of food safety issues was positively correlated with the age of the main meal planner. He reported that those most concerned with food safety tended to be older women. In addition, Lin (1995) found out that individuals with young children in the household also have the greatest concern about food safety.

Enete and Amusa (2010) found the level of education of women to be positively and significantly related with their level of contribution to household farming decisions. In other words, highly educated women are likely to make greater contributions to farming decisions than those who are less educated. Enete and Amusa (2010) reported that educated women may be more aware of their rights and responsibilities in the household and may be more assertive about them than uneducated women. Awuah et al. (2009) studied the factors affecting sorting in peanut in Ghana and discovered that illiterate farmers and those who have only attained a primary school education are more likely to sort their peanut before consumption and be involved in post-harvest activities. He attributed this reason to the fact that educated farmers tend to be absentee farmers leaving the less educated behind to perform farm roles. Education has also been known to affect awareness of diseases (risk). Dosman et al. (2001) stated that education affected respondents' perceptions of health risks in two ways. Individuals with higher levels of education may have a better understanding of food risks, and how to mitigate these risks. Jolly, Bayard and Vodohue (2009) found a significant relationship between farmers' level of education and their perception of the seriousness of aflatoxin contamination. They concluded that better educated farmers had a greater perception of the seriousness of aflatoxin in peanuts and perceived greater benefits of reducing risks associated with the consumption of aflatoxin.

For the present study, most participants in have no formal education. Thus, we focus on agricultural training through farmer groups or extension agents. This type of training is mostly directed toward improving the ability of an individual to do their work more effectively and efficiently. Generally, training involves acquiring information and developing abilities or changing attitudes, which will result in greater competence in the performance of a work activity. Training also creates awareness among individuals and groups of people. Awuah et al. (2009) also found that individual farmers with knowledge about the health problems of aflatoxin are more likely to sort their peanuts than those who are not aware of the health risks. Atta (2012) found that training of farmers by extension agents increases both aflatoxin awareness through teachings on good farming practices in Ghana. This will help reduce aflatoxin contamination in peanut.

The influence of gender on awareness, knowledge, and perceptions is worth mentioning. Previous studies have shown that gender roles in food preparation influences food safety risk perception. Danso et al. (2004) reported that women are more likely to engage in food preparation and consumption in their homes. However, Jolly et al. (2009) showed that men are more likely to be aware of aflatoxin contamination in peanuts than women.

CHAPTER 3: METHODS

This study is part of a larger project that seeks ways of reducing aflatoxin contamination along the peanut supply chain. In this thesis, quantitative analysis is used to explore the socio-demographic factors that affect women's post-harvest activities along the peanut supply chain. Similarly, the factors affecting supply chain actors awareness and knowledge of aflatoxin contamination are also explored. "Supply chain" refers to all actors along the production-consumption chain. But for the purpose of this project "supply chain" is limited to farmers, processers and retailers because these actors are most involved in the handling of peanuts during post-harvest activities where the bulk of aflatoxin contamination is known to occur. In addition, this study interviewed only Ghanaian women involved in peanut handling along the supply chain. Structured face-to-face interviews were use to collect the data and it was analyzed using Logistic regression.

Research Questions

- What are the roles of Ghanaian women in post-harvest handling of peanuts?
- What sociodemographic factors influence aflatoxin awareness among Ghanaian women in the peanut post-harvest supply chain?
- What sociodemographic factors influence the behavior of Ghanaian women in the post-harvest peanut supply chain?

Study Area

Ghana, a West African nation, borders Burkina Faso to the north, Togo to the east and Côte d'Ivoire to the west (Figure 3.1). It occupies a total area of about 24 million hectares (Gumma et al. 2011) and it is divided into ten administrative regions (Figure 3.1) and six ecological zones. The country is dominated by semi-deciduous forest and Guinea savannah.

Ghana experiences both warm and humid temperatures. It is often relatively dry in the north and humid along the southeast and west coast. The topography is predominantly gentle and undulating with slopes less than 5%. Rainfall ranges from 700 mm/yr in the coastal zone to 2,200 mm/yr in the southwestern rainforests. Most parts of the country have one distinct rainy season and one dry season, the latter of which last longer in the northern parts of Ghana than in the south (Quansah 2000).

Peanuts are produced mainly in the Upper West, Upper East, and Northern regions. National production in 2003 was estimated at 439,030 metric tons with Upper West, Upper East and Northern regions producing approximately 91% of the national production (SRID 2004). The north which is the first region of study is more productive because it is dryer than the southern part of Ghana. The dry season in the North runs from November to April, whereas the rainy season runs from the end of April through September, with an annual rainfall varying between 900 and 1,100 mm. The second region of study is Brong Ahafo Region. It has the second largest region of the country with a population of 1,824,822 representing 9.9% of the nation’s total population (MOFA 2001). The inhabitants are mostly peasant farmers producing all kinds of foodstuffs including peanuts, plantain, cassava, yam, cocoyam and vegetables such as tomatoes, pepper, onion and eggplant. They also grow cash crops such as cocoa, coffee, and cashew.

Figure 3.1. Map of Ghana.

Source: Google Images

Supply Chain Participant Identification

The study was conducted in three peanut producing districts of Ghana: Savelugu (North), Tamale (North) and Atebubu (South). Agricultural extension officers in the Ministry of Food and Agriculture (MoFA) and personnel from Kwame Nkrumah University of Science and Technology, which is located in Kumasi, Ghana, assisted in the identification of peanut supply chain participants.

Sample Size

A total of 300 supply chain actors were selected for the survey. The three hundred respondents included one hundred respondents from each of the three selected districts. Farmers were selected based on their involvement in peanut farming, as well as post-harvest handling activities. Processors in the selected districts were solely involved in processing of peanut into other products such as peanut cake, peanut paste and peanut oil. Similarly, retailers are those who are involved in peanut trade in both small and large market centers in each district where substantial quantities of peanut sales took place.

The larger the sample size, the smaller the magnitude of errors through sampling and the higher the probability that the sample will be representative of the population. This is the case when the sample is chosen randomly. Tabachnick and Fidell (2001) reported that sample size for regression analysis, a technique that will be used in this study, should be greater than fifty to minimize errors.

Selection of Districts, Households and Communities

Stratified random sampling was used in the selection of districts, communities and households. However, the selection of districts was also based on peanut production level and climatic conditions. An extension officer from the Ministry of Food and Agriculture assisted in the district selection procedure. Two or more respondents actively involved in peanut farming and its associated post-harvest handling (when/where possible) were chosen from all selected households. This is because of polygamous marriages and extended family system that exist in these communities. These respondents were chosen through the help of household heads who in most cases were males. The same was done for processors and retailers in various districts but this time, the interviewers and I visited respondents at their various market locations and sometimes in their homes for the interviews.

Survey Instrument

The survey instrument is both an open- and close-ended questionnaire with four different sections. The close-ended questions were designed so that each element (choice response) represented an answer a respondent might give if asked the question (Krummel et al. 2002). This structured interview guide also provided directions for the interviewer (Appendix A). For example the first section of the questionnaire included sociodemographic information such as age, educational level, household income, land ownership and marital status. The second section included questions on awareness and knowledge of aflatoxin. Since many of actors in the peanut supply chain in Ghana have no formal education or training in agriculture, we assumed it was unlikely that the participants would have any knowledge of aflatoxin contamination in peanuts. Pictures of moldy nuts were, therefore, shown to respondents for identification and awareness purposes. Examples of questions included were (See Appendix A):

- Have you heard of aflatoxin?
- Are you aware of moldy nuts?
- Are you aware that improper drying, lack of sorting and storage in inappropriate structures can contribute to moldy nuts?
- How do you identify spoilt nuts?

The third section included questions on their specific post-harvest role in the peanut supply chain. Questions such as:

- Do you dry nuts immediately after harvesting?
- How are the nuts dried?

- Do you sort nuts before using as food?
- Do you store nuts with other crops in the same storage room?
- What are some of the crops you store nuts with?

The final section on remuneration asked questions as:

- Do you get paid for your post-harvest activities?
- In what form do you receive the payments?
- Do you get financial help outside of peanut production?

Before data collection, the survey instrument was pre-tested and subjected to an assessment of internal consistency, reliability, and construct validity as noted below. The instrument was then reviewed after pretesting by selected agricultural and field personnel.

Pre-testing and Pilot Study

Pre-testing was done in one of the selected study districts (Savelugu metropolis). The purpose of the pre-test was to determine if any errors were made in the design of the survey, question format, and whether or not the survey was leading or misleading in any way. This was done through group discussions held in the district and the members present were asked about aflatoxin and its health effects on humans, as well as moldy nuts and the effects of eating these nuts on human health. We also asked about the specific roles they were involved in during post-harvest.

Training of Interviewers

Four field assistants were selected by the researcher to aid in data collection. Two were Agricultural master's students from Kwame Nkrumah University of Science and Technology, Kumasi and the other two were extension officers from the Ministry of Food and Agriculture, Tamale. The field assistants were selected based on their knowledge of the local language, previous research experience and ability to understand and write in the local dialect and English. The selected interviewers were trained by the researcher. The researcher provided the interviewers with copies of the survey instruments two days before the scheduled meeting day. This was to allow them to go through the questions before the training. The training was held three days before data collection was scheduled to start. The researcher explained the questions to them and showed them how the instrument was to be filled out.

Data Collection Procedure

Questionnaires were administered to peanut supply chain participants by trained interviewers from Kwame Nkrumah University of Science and Technology and Ministry of Food and Agriculture. The questions were asked in the local dialect by interviewers since most respondents are unable to read. A total of 40 farmers, 30 traders and 30 processors were selected in each of the peanut producing districts of Ghana during the period of May 2012 to July 2012[1]. A total of 300 interviews were conducted (Table 3.1).

[1] This project was approved by the Auburn University Institutional Review Board

Table 3.1 Number of Interviews Conducted by Supply Chain actors by Districts

Supply Chain Actors[2]	Atebubu	Savelugu	Tamale	Total
Farmers	40	40	40	120
Processors	30	30	30	90
Retailers	30	30	30	90
Total	100	100	100	300

The instruments were translated and read to the respondents in their local dialects, which included Dagbani and Mampruni, as well as Hausa. Responses were then recorded in English by the field assistants for use by the researcher.

Secondary Sources

This study also relied on secondary data. Secondary data was obtained through published and unpublished works in books, journals, newspapers, and internet, as well as conference papers and working papers that addressed various aspects of the research topic under investigation.

Data Analysis

The survey was coded and the data entered into SPSS. Then, the survey data was analyzed in two parts using the Statistical Package for Social Scientists software (SPSS version 11.0) and Statistical Analysis System Software (SASS version 12). First, descriptive statistics were produced for socio-demographic variables, knowledge about aflatoxin in peanuts, roles in

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[2] In several cases, interview respondents' performed more than one role in the supply chain (farmer and processor, processor and retailer, etc.). I identify the main role associated with each supply chain actor based on their primary activity as expressed by the respondent during the interview.

post-harvest activities and remuneration. Second, logistic regression models were used to measure factors that affect women's decision to dry, sort and store peanuts along the supply chain and the factors that affect supply chain actors awareness of aflatoxin contamination in Ghana.

A logistic model is a member of the generalized linear model (GLM) family. Compared to other models that have continuous response variables, the response variable of a logistic regression is categorical (i.e., discrete, dichotomous, ordinary). On the other hand, in logistic regression there are no limitations on data types and distribution of explanatory variables. Therefore the choice of using binary logistic regression analysis is appropriate for this study because the response variables are dichotomous, and the procedure can take the value "0" with a probability of success, or the value "1" with a probability of failure. In addition, estimating log odds or maximum-likelihood ratios from logistic regression, only indicates direction of influence on probabilities and not actual probabilities. To determine the actual probabilities and to test the hypotheses, the magnitude of the marginal effects is used (Madala 1987; Armah and Kennedy 2000).

Logistic Regression

The model is specified as:

$$\log\left(\frac{Y}{1-Y}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_n X_n$$

The empirical regression models were developed to investigate the factors affecting supply chain actors decisions to dry, sort and store peanuts. It was also developed to investigate the factors affecting supply chain participants' awareness of aflatoxin contamination. The dependent variable (Y) in this case is a dichotomous variable with a value of 0 for yes and 1 for no. The X_1 in the equation represent a vector of the explanatory variables (independent variables) and $\beta_{1, 2, 3}$

are parameter coefficients. The descriptions of the explanatory variables used in the development of the models are seen in Table 3.2

Table 3.2 Variables used in the Logistic Regression and its Definition

Variables	Definitions
Age	Age of respondents in years
Household Income	Household income in Ghana cedis
Gender of household head	0=Male, 1=Female
Agricultural training	0= Yes, 1=No
Household size	Household size of participants
Aware of health implications of aflatoxin	0=No, 1=Yes
Hire extra labor	0=No, 1=Yes
Amount of peanut produced	Amount of peanut produced in kg
Aware of improper drying contributing to mold	0=No , 1=Yes
Remuneration	0= Receive no form, 1= Money , in Kind
Amount of peanut marketed	Amount of peanut marketed in kg
Educational level	0= No formal education, 1= Primary
Marital status	0= Married, 1= single or divorced or widow
Quantity of peanut bought to be sold	Amount in Kg
Quantity of peanut bought to be processed	Amount in Kg

Hypothesis

Below are the hypotheses to be tested by the study. H_0 represent the null hypothesis and H_1 represents my research hypothesis.

Factors that Affect Respondents' Decision to Sort Peanuts along the Supply Chain

- H_0: Farmers, processors and retailers above 50 years of age are less likely to sort peanuts.
- H_1: Farmers, processors and retailers above 50 years of age are more likely to sort peanuts.
- H_0: Household income does not increase the likelihood that farmers, processors and retailers will sort peanuts.
- H_1: Household income increases the likelihood that farmers, processors and retailers will sort peanuts.
- H_0: Household size increases the likelihood that farmers, processors and retailers' decision to sort peanuts.
- H_1: Household size does not increase farmers, processors and retailers' will sort peanuts.
- H_0: Agricultural training does not increase the likelihood that farmers, processors and retailers will sort peanuts.
- H_1: Agricultural training increases the likelihood that farmers, processors and retailers will sort peanuts.

Factors that Affect Respondents' Decision to Dry Peanuts

- H_0: Farmers, processors and retailers above 50 years of age are more likely to dry peanuts.
- H_1: Farmers, processors and retailers above 50 years of age are less likely to dry peanuts.
- H_0: Household income does not increase the likelihood that farmers, processors and retailers will dry peanuts.
- H_1: Household income increases the likelihood that farmers, processors and retailers will dry peanuts.

- H_0: Household size does not increase the likelihood that farmers, processors and retailers will dry peanuts.
- H_1: Household size increases the likelihood that farmers, processors and retailers will dry peanuts.
- H_0: Agricultural training does not increase the likelihood that farmers, processors and retailers will dry peanuts.
- H_1: Agricultural training increases the likelihood that farmers, processors and retailers will dry peanuts.

Factors that Affect Supply Chain Actors' Decision to Store Peanuts

- H_0: Household income increases the likelihood that farmers, processors and retailers will store peanuts in mixed used structures.
- H_1: Household income does not increase the likelihood that farmers, processors and retailers will store peanuts in mixed used structures.
- H_0: Household size does not increase the likelihood that farmers, processors and retailers will store peanuts in mixed used structures.
- H_1: Household size increases the likelihood that farmers, processors and retailers will store peanuts in mixed used structures.
- H_0: Agricultural training increases the likelihood that farmers, processors and retailers will store peanuts in mixed used structures.
- H_1: Agricultural training does not increase the likelihood that farmers, processors and retailers will store peanuts in mixed used structures.

Factors Affecting Supply Chain Actors Awareness of Aflatoxin

- H_0: Age does not increase the likelihood that farmers, processors and retailers will be aware of moldy nuts.
- H_1: Age increases the likelihood that farmers, processors and retailers' will be aware of moldy nuts.
- H_0: Education does not increase the likelihood that farmers, processors and retailers will be aware of moldy nuts.
- H_1: Education increases the likelihood that farmers, processors and retailers will be aware of moldy nuts.
- H_0: Household income does not increase the likelihood that farmers, processors and retailers will be aware of moldy nuts.
- H_1: Household income does not increase the likelihood that farmers, processors and retailers will be aware of moldy nuts.
- H_0: Agricultural training does not increase the likelihood that farmers, processors and retailers will be aware of aflatoxin contamination.
- H_1: Agricultural training increase the likelihood that farmers, processors and retailers will be aware of moldy nuts.

CHAPTER 4: FINDINGS AND ANALYSIS

The objectives of this thesis are to determine the sociodemographic factors that influence supply chain participants awareness of aflatoxin and post-harvest handling practices. Sociodemographic and behavioral data was obtained in a face-to-face survey of female Ghanaian peanut producers, processors and retailers. In this chapter, descriptive statistics of the survey data are presented so as to describe the sociodemographics characteristics of the supply chain participants. Next, logistic regression analysis is used to determine the influence of participants' sociodemographic characteristics.

Sociodemographics of Supply Chain Actors

This section discusses the sociodemographic characteristics of the supply chain participants who were surveyed. Table 4.1 shows sociodemographic characteristics of supply chain actors, all of whom were women.

Age

The majority of supply chain actors are between the ages of 31 and 50 years old, particularly processors and retailers (76.7%). Farmers tended to be somewhat younger with nearly 22% below 30 years of age.

Education

A large number of respondents along the supply chain have no formal education (illiterate) especially farmers (83.2%). In contrast, 31.1% of processors and more than 26% of retailers had at least junior high education.

Income Level

Farmers also have the lowest income with 66.7% earning less than 500 Ghana cedis per month. Income increases as peanuts move up the supply chain with 60% of processors and 73.4% of retailers earning at least 500 Ghana[3].

Marital Status and Gender of Household Head

Most of the supply chain actors are married, particularly retailers (90.0%). However, almost a third of farmers (32.2%) are unmarried. Retailers also have the highest number (94.4%) of male headed households, while farmers had the lowest number.

Household Size and Land Tenure

Typically, respondents had household sizes between 5 and 10 persons. However, almost 38% of farmers had household sizes larger than 10 people. Most (nearly 100%) of all farmers surveyed worked on land owned by their families.

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[3] 2.08 Ghana cedis is equivalent to 1 dollar.

Table 4.1 Socio-Demographics of Supply Chain Actors

	Farmers	Processors	Retailers
Age Categories			
30 years and below	21.9% (26)	14.4% (13)	16.7% (15)
31 – 50 years	64.7% (77)	76.7% (69)	76.7% (69)
51 years and above	13.5% (16)	8.9% (8)	6.7% (6)
Education			
No Formal Education	83.2% (99)	68.9% (62)	73.3% (66)
Primary	14.3% (17)	30.0% (27)	25.6% (23)
High School	2.5% (3)	1.1% (1)	1.1% (1)
Total education[4]	16.8% (20)	31.1% (28)	26.7% (24)
Household Income			
Less than GH¢ 500	66.7% (80)	40.0% (36)	26.7% (24)
500 – 1500 GH¢	24.2% (29)	36.7% (33)	46.7% (42)
GH¢ 1500 and above	5.8% (7)	23.3% (21)	26.7% (24)
Total household income[5]	30.0% (36)	60.0% (54)	73.4% (66)
Marital Status			
Single	0.0% (0)	2.2% (2)	3.3% (3)
Married	68.1% (81)	77.8% (70)	90.0% (81)
Divorced	6.7% (8)	7.8% (7)	0.0% (0)
Widowed	24.7% (29)	7.8%(7)	4.4% (4)
Separated	0.8% (1)	4.4% (4)	2.2% (2)
Total marital status[6]	32.2% (38)	20.0 % (18)	6.6% (4.4)
Gender of Household Head			
Male	71.4% (85)	82.2% (74)	94.4% (85)
Female	28.6% (34)	17.8% (16)	5.6% (5)
Household Size			
1-5 persons	16.8% (20)	16.7% (15)	17.8% (16)
5-10 persons	45.4% (54)	64.4% (58)	55.5% (50)
10-15 persons	27.7% (33)	15.6% (14)	18.9% (17)
15-20 persons	10.1% (12)	3.3% (3)	7.8% (7)

[4] Total number of primary and secondary education along the peanut supply chain.
[5] Total figure for supply chain participants who earn between 500-1500 GH¢ and above GH¢ 1500.
[6] Total figure of supply chain participants who are divorced, widowed and separated.

Post-Harvest Role of Supply Chain Participants

More than half of all farmers are involved in the peanut harvesting process. A majority of farmers use a combination of all the various forms of transportation such as truck, “motorking”, wheelbarrow, cart and headpan. Of all the combinations, headpan (53.0%) or truck (50.4%) was used the most. Almost half of farmers (46.0%) use motorking to carry peanuts home after harvesting. When harvested nuts are brought home, drying is usually done immediately. Processors who purchase nuts from farmers tend to carry them home using a headpan (33.0%) or motorking (29.0%). Retailers typically use a wheelbarrow (nearly 100.0%), or a cart (82.0%), but many use a headpan (44.0%), as well. It was also noted that both processors and retailers use a combination of the various forms of transportation.

Drying

Drying is done in the sun. About 53.8% farmers, 64.4% processors and 65.5% retailers of spread the nuts on the bare ground during drying. As many as 46.0% farmers spread nuts on a raised platform above the ground (Table 4.2). Approximately 70.0% of farmers dry the nuts immediately after harvesting (Table 4.2). Processors and retailers, on the other hand, buy dried nuts. The data also revealed that supply chain actors determined whether or not the nuts were well dried by the amount of pressure required to crack the shell, the sound of the kernels in the shell when shaken, the feel of the shell when chewing a sample, the amount of pressure required to peel off the kernel, and years of experience. When the nuts are not properly dried or when mold growth is visibly seen among the purchased nuts, drying is done again. A total of about 86.0% of processors and 51.0% of retailers responded that they will dry purchased peanuts when they are not well dried (Table 4.2).

Sorting

Nearly 60% of all supply chain actors said they sorted nuts to attract customers. Almost 64.0% of farmers sorted nuts before storing whereas 78.2% sorted before using as food. However, only a third of farmers (32.0%) sorted before selling nuts. Approximately, 93% of processors sort before processing into peanuts products such as peanut cake, peanut paste and peanut oil (Table 4.2). Similarly, 57% of retailers sorted before selling (Table 4.2). Only about 18% of all respondents gave higher profit as a reason for sorting and less than 10% of retailers were concerned with sorting for health reasons.

Storage

Over 50% of supply chain actors are involved in the storage of peanuts. Maize was reported to be the number one crop stored with peanuts. As many as 87% of the participants store the peanuts in rooms dedicated to crop storage. The most commonly used storage material is the polythene sack, which is used by as many as 81% of farmers and 82% of processors. However, nearly 37% retailers use jute sacks for storage of peanuts and peanut products (Table 4.2).

Awareness, Knowledge and Identification of Aflatoxin

Up to 93% of farmers had never heard the word aflatoxin and are not aware of its effect on humans (Table 4.2). The few (6.7%) who have heard of aflatoxin, reported malaria, diarrhea and coughing as illnesses associated with the consumption of aflatoxin contaminated peanuts. However, as many as 74.8% farmers and 52.2% processors and 72.2% retailers were aware of mold growth in nuts (Table 4.2) though some still process moldy nuts into other forms for consumption. About 38.0% of farmers and retailers indicated using moldy nuts for food by processing it into dawadawa (a spice used for stews, sauces and soups). Somewhat fewer processors (32%) reported using moldy nuts (dawadawa a spice) used for food (Table 4.2). When supply chain actors were asked about the criteria used to identify spoiled nuts, approximately 98% farmers and processors and 68% retailers reported a change in peanut color as the obvious criteria used. The most common color changes indicated were brown, black and greenish.

Table 4.2. Post-Harvest Roles (Drying, Sorting and Storage), Identification and Knowledge of Aflatoxin of Supply Chain Participants.

	Farmers	Processors[7]	Retailers[8]
Do you dry nuts?			
Yes	69.2% (83)	85.6% (77)	51.1% (46)
No	30.8% (37)	14.4% (13)	48.9% (44)
What drying method do you use?			
Spreading on the ground	53.8% (64)	64.4% (58)	65.6% (59)
On raised platform	46.2% (55)	35.6% (32)	34.4% (31)
Do you store in mixed used structures?			
Yes	77.3% (92)	86.7% (78)	85.4% (76)
No	22.7% (27)	13.33 (78)	15.6% (14)
What storage method do you use?			
Polythene sacks	80.7% (96)	82.2% (74)	60.0% (54)
Jute sacks	20.2% (24)	17.8% (16)	36.7% (33)
Do you sort nuts?			
Yes	63.9% (76)	93.3% (83)	56.7% (51)
No	36.7% (44)	7.7% (7)	43.3% (39)
How do you identify spoiled nuts?			
Change in Color	97.5% (116)	97.8% (88)	67.7% (61)
Insect Infestation	2.5% (3)	2.2% (2)	32.2% (29)
What is done to spoiled nuts?			
Throw away	59.7% (71)	66.7% (60)	52.2% (47)
Process into other products	38.0% (45)	32.0% (29)	37.8% (34)
Have you heard of aflatoxin?			
Yes	6.7% (8)	12.2% (11)	16.7% (15)
No	93.0% (111)	87.7% (79)	83.3% (75)
Are you aware of moldy nuts?			
Yes	74.8% (89)	52.2% (47)	72.2% (65)
No	25.3% (30)	47.8% (43)	27.8% (25)

[7] Response for processors who will re-dry when purchased nuts are not properly dried or when mold growth is visibly seen

[8] Response for retailers who will re-dry when purchased nuts are not properly dried or when mold growth is visibly seen

Agricultural Training

More than half (56%) of farmers have had some formal agricultural training whereas only 35% of processors and 38% of retailers have had agricultural training (Figure 4.3).

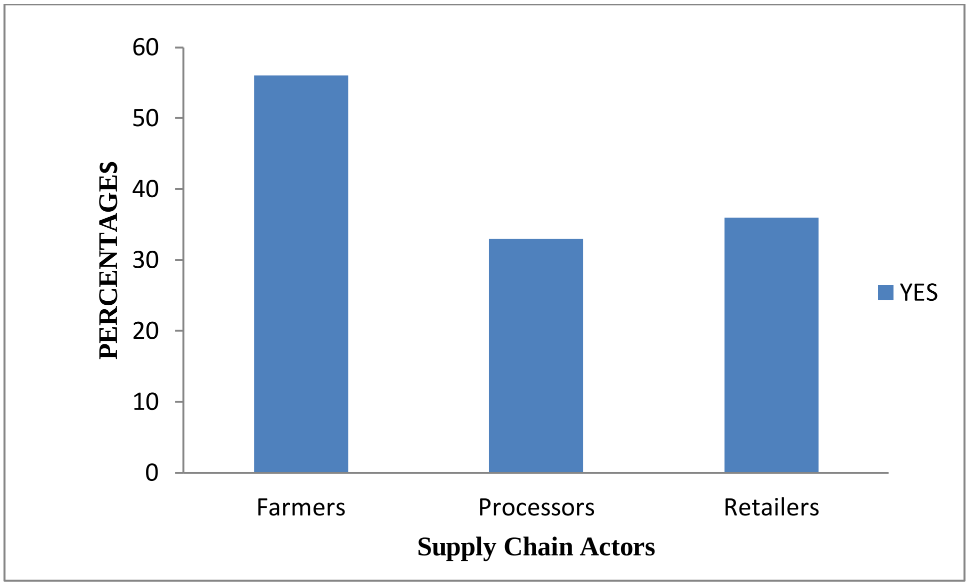

Figure 4.3 Supply Chain Actors who had Agricultural Training.

Factors Contributing to Moldy Nuts

Supply chain actors were asked if they were aware that improper drying of nuts, lack of sorting, insect damaged nuts, inadequate shelling techniques, and storage in mixed use structures can contribute to mold formation. Generally, processors were more aware of improper drying (87.7%), lack of sorting (75.6%), damaged nuts (68.9%) and storing in mixed use structures (85.6%) as possible contributors to mold growth than farmers or retailers (Table 4.3).

Table 4.3 Supply Chain Awareness of Factors Contributing to Mold Growth in Peanuts.

	Farmers	**Processors**	**Retailers**
Improper Drying			
Yes	51.3% (61)	87.8% (79)	38.4% (32)
No	48.7% (58)	12.2% (11)	61.1% (55)
Lack of Sorting			
Yes	44.55 (53)	75.6% (68)	52.2% (47)
No	55.4% (66)	24.4% (22)	47.8% (43)
Storing in Mixed use Structure			
Yes	62.8% (74)	85.6% (77)	43.3% (39)
No	37.8% (45)	14.4% (13)	56.7% (51)
Damaged Nuts			
Yes	46.2% (55)	68.9% (62)	44.4% (40)
No	53.8% (64)	31.1% (28)	55.6% (50)

Remuneration

Most supply chain actors receive no form of benefit, be it money or "in kind"[9], for the various roles they play in post-harvest handling activities. Out of the supply chain actors who are involved in drying nuts (61.3%), less than a third of processors (28.6%) and a little more than half retailers (52.2%) are financially compensated (Table 4.4). About 30.2% of farmers who were involved in the drying of peanuts received "in kind" benefits. These participants indicated

[9] The phrase 'in kind" means they receive a bowl or a bag of peanuts depending on the amount available during handling.

they that they earned approximately two to three bowls of peanuts depending on the quantity dried.

Processors recorded the highest (37.4%) likelihood of receiving financial compensation for sorting peanuts, which they often do as hired labor (Table 4.4). However, 61.8% of farmers and 60% of retailers receive compensation “in kind” in the form of culled nuts. For all supply chain actors who are involved in storing peanuts (77.0%), 64.7% of farmers, 86.7% of processors and 84.4% of retailers receive no form of compensation at all. These participants indicated that they work for their families and do not expect anything in return. All supply chain actors involved in selling peanut and peanut products reported that they manage the money earned from the sale of peanuts. Up to 74% of supply chain actors use the money for housekeeping whereas only 48% invest into their next season of peanut production.

Table 4.4 Remuneration for Supply Chain Actors Role in Post-Harvest Handling.

	Money	"In Kind"	Nothing	Total
Farmers				
Drying	3.6% (3)	30.2% (25)	66.3% (55)	69.7% (83)
Sorting	14.5% (11)	61.8% (47)	23.7% (18)	66.4% (76)
Storage	0.0% (0)	0.0% (0)	64.7% (77)	64.7% (77)
Processors				
Drying	28.6% (22)	23.4% (18)	48.1% (37)	85.5% (77)
Sorting	37.4% (31)	22.9% (19)	39.8% (33)	92.2 % (83)
Storage	0.0% (0)	0.0% (0)	86.7% (78)	86.7% (78)
Retailers				
Drying	52.2% (24)	26.1% (12)	21.7% (10)	54.4% (24)
Storage	0.0% (0)	0.0% (0)	84.4% (76)	84.4% (76)
Sorting	43.1% (22)	60.0% (26)	5.88% (3)	56.7% (51)

Results of Logistic Regression

This section provides logistic regression estimates of the sociodemographic factors that affect womens' post-harvest activities and awareness of aflatoxin. It identifies hypotheses to be tested for various supply chain participants, as well as the independent variables used in the model. And provide the results of the analyses.

Factors that Affect Respondents Decision to Sort Peanuts Along the Supply Chain

As indicated in chapter 3 the dependent variables for these models are:

- Sorting before using as food for farmers.
- Sorting before processing into other products for processors.
- Sorting before selling for retailers.

The independent variables used are age, gender of households, household income, agricultural training, household size, awareness of health implications of aflatoxin, amount of peanuts produced, amount of peanuts marketed, quantity of peanuts bought to be sold, quantity of peanuts purchased to be processed, and remuneration (see chapter 3 for specific research hypotheses).

Farmers. The overall model for sorting peanut before using as food for farmers is significant at the 0.01 (99% confidence level) (Table 4.5). The model indicates that farmers who have had agricultural training are more likely to sort the nuts before using them as food at the $p<0.1$ level of significance (Table 4.5). Based on this result the null hypothesis is rejected. An increase in farmers' household size increases the likelihood to sort peanuts before using as food at the $p< 0.05$ significance level (Table 4.5). Based on this result I fail to reject the null hypothesis. The model also revealed that farmers above 50 years are more likely to sort nuts before using as food at $p<0.05$ significance level. However household income did not show any significant influence on farmers' decision to sort before using peanuts as food. The model further revealed that farmers who are remunerated (money) are more likely to sort peanuts before using as food at the $p<0.05$ level (Table 4.5).

Processors. The overall model for processors is significant at the $p<0.01$ level (99% confidence) (Table 4.5). The model indicates that increase in processors' income level increases the likelihood to sort before processing peanuts into other products such as paste or peanut oil at the $p< 0.05$ level (Table 4.5). I reject the null hypothesis based on the results. Age, household size and agricultural training did not show significant influence on processors decision to sort peanuts. The model further revealed that processors who are remunerated in terms of money are more likely to sort whereas processors from female headed households are less likely to sort peanuts before processors at the $p<0.1$ level (Table 4.5).

Retailers. The overall model for retailers is significant at the $0<0.01$ level (99% confidence) (Table 4.5). Retailers who have had agricultural training are more likely to sort peanuts before selling at the $p<0.01$ level. I therefore reject the null hypothesis based on the results. However, I fail to reject the null hypothesis for household size. This is because the result shows an increase in household size increases retailers likelihood to sort peanuts before selling. The model further revealed that retailers from female headed households are more likely to sort nuts before selling at $p<0.1$ level. Retailers who are remunerated in terms of money are more likely to sort peanuts before selling at $p<0.1$ level.

Table 4.5 Logistic Regression Estimates of Factors Affecting Decision to Sort Peanuts along the Supply Chain.

Sort	Farmers	Processors	Retailers
Age>50	0.34 (0.14)**	0.17 (0.16)	0.12 (0.18)*
Female Headed households	-0.06 (0.13)	-0.26 (0.14)*	0.39 (0.24)*
Household Income	0.02 (0.11)	0.14 (0.05)**	0.03 (0.06)
Agricultural Training	0.28 (0.12)*	0.03 (0.11)	0.32 (0.10)***
Household Size	0.03 (0.01)**	0.01 (0.01)	-0.01 (0.01)**
Aware of Health Implications	0.11 (0.11)	0.00 (0.00)	0.13 (0.13)
Quantity of Peanut Produced	-0.11 (0.09)		
Amount of Peanut Marketed	0.30 (0.24)		
Remuneration (Money)	0.35 (0.15)**	0.22 (0.12)*	0.25 (0.12)*
Remuneration (In Kind)	0.14 (0.13)	-0.18 (0.17)	-0.06 (0.16)
Quantity of Peanut Bought to be Sold			-0.06 (0.11)
Quantity Purchased		-0.12 (0.12)	
Constant	-5.18 (-1.63)	-4.92 (2.11)	0.64 (1.08)
LR Chi^2	17.03	15.54	21.13
R-squared	0.16***	0.20***	0.12***

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Factors that Affect Respondents Decision to Dry Peanuts

The dependent variables for this model are:

- Drying immediately after harvesting for farmers.
- Re-drying before processing peanuts into other products for processors.
- Re-drying before selling for retailers.

Independent variables used are age, gender of households, household income, agricultural training, household size, and awareness of health implications of aflatoxin, amount of peanut produced, amount of peanut marketed, quantity of peanut bought to be sold, quantity purchased to be processed, and remuneration (see chapter 3 for hypotheses).

Farmers. The overall model for farmers is significant at $p<0.01$ level (99% confidence level) (Table 4.6). The model showed that age, household income, and agricultural training did not have any significant influence on farmers' decision to dry immediately after harvesting (Table 4.6). However increase in household size increases farmers likelihood to dry immediately after harvesting at $p<0.1$ (Table 4.6). I therefore reject my null hypothesis based on this result. The model further reveals that farmers who are remunerated (money) are less likely to dry immediately after harvesting at $p<0.05$ (Table 4.6). In addition, an increase in the amount of peanuts produced decreases farmers' decision to dry immediately after harvesting at the $p<0.01$ level (Table 4.6). An increase in amount of peanuts marketed also increases farmers' decision to dry immediately after harvesting at the $p<0.1$ level.

Processors. The overall model for processors is significant at $p<0.01$ level (99% confidence level) (Table 4.6). Increase in processors income level increases the likelihood to dry peanuts at the $p<0.5$ level. In addition, an increase in processors' household size increases the likelihood to dry peanuts at the $p<0.05$ level (Table 4.6). I reject the null hypothesis based on these results. However, age and agricultural training did not show any significant effect on drying nuts.

Retailers. The overall model for retailers is significant at $p<0.05$ level (95% confidence). The model indicates that retailers increase in age increases the likelihood that they will dry peanuts at $p<0.1$ level (Table 4.6). The null hypothesis is rejected based on this result. The result further revealed that retailers' who hire extra labor are more likely to dry nuts at the $p<0.1$ level (Table 4.6). Household income, household size and agricultural training did not show a significant difference on retailers' decision to dry peanuts.

Table 4.6 Logistic Regression Estimates of Factors Affecting Decision to Dry Peanuts along the Supply Chain.

Dry	Farmers	Processors	Retailers
Age	0.01 (0.10)	0.09 (0.08)	0.10 (0.12)*
Female headed households	-0.08 (0.07)	-0.04 (0.10)	-0.35 (0.26)
Household Income	0.01 (0.08)	0.09 (0.04)**	-0.10 (0.09)
Hire Extra Labor	-0.04 (0.07)	0.06 (0.08)	-0.36 (0.18)*
Agricultural Training	0.01 (0.08)	0.10 (0.09)	0.03 (0.13)
Aware of Health Implications	0.17 (0.13)	0.05 (0.07)	0.18 (0.16)
Quantity of Peanut Produced	-0.43 (0.11)***		
Amount of Peanut Marketed	0.12 (0.06)*		
Remuneration (Money)	-0.33 (0.12)**	0.07 (0.09)	0.03 (0.30)
Remuneration (In Kind)	-0.03 (0.07)	0.06 (0.06)	0.02 (0.24)
Household Size	0.02 (0.01)*	0.02 (0.02)**	0.03 (0.01)
Quantity of Peanut Bought to be Sold			-0.19 (0.20)
Quantity Purchased		-1.14 (0.95)	
Constant	1.03 (0.61)	- 17.30 (6.64)	-10.45 (4.79)
LR Chi^2	67.87	31.02	13.69
R-squared	0.77***	0.43***	0.21**

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Factors that Affect Supply Chain Actors decision to Store Peanuts

The dependent variable for this model is storage in mixed-use structures along the supply chain. Independent variables used are age, gender of head of household, household income, agricultural training, household size, awareness of health implications of aflatoxin, amount of peanuts produced, amount of peanuts marketed, quantity of peanuts bought to be sold, quantity purchased to be processed, and remuneration (see Chapter 3 for hypotheses).

Farmers. The overall model for farmers is significant at $p<0.05$ (95% confidence level). The model indicates that an increase in farmers' household income does not increase farmers' likelihood of storing peanuts in mixed-use structures at $p<0.1$ level (Table 4.7). I reject the null hypothesis based on this result. However, an increase in farmers' household size increases the likelihood of storing peanuts in mixed-use structures at the $p<0.01$ level (Table 4.7). I reject the null hypotheses based on this result. The model further revealed that an increase in the amount of peanuts marketed decreases the probability of storing nuts in mixed-use structures at the $p<0.01$ level.

Processors. The overall model for processors is significant at $p<0.1$ (90% significance). An increase in processors' income level decreases the likelihood of storing peanuts in mixed-use structures at $p<0.1$ level (Table 4.7). I fail to reject the null hypothesis based on this result. However, household size and agricultural training showed no significant influence on processors' decision to store peanuts in mixed-use structures.

Retailers. The overall model for retailers' is significant at the 0.05 level (95% confidence level). The model indicates that household income, agricultural training and household size had no significant influence on retailers' decision to store in nuts in mixed-use structures (Table 4.7). However, the model revealed that retailers who are aware that poor drying contributes to mold growth are less likely to store nuts in mixed-use structures at $p<0.1$ level of significance (Table 4.7).

Table 4.7 Logistic Regression Estimates of Factors Affecting Decision to Store Peanuts along the Supply Chain.

Storage	Farmers	Processors	Retailers
Age	-0.01 (0.01)	-0.00 (0.01)	0.01 (0.01)
Female headed household	-0.06 (0.11)	0.02 (0.10)	0.05 (0.08)
Household Income	-0.21 (0.11)*	0.11 (0.07)*	-0.03 (0.07)
Hire Extra Labor	-0.06 (0.10)	0.04 (0.09)	-0.17 (0.15)
Agricultural Training	0.03 (0.09)	0.09 (0.09)	0.14 (0.15)
Household Size	0.05 (0.01)***	0.00 (0.01)	0.02 (0.02)
Aware of Health Implications	0.24 (0.10)	-0.00 (0.00)	0.11 (0.13)
Poor Drying	-0.10 (0.01)	0.01 (0.13)	-0.23 (0.16)*
Quantity of Peanut Produced	0.01 (0.10)		
Remuneration (Money)	-0.23 (0.25)	0.09 (0.10)	-0.02 (0.15)
Remuneration (In Kind)	0.24 (0.12)*	-0.02 (0.12)	0.03 (0.18)
Amount of Peanut Marketed	-0.53 (0.10)***		
Quantity of Peanut Bought to be Sold			0.04 (0.21)
Quantity Purchased		0.37 (0.64)	
Constant	1.69(0.69)	-4.45 (5.23)	1.28 (1.95)
LR Chi^2	22.88	7.07	9.7
R-squared	0.12**	0.35*	0.21**

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Factors Affecting Supply Chain Actors' Awareness of Aflatoxin

The dependent variable for this model is aware of moldy nuts. Independent variables used are age, gender of households, household income, agricultural training, household size, awareness of health implications of aflatoxin, amount of peanut produced, amount of peanuts marketed, quantity of peanuts bought to be sold, quantity purchased to be processed and remuneration (see Chapter 3 for hypotheses).

Farmers. The overall model for farmers is significant at the $p<0.05$ level (95% confidence). The model indicates that age ($p<0.01$), household income ($p<0.1$) and agricultural training ($p<0.1$) influence farmers awareness of mold growth in nuts (Table 4.8). In other words, farmers who have had agricultural training are more likely to be aware of moldy nuts than those who have not. I reject the null hypothesis. However, education did not show any significant difference on farmers' awareness of mold growth in nuts.

Processors. The overall model for processors was significant at the $p<0.01$ level (95% confidence level). Age ($p<0.01$) and agricultural training ($p<0.01$) positively influence processors' awareness of mold growth in nuts. I reject the null hypothesis base on these results. Household income and agricultural training did not show a significant difference on farmers' awareness of moldy nut.

Retailers. The overall model for retailers is significant at $p<0.01$ (99% confidence level). The model indicates that age ($p< 0.01$) positively influences retailers' awareness of mold growth in peanuts (Table 4.8). Retailers who have had agricultural training are more likely to be aware of mold growth than those who have not. From these results I reject the null hypothesis.

Table 4.8 Logistic Regression Estimates on Factors affecting Awareness to Mold Growth in Peanut by Supply Chain Participants.

VARIABLES	Farmers	Processors	Retailers
Age	0.03 (0.00)***	0.03 (0.01)***	0.04 (0.00)***
Region	0.08 (0.06)	0.19 (0.10)*	0.10 (0.05)
Marital Status			
Single			0.15 (0.03)
Divorced	0.09 (0.14)	-0.10 (0.03)	
Widowed	-0.04 (0.09)	-0.16 (0.03)	
Female	0.01 (0.10)	0.18 (0.27)	-0.14 (0.69)
Household Income	0.15 (0.11)*	0.01 (0.03)	-0.02 (0.04)
Primary Education	-0.08 (0.08)	0.12 (0.09)	0.04 (0.08)
Hire Extra Labor	0.08 (0.06)	-0.17 (0.09)*	0.07 (0.10)
Agricultural Training	0.10 (0.01)*	0.39 (0.08)***	0.2821 (0.09)**
Constant	-11.22 (2.70)	-12.47 (3.21)	-15.79 (4.17)
LR Chi^2	64.63	54.53	54.81
R-squared	0.49***	0.46***	0.55***

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.

CHAPTER 5: CONCLUSIONS

Summary

This thesis sought to examine two main questions related to women's roles in post-harvest handling and awareness of aflatoxin contamination of peanuts in Ghana. First, what are the sociodemographic factors that influence aflatoxin awareness among Ghanaian women in the peanut supply chain? Second, what are the sociodemographic factors that influence the behavior of Ghanaian women in the post-harvest supply chain? Descriptive analysis of my survey data was used to examine supply chain participants' sociodemographics, women's role in post-harvest handling and how these roles are performed. In addition, descriptive statistics were used to examine the level of awareness of aflatoxin contamination and the amount and type of remuneration along the supply chain. Logistic regression analysis was used to determine socio-demographic factors that influence respondent's awareness of aflatoxin and their decision to sort, dry and store along the peanut supply chain.

This research indicates that a large number of female Ghanaian peanut farmers (83.3%), processors (69.0%) and retailers (73.3%) have never been to school. This is a result of a variety of cultural and traditional practices in the study districts that prefer male education to female education. This situation is further confounded by patrilineal societies where social rank and property are passed in the male line from fathers to sons (Sarpong 2006). Women are relegated to household chores and farm work in these study districts. Despite the acceptance of women in some societies in the study districts, it still remains a taboo for women to gain an education, acquire property or engage in very lucrative business as it is believed that they were ordained to be caretakers of the kitchen and have been confined there as such. Education is reported a key factor in empowering women in decision-making in and around the household (Kabeer 1994).

This means that without an increase in the level of education among peanut supply chain participants in Ghana, peanut handling decision that will reduce the consumption of aflatoxin may be difficult.

Most farmers (64.7%), processors and retailers (76.7%) are between the ages of 31 to 50 years. This shows that most peanut supply chain participants fall within the active working class and also indicates that physical ability is not likely to be a serious constraint related to proper handling of peanuts.

Most women along the peanut supply chain earn below GH ¢500 ($ 234.77) per month. This could be a result of the lack of resources including available land to produce good quality nuts for sale. It is also a result of the abject poverty many women face in these study areas. The majority of farmers (71.4%), processors (82.2%) and retailers (94.4%) are from male headed households. It was further revealed that widowed and divorced women did not accept the title of household heads but rather pushed the title to their male sons or other male figures within the household. This emphasizes male superiority in patrilineal societies. Most (nearly 100%) of women farmers surveyed worked on lands they did not own. In the study districts, women farmers farm at the subsistence level to feed their families and also sell some of the produce to pay for their children's school fees. Yet, it becomes almost impossible for women to acquire lands for farming because of the existence of a male biased structural system. This system removes property owning privileges of women because it is believed to create competition between men and women. Even in situations where lands are released to women for farming purposes, such lands are often less fertile and small (Goler von Ravensberg et al. 1999). Meizen-Dick et al. (1997) reported that a lack of direct control over land placed boundaries on women's roles in and around the households and diminished their power and influence in the household.

The results showed that the majority of supply chain participants (93%) have not heard of aflatoxin contamination in Ghana. Those who have heard of aflatoxin gave illnesses such as diarrhea, malaria, and coughing as illnesses associated with the consumption of aflatoxin contaminated peanuts. As indicated in Chapter 1, these are not the illnesses recognized by the medical community as being associated with aflatoxin. This finding was consistent with Jolly et al. (2006) who showed that over 80% of farmers, processors and retailers have not heard of the word aflatoxin and are not aware of the health effects associated with it. Similarly, Awuah et al. (2009) reported similar results among farmers, processors and consumers in Ghana. The study also revealed that supply chain participants were aware of mold growth in peanuts though some process spoiled nuts into other forms (*dawadawa*) for consumption. Some participants said they believed they do not get ill from eating processed spoiled nuts. This exposes households who consume these spoiled nuts to the risk of aflatoxin contamination. Though this research did not determine aflatoxin level in peanuts, research has shown that nuts with mold growth are more likely to contain aflatoxin content (Gourama and Bullerman 1994). The majority of farmers (56%) have had agricultural training compared to processors (35%) and retailers (38%). The reason could be that agricultural training organized in the study districts is offered mainly for farmers who produce peanuts rather than those who sell or process the nuts. Most supply chain actors are aware that improper drying, lack of sorting and storage in mixed-use structures contribute to mold growth in peanuts.

The study also revealed that farmers, processors and retailers use a combination of various types of transportation such as headpans, truck, wheelbarrow and motorking to transport the nuts from one point to another. These forms of transportation may increase cross contamination due to the re-use of the transportation systems in carrying different crops. It may also increase peanuts susceptibility to aflatoxin through injuries when nuts are not well handled during transportation. The study also revealed farmers (70%), processors (86%) and retailers (56%) dry nuts before sorting and storing. However, a majority of participants spread their nuts on the ground for drying. This may increase peanuts susceptibility to aflatoxins as spreading done on a hard surface may cause injury to the nuts. It may also increase cross-contamination as a different crop may be spread on the same ground that was used for drying peanut. Participants interviewed determined whether or not the nuts were well-dried either by the difficulty to crack, the sound of the kernels when shaken and applying pressure to determine the ease at which the scale peels off the kernel. In the absence of mechanical driers in the study areas, and moisture detectors these practices tend to introduce variations in moisture levels.

The majority of farmers (90.0%), processors (93.0%) and retailers (57.0%) sorted peanuts before use as food, processing into other products or selling. However, the culled nuts which were processed into *dawadaw*a (a spice) were used by households for stews and soups. This practice increases the risk of aflatoxin contamination in households. This is consistent with Awuah et al.'s (2009) study who found that about 40% farmers and 20% retailers converted spoiled nuts into other products for consumption. A majority of participants store peanuts in mixed used structures. This has serious implications for cross-contamination and pest proliferation, thus increasing the risk of aflatoxin during storage. Fandohan et al. (2005) reported that aflatoxin production is further increased during storage and improper handling practices. During the data collection, I observed unsanitary conditions in the storage structures such as cracks on the walls of the storage houses and water on the floors of the storage rooms. The inability to use independent and well maintained storage structures for peanut storage may be attributed to the low income in the study districts.

Based on the logistic regression analysis, farmers who are above 50 years of age are more likely to sort peanuts before using them as food. This is because women retire from active work around that age and are more likely to be at home to sort peanuts. This is consistent with Awuah et al.'s (2009) research on factors that affect sorting of peanuts in Ghana. Agricultural training has showed a significant influence on farmers' and retailers' decision to sort peanuts. This may be due to the content of the agricultural training in which farmers and retailers are taught the relevance of sorting and how sorting will help reduce the risk of consuming aflatoxin contaminated peanuts. Remuneration (money) also showed a significant influence on farmers' and processors' decision to sort peanuts before using them as food. Perhaps farmers and processors who are remunerated (money) are encouraged to sort peanuts before using as food. However, household size increased farmers' decision to sort peanuts before using them as food. This may be due to the presence of younger children, as well very old members present in the household. Lin (1995) found that individuals with young children and elderly members in the household may have the greatest concerns about food safety. In addition, larger households perhaps contribute more labor to sorting. This may be attributed to the greater numbers of people available and particularly the greater numbers of elderly retiree household members. Household income affected processors' decision to sort peanuts before processing.

The study revealed that processors from female headed households are less likely to sort peanuts before processing. Perhaps is easier to hide imperfect peanuts in processing but not in retailing. However, it showed a positive significance for retailers. High poverty rate have been reported among female headed households. This makes women from female headed households less likely to sort peanuts before using them as food. In addition, women from female headed households have less time to sort as they take on many household roles in the absence of a husband or male household head. Moreover, as a consequence of their poverty, these women may be more concerned with quantity than quality of food. The inconsistency in the results among processors and retailers from female headed households in respect to sorting of peanuts requires further research.

Household size significantly affected farmers' and processors' decision to dry peanuts. This may be because an increase in household size may provide more family labor to help in the drying of nuts. The study further revealed that the amount of peanuts produced and the amount of peanuts marketed affected farmers decision to dry peanuts. This may be due to the fact that an increase in the amount of peanuts produced may require structures that will help dry large quantities of peanuts. Facilities for drying large quantities of peanuts are not available to farmers in the study areas reducing their ability or motivation to dry peanuts immediately after harvesting. Drying may, however, be done in portions and may encourage mold growth due to prolonged drying periods. Household income also affects processors' decision to dry peanuts before processing. This may be due to the fact that sorting adds value by enhancing product taste which gives higher price when sold. This increases income level of processors. Age and hiring of extra labor increases retailers' decision to dry before selling peanuts. The results further revealed that retailers from female headed households are less likely to re-dry their nuts before selling. This may be because retailers from female headed households sell off their peanuts immediately to earn income to take care of their poverty stricken homes.

Increase in household income decreases farmers' and processors' decision to store peanuts in mixed-use structures. The results further revealed that household size positively affects farmers' decision to store peanuts in mixed used structures. However, increases in the amount of peanuts marketed decreases farmers' decision to store in mixed-use structures. This could be due to ready markets available for peanuts in these study areas, decreasing the amount of peanuts that would need to be stored in mixed-use structures. The study further revealed that retailers who are aware of the effect of improper drying of peanuts are less likely to store their nuts in mixed-use structures. Unknown why (need future studies).

Age and agricultural training positively affected supply chain participants awareness of mold growth in peanuts. Though education has been found to influence awareness of aflatoxin, agricultural training is the most important platform for rural people, especially women, to gain awareness and information. Agricultural training can be done through farm groups and extension officers (Atta 2012). Since people who have had agricultural training are more likely to be aware of mold growth and its effects, it will be prudent for policy makers to tackle this area as a way to reduce aflatoxin along the peanut supply chain. The study further revealed household income positively affects farmers' awareness of mold growth in nuts.

In summary, the study revealed that factors such as age, household income, household size, agricultural training and remuneration (money) aid aflatoxin reduction in peanuts. It was also discovered that the conditions in female headed households (mainly poverty) tend to contribute heavily to aflatoxin contamination.

Limitations

A major limitation to the study was created by cultural conditions in the study districts. The districts practice the patrilineal system where supremacy of the household is in the hands of men. This made it difficult to get one-on-one interviews with the women without their husbands or male household heads members being present. This affected the interviews as men were sometimes responding to questions meant for their wives, daughters or sisters and create a situation where women could not speak freely. Another limitation was the existence of language barriers which also very much challenged effective communication challenge. In addition the study was undertaken in May-June by which time most people had just planted peanuts and post-harvest handling activities were not being performed. Therefore future studies should be done around August or around the time when peanuts have just been harvested. Longitudinal studies on post-harvest activities could be insightful in future research. This I believe will give the researcher ample time to observe and perhaps strike better acquaintances with farmers. This will facilitate a more informative research process. Also it would be of interest to interview men so as to compare their roles in post-harvest activities and their awareness of aflatoxin contamination in peanuts. Finally, future research should make efforts to include southern regions (districts) with different lineage systems to give a much better insight into the roles of women in peanut post-harvest activities.

Recommendation

Based on the findings of the study, more emphasis should be placed on agricultural training. Agricultural training will create women's awareness of aflatoxin problems in peanuts and enhance their roles in post-harvest handling in Ghana. Practical illustration on how women should perform their post-harvest roles should be done during agricultural training. Awareness has been reported as a key factor in mitigating aflatoxin problems in developing economies (Awuah et al. 2009). Therefore, appropriate policy formulation requires decision makers to stress the health awareness aspects of aflatoxin-contaminated peanuts and emphasize the diffusion of information on the importance of the hygienic aspects of peanut handling to reduce aflatoxin levels and improve peanut quality.

Education on peanut handling and food safety issues related to consuming aflatoxin contaminated peanut should be directed to entire households since everyone should be aware of the effects on health. Particular attention should be given to women as they are primarily responsible for food preparation and production for the household. Comprehensive educational programs should be aimed at reaching rural women who participate in peanut post-harvest handling. Yet it is also recognized that structural change must take place as education will not be valuable if women have no means of changing their behavior. The Ministry of Food and Agriculture (MoFA) should encourage farmer groups and awareness campaigns that constantly inform all members of the household, as well as the consumers, of the risk associated with using moldy nuts as food and other grains. In addition, resource allocation towards the handling and processing of safe foods should include the use of traditionally improved technology such as well aerated storage rooms, drying on raised platforms and the use of sorting machines.

Particular attention in terms of education and policy-making should be decided toward peanut farmers from female headed households who seem to have greater obstacles in reducing aflatoxin contamination. Policies that provide subsidized inputs such as improved peanut varieties, fertilizer, good land and improved traditional technology should focus on farmers in female headed households. In addition, a ready market, (i.e., ready buyers/consumers of peanuts and peanut products) should be created to target over supply of peanuts from farmers in female headed households.

Conclusion

This research is on the supply chain participants' role in peanut post-harvest handling specific to Ghana. However, it has implications for peanut supply chain actors throughout the West African countries. Women in the peanut supply chain in West Africa should be sensitized to food safety issues and aflatoxin contamination of peanuts. In other words, agricultural training should be encouraged across West Africa to help farmers, processors and retailers handle peanuts in a way that will encourage food safety and quality for local households. Attention should also be given to farmer groups and extension agents as these groups are more likely to be the best means of acquiring information for the foreseeable future. Women should be educated with appropriate training materials that will provide awareness of aflatoxin contamination and its health effects. Women in the peanut supply chain need to be trained on how to properly care for and treat peanuts during post-harvest handling activities to avoid aflatoxin related problems in the future. Since remuneration had an effect on supply chain participants' role in peanut handling, women should be compensated for their post-harvest labor. Compensation will encourage women to work in ways that will reduce aflatoxin contamination along the supply chain. And as a consequence, women will be empowered, as they will have an opportunity to provide safer foods for their households.

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Appendix A: Log Odds Tables

Sort	Farmers	Processors	Retailers
ageless50	1.7577**	-0.7957	0.6582
	(0.847)	(0.759)	(0.988)
Female Headed Household	-0.3174	-1.2221*	2.0710*
	(0.652)	(0.715)	(1.370)
Household Income	0.0770	0.6843**	0.1757
	(0.558)	(0.277)	(0.303)
Agricultural Training	1.1962*	0.1612	1.7240***
	(0.647)	(0.520)	(0.666)
Household size	0.1613**	-0.0585	0.2310***
	(0.076)	(0.055)	(0.086)
Aware of Health Implication	0.6116	0.0001	0.7134
	(0.598)	(0.001)	(0.716)
Quantity of Peanuts Produced	-0.5640		
	(0.498)		
Quantity of Peanuts Marketed	1.3218		
	(1.257)		
Remuneration (money)	1.6865**	1.0316*	1.3282*
	(0.841)	(0.611)	(0.699)
Remuneration (kind)	0.7024	-0.8928	-0.3393
	(0.666)	(0.847)	(0.852)
Quantity bought to be sold kg			-0.5995
			(0.612)
Quantity of peanuts purchased		-5.5439	
		(5.910)	
Constant	-5.1753***	0.6377*	-4.9121**
	(1.628)	(1.083)	(2.107)
Observations	119	90	90
Log Likelihood	-43.39	-54.52	-42.11
LR Chi^2	17.03	15.54	21.13
Prob > Chi^2	0.0074	0.0078	0.0121
R-squared	0.1640	0.1247	0.2005

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Dry	Farmers	Processors	Retailers
Age >50	0.2955	0.4302	1.1306*
	(2.389)	(0.5328)	(0.9270)
Female Headed Household	-2.0626	-0.5159	-1.9344
	(1.852)	(1.286)	(1.532)
Income level	0.1525	1.2054*	-0.5524
	(2.048)	(0.624)	(0.508)
Hire Extra labor	-1.0274	-0.7632	-1.9237*
	(1.703)	(1.029)	(1.109)
Agricultural Training	0.2832	1.3593	0.1729
	(1.969)	(1.236)	(0.732)
Household size	0.5123*	0.4069**	0.1143
	(0.279)	(0.199)	(0.112)
Aware of Health Implications	4.3775	0.6156	0.9585
	(3.356)	(0.958)	(0.909)
Quantity of Peanut Produced	-11.1797***		
	(4.043)		
Quantity of peanut Marketed	3.2437*		
	(1.767)		
Remuneration (money)	-8.8167**	0.9335	0.1625
	(3.899)	(1.159)	(1.608)
Remuneration (kind)	-0.8450	1.2111	0.0781
	(1.940)	(1.286)	(1.573)
Quantity bought to be sold kg			-1.0610
			(1.365)
Quantity purchased		-2.2606	
		(11.459)	
Constant	8.6832*	-6.0725**	0.0605*
	(4.884)	(2.770)	(2.656)
Observations	119	90	90
Log Likelihood	-9.87	-19.81	-25.64
LR Chi^2	67.87	31.02	13.69
Prob > Chi^2	0.000	0.0006	0.0188
R-squared	0.7747	0.4391	0.2108

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Storage	Farmers	Processors	Retailers
Age	-0.007	-0.034	0.080
	(0.035)	(0.047)	(0.085)
Female	-0.367	0.210	0.451
	(0.724)	(0.988)	(0.862)
Household Income	-0.001*	0.001*	-0.000
	(0.001)	(0.001)	(0.001)
Hire Extra Labor	-0.348	0.400	-1.764
	(0.622)	(0.819)	(1.633)
Agricultural Training	0.207	0.851	1.397
	(0.598)	(0.822)	(1.527)
Household size	0.340***	0.020	0.221
	(0.110)	(0.086)	(0.173)
Aware of Health Implications	1.497**	-0.001	1.118
	(0.717)	(0.002)	(1.337)
Amount of Groundnut Produced	0.000		
	(0.001)		
Poor Drying	-0.621	0.057	-2.333*
	(0.646)	(1.220)	(1.654)
Storage Remuneration (Base=Receive Nothing)			
Money	-1.476	0.878	-0.170
	(1.604)	(0.926)	(1.566)
In Kind	1.509*	-0.179	0.331
	(0.794)	(1.134)	(1.840)
Amount of Groundnut Marketed	-0.003***		
	(0.001)		
Quantity of Groundnut Bought to be sold			0.000
			(0.002)
Quantity of Groundnut Bought to be Processed		0.013	
		(0.016)	
Constant	-1.688*	1.275	-4.450
	(1.719)	(1.688)	(4.700)
Observations	119	90	90
Log Likelihood	-39.35	-30.49	-13.99
LR Chi^2	22.88	9.70	7.07
Prob > Chi^2	0.018	0.058	0.0192
R-squared	0.2253	0.1372	0.2016

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Aware of moldy nuts	Farmers	Processors	Retailers
Age	0.297***	0.265***	0.420***
	(0.079)	(0.070)	(0.111)
Region (Base=Brong Ahafo)			
Northern Region	0.899	1.562*	1.164
	(0.723)	(0.924)	(1.029)
Marital Status (base=Married)			
Single			1.7093
			(0.3307)
Divorced	1.013	-1.651	
	(1.533)	(0.0274)	
Widowed	-0.467	-1.329	
	(0.987)	(0.224)	
Female	0.063	1.511	-1.5738
	(1.074)	(2.464)	(0.7451)
Household Income ($1000)	1.720*	0.1173	-0.1755
	(1.328)	(0.2792)	(0.5012)
Educational level (base no education)			
Primary	-0.896	1.033	0.517
	(0.857)	(0.744)	(0.947)
Hire Extra Labor	0.847	-1.417*	0.793
	(0.691)	(0.779)	(1.167)
Agricultural Training	1.150*	3.266***	3.288**
	(0.717)	(0.968)	(1.305)
Constant	-11.220***	-12.470***	-15.791***
	(2.695)	(3.214)	(4.173)
Observations	119	90	90
Log Likelihood	-33.203	-31.646	-22.511
LR Chi^2	64.63	54.53	54.81
Prob > Chi^2	0.000	0.000	0.000
R-squared	0.4932	0.4628	0.5490

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Interview Guide

QUESTIONNAIRE ON WOMEN'S ROLE AND AFLATOXIN CONTAMINATION IN GROUNDNUT

Name of Enumerator: ……………………………………Date: ………………………
Questionnaire Number: ………………...

1. Name ___________________________ /____/
2. Age of respondent______________________________ /____/
3. Region_______________________________________ /_____/____/___/
4. District________________________________ /_____/____/____/
5. Village __________________________________ /____/___/____/___/
6. Marital status /____/
   1= single, 2=married, 3=divorced, 4=widowed, 5=separated
7. Gender of household head ________________________ /___/___/___/___/__/

8. Household size? Please give the correct answer

Household members	Those at school	Sex (how many females or males)	Working in the home
Less than18		Female --- Male --	
Between 18-35			
Between 35-60			
Above 60			

9. Household income………………………………
10. Educational level 1. Non formal/vocational….. 2. Primary……. 3.Secondary…..4. Tertiary………
11. Do you hire extra labor from outside to help with activities after harvesting? (1= yes, 2=no) /_____/
12. If yes, Number of female labor__________________ /___/___/

A. Aflatoxin Knowledge and Awareness

1. Have you heard of the word aflatoxin? (1=yes, 2=no) /___/
2. Are you aware of illnesses associated with consumption of aflatoxin contaminated peanuts? (1=yes,2=no) /___/
   If yes what are some of the illnesses ________________________________

3. Are you aware of moldy groundnuts? (1=YES, 2= No) /____/
4. What do you do with the moldy groundnuts? (a=discard b= process into food (dawadawa) _____
5. Are you aware eating moldy groundnuts can make you sick? (1=yes, 2=no) /______/
   What are the some illnesses associated with eating moldy nuts?
   a) ____
6. Have you had any agricultural training? (1=YES, 2=NO) /_____/
7. Can you tell if groundnuts are spoiled? (1=yes,2=no) /______/
8. Indicate how you would identify spoiled groundnut. 1=groundnuts changes color, 2 = broken, 3=insect infested /___/
9. Are you aware that: can contribute to moldy groundnuts? Circle correct answer

No treatment (eg. Chemical dressing) of groundnuts	1=yes, 2=no
Improper drying of groundnuts	1=yes, 2=no
storage in mixed used structures	1=yes, 2=no
Lack of sorting	1=yes, 2=no
Damaged nuts through inadequate shelling and transportation	1=yes, 2=no

B. Specific role of women from household in post harvest activities of peanuts

10. By what means do you transport your groundnuts to the marketing center? A) truck (1=yes, 2=no) /___/ b) ox/donkey (1=yes 2=no) /____/ c) wheelbarrow (1=yes, 2=no) /___/ d) head pan (1=yes, 2=no) /___/ e) motorking
11. Do you sort groundnuts before selling or eating? (1=yes, 2=no) /____/
12. If yes, why do you sort? (1= health purposes, 2=attract customers, 3=higher profit) /____/
13. If no, why don't you sort? (1=sorted nuts are expensive, 2=sorting is time consuming, 3=there is no difference between products from sorted and unsorted , 4=other (specify)__________________________ /____/
14. What is done to sort out nuts? 1=discard 2= process into other food (dawadawa)
15. Method of sorting? 1=handpicking, 2= mechanical 3=other (specify) __________________________ /____/
16. Do you dry the groundnuts again after buying? (1=yes,2=no) /_____/
17. If yes, reasons for drying? ....
18. Method of drying (a=spread on the bare ground b=spread on a wood structure above the ground).
19. Are you involved in storing peanuts (1=yes, 2=No)
20. Place of storage (1=silos outside, 2=traders sleeping room,3=traders storage room, 4 =others (indicate)______________-

21. Method of storage most commonly used (1=jute sacks ,2=polythene sacks , 3=others ___________

22. Do you store groundnuts with other crops (mixed used structures)? (1=yes. 2=No).
23. What other crops you store the groundnuts with? A .maize (1=yes,2=no) /___/, b. sorghum (1=yes,2=no) /__/,c. Millet (1=yes,2=no), d. rice(1=yes, 2=no) /___/
24. Do you get paid for your post harvest activities

Chores	Hours spent per season	Remuneration (money or kind)
_____Drying	_____	_____
_____ Sorting	_____	_____
____Storage	_____	_____
_____Shelling	________________________	_____

Do you get assistance in terms of money for retailing of the groundnuts? (1=yes,2=no)

If yes, from where do you get the help __________

a. Corporative societies (1=yes,2=no) /___/
b. NGO's (1-yes,2=no) /___/
c. Farmer groups (1=yes, 2=no) /____/
d. Other (specify) _________

25. Who controls the money generated from the sale of the processed groundnut? _(a=men, b=women)
26. If husband or the man in the family what is used for a) buying of cloths(1=yes, 2=no) /___/

b) taking care of the children(1=yes, 2=no) /___/

c. buying materials needed for retailing (1=yes, 2=no)

d) feeding the family (1=yes, 2=no) /___/

e) other (specify)____________________________________