

# **MARKET-BASED APPROACHES FOR POSTHARVEST LOSS REDUCTION**

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## **MARKET-BASED APPROACHES FOR POSTHARVEST LOSS REDUCTION**

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To Simon and Dr. Thomas Boston

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## **LIST OF ACRONYMS**

ADB- Agricultural Development Bank

ADB- Agricultural Development Bank of Ghana

AEA- Agricultural Extension Agent

AFD- Agence Française de Développement

ANSIPRJ- Alliance nationale Pour La Sauvegarde De L'identité Peule Et La Restauration De La Justice

APHLIS- African Postharvest Loss Information System

AU- African Union

BFP- Block Farms Program

CF- Contract Farming

DADU- District Agricultural Development Units

DFID- Department for International Development

ECOWAS- Economic Community of West African States

FAO- Food and Agriculture Organization

FLM- Macina Liberation Front de Libération du Macina,

GGBL- Ghana Guinness Breweries Limited

GLM- Generalized Linear Model

GREL -Ghana Rubber Estates Limited

HDI- Human Development Index

HYV- High Yield Varieties

IITA- International Institute of Tropical Agriculture

IMF- International Monetary Fund

LBC- Licensed Buying Agents

LDCs- Less Developed Countries

LSMS-ISA -Living Standards Measurement Study - Integrated Surveys on Agriculture

MCA- Millennium Challenge Account

MCC- Millennium Challenge Corporation

MDGs- Millennium Development Goals

MiDA- Millennium Development Authority

MMDA- Metropolitan, Municipal, And District Assemblies

MNCs -Multinational Corporations

MoFA- Ministry of Food and Agriculture

MUJWA- Movement for Unity and Jihad in West Africa

NAFCO- National Food Buffer Stock Company

NGO- Non-Governmental Organization

NIE- New Institutional Economics

OECD- Organization for Economic Co-operation and Development

PFJ- Planting for Food and Jobs

PHL- Postharvest Loss

RADU- Regional Agricultural Development Units

RCB- Rural and Community Banks

ROPP- Rubber Outgrowers' Plantation Project

SARI- Savannah Agricultural Research Institute

SDGs- Sustainable Development Goals

TNC- Transnational Corporations

TNS- TechnoServe

UN- United Nations

UNCTAD- United Nations Conference on Trade and Development

UNDESA- United Nations Department of Economic and Social Affairs

UNESCO- United Nations Educational, Scientific, and Cultural Organization

USDA- United States Department of Agriculture

GDP- Gross Domestic Product

## **SUMMARY**

Post-harvest loss (PHL) is the waste and spoilage of food product that occurs after harvest and before human consumption. Food loss occurs on-farm when grain is threshed, winnowed, and dried, and during storage, transportation, processing, wholesale, and retail distribution. The United Nations Sustainable Development Goals consider PHL a major contributor to food insecurity in developing countries, a threat to environmental sustainability, and a major current and future challenge. The problem is particularly acute in Sub-Saharan Africa, because of the region's high concentration of low-income developing countries. As population increases, there will be growing pressures on resources needed to satisfy basic human needs, particularly food, clothing, and shelter. To meet global food and biofuel demands by 2050, food supplies must increase by 60 percent. At its current production levels, Africa would be able to fulfill only about 13 percent of its food needs by that time, a situation that would lead to great food insecurity, malnutrition in children, and threaten the livelihoods of about 65 percent of workers in the agriculture sector. The looming crisis has prompted governments and international donor organizations to introduce bioengineered seeds to increase food production and provide improved provide better storage technologies. However, merely increasing productivity and improving storage may not be enough to reduce loss or meet these demands. Scaling back on food loss is vital to ensuring food security.

### **Statement of the Problem**

According to the African Postharvest Loss Information System, about eighteen percent of maize harvested in Ghana is lost before it is consumed. These losses are attributed to poor infrastructure, labor shortages, inefficient harvesting methods and poor marketing policies.

Africa's population is projected to increase by almost twenty-two percent, reaching 2.1 billion by 2050. The conventional wisdom in the 1970s and 1980s was that agricultural modernization, through technology adoption, was the solution to reducing global postharvest loss. Even today it is assumed that postharvest losses in cereals are higher among smallholder farmers who adopt traditional agricultural methods. Therefore, to reduce the losses, the prevailing assumption is that farmers need to adopt modern farming practices in mechanization and biotechnology. This belief is based on the successes recorded by the Green Revolution in Asia and Latin America. Those experiences suggest that global increases in food production and supply were the result of technology adoption and transfer. It is believed that by adopting high yield varieties (HYVs) of seeds, combined with fertilizers and irrigation, farmers can convert from practicing subsistence farming to commercial agriculture, thus leading to surplus food.

However, when it comes to post harvest loss the success of these technology interventions is inconclusive. Some studies conclude that postharvest loss is reduced with technology adoption, while others suggest that technology adoption and transfer do not affect postharvest loss. In fact, they may even increase it. For example, it has been found that increases in food productivity may lead to market surpluses that, given the low adoption of storage technologies, may result in greater PHL.

The uncertain outcomes in Africa regarding the impact of technological solutions on postharvest loss have prompted others to consider market-based approaches and interventions to reduce loss. Some market-led strategies include assuring demand from anchor buyers, purchasing from smallholder farmers through links created with processors and traders, reducing the distance between smallholder farmers and the markets, and creating alternative markets for excess

production. This research examines the impact of one market-based approach, contract farming, on reducing postharvest loss.

## **Research Questions**

The central research question in this study is the following. Do farmers in contract farming (CF) arrangements have lower levels of postharvest losses than do farmers who do not participate in contract farming? To answer this question, the research examines numerous factors that contribute to postharvest losses, some of which have not been considered previously.

The research finds that the prevailing understanding of postharvest loss is limited because the issue has been approached at the macro-level. Yet to really understand the true drivers of postharvest loss one must investigate what happens at the micro-level. A micro analysis allows one to better understand the problems that farmers face in their day-to-day lives. By surveying 450 farmers in two regions of Ghana, and interviewing key representatives of farming organizations, government agencies, and contract farming entities, the research concludes that farmers who participated in formal contract farming schemes experienced lower postharvest loss than farmers who did not. One caveat is that the research also found that farmers participating in informal contracting schemes experienced greater postharvest loss than did farmers in formal schemes or no schemes at all.

## **Findings**

1. Farmers participating in CF schemes produced three times the output of maize than farmers who did not participate. This is because of the training and inputs (fertilizers and high yield variety seeds) that the farmers receive. Also, CF farmers are incentivized to produce more because they have a ready market for their produce.



2. The odds of PHL for a farmer that does not participate in a CF scheme increases by 55 percent.
3. The odds of PHL for a farmer that does not participate in a CF scheme increases by 55 percent.
4. The odds of PHL for a female farmer reduces by 31 percent.
5. The odds of PHL for a farmer with a polytechnic/university education reduces by 10 percent.
6. For every additional person employed on the farm, the number of bags of maize lost increased by a factor of 1.04.
7. Increasing food production did not predict an increase in postharvest losses.
8. Cultural norms and practices discouraged women from holding land and making decisions about farm operations.
9. Postharvest losses do not exist in isolation but are manifestations of the inefficiencies in infrastructure development, governance, a lack of market access, declining regional security, cultural norms, and traditions that promote gender inequality, and poverty.

## **Policy Options**

### **1. Maintain status quo**

The government and other stakeholders could do nothing about solving the problem because of the financial costs and the social costs of changing traditions. However, it is clear that doing nothing has negative consequences on the environment, reduces farmers' incomes, and could harm food security in the country.

## **2. Encourage Contract Farming.**

Two approaches are available to encourage farmers' participation in contract farming. Firstly, the government could motivate farmers to participate by offering subsidies and incentives to members of a contract farming scheme. For example, the government could provide insurance and risk advisory services to farmers who choose to participate in CF schemes. Secondly, the CF schemes can drive farmers' participation through creating economic opportunity; specifically, by offering rewards and incentives to farmers who participate, deliver the expected volumes, and comply with the recommended quality standards.

Also, as contract farming participation increases, there is a need to create or modify the existing bodies of law to accommodate these changes. In developing these laws, it is recommended that the government set up an organization that will include farmers, agents of contract farming schemes and tribal chiefs. This will ensure that the voices of all the stakeholders in the agricultural sector are considered and heard in the formulation of the laws.

## **3. Improve Educational Attainment and Access to Education**

The results suggest that farmers with higher levels of education experience fewer losses and produce more per acre when compared with other farmers. The government could offer incentives to families that enroll their school-age children and attain a minimum number of days of school attendance. The government should also need to provide incentives for teachers that decide to work in these remote farming communities.

## **4. Gender Gaps in Agriculture**

The results suggest that women make better farmers than men; women have fewer losses than men and produce more per acre than their male counterparts. However, the full benefit that can be derived from women's participation in agriculture is not being achieved because of the gender

barriers that exist in the agricultural sector. One of the recommendations for closing these barriers is to expand the Block Farms Program (BFP) to focus on and prioritize women. In developing the program to prioritize women farmers, the government could bypass the cultural challenges of land ownership by mandating the Ministry of Agriculture (MoFA) to allocate land to women who choose to be a part of the program. This program would enable women to have access to land and capital, make the day-to-day decisions of their farm, and also guarantee a source of income.

Also, to close the gender skills gap, the government should create demonstration farms that would serve as a venue for teaching women agricultural skills.

#### **5. Improve Regional Security**

Tackling the issue of bushfires set by Fulani pastoralists would require concerted efforts of regional security agencies. This is because of their nomadic lifestyle. It is recommended that the governments in the West African sub-region set up a security initiative to track the activities and contain the movement of this tribe. One of the ways to do this is to create a mode of identification that is mandatory for all citizens and residents of the sub-region to carry.

It is also recommended that there be enacted a Cattle Ranching Law that prescribes the mechanisms for breeding animals and other procedures to ensure the safety and protection of lives and properties and provides a dispute settlement mechanism for agro-pastoral disputes.

#### **6. Adopt a Systems Approach to Framing the Postharvest Loss Problem**

Evidence from the qualitative study of postharvest loss of maize in northern Ghana suggests that the problem transcends the challenges of transportation infrastructure and storage. Instead, other factors that farmers encounter in their daily life and other social factors contribute to the problem and are critical to consider in the definition, perception, and resolution of loss. Therefore, in

proposing solutions that reduce loss, efforts must be made to consider the social and institutional factors that contribute to losses.

### **Policy Recommendations**

Based on the policy options described in the previous sections, reducing losses should focus on these three priority areas. The quantitative and qualitative data suggest that these areas have the greatest impact on postharvest losses. These recommendations are discussed in order of priority that should be followed.

The results from the quantitative study show that participating in a formal contract farming scheme has the most significant effect on postharvest losses. For farmers participating in a formal contract scheme, the odds of PHL reduces by 45 percent in comparison with a farmer that does not join. Therefore, it is recommended that the government prioritizes the growth of contract farming schemes in the country by providing a conducive environment that encourages contract farming to thrive. For example, in setting prices for subsidized inputs, the government should consult with the contract farming schemes that provide the same services. Thus, it is particularly crucial for contract farming that sells inputs as seen in the Heritage Seeds example, where the government's subsidized prices are negatively affecting the ability of the profitability of the scheme.

Next, the government should focus on increasing educational attainment. The quantitative data suggest that farmers with the highest educational attainment have the least losses. According to the key informants, these groups of highly educated farmers were more likely to adopt good agricultural practices to reduce losses because of their education. Closely related to this is the need for the government to employ more extension workers. According to the farmers in the two regions, the lack of training services created an information gap on the best agricultural practices.

The farmers stated that only farmers participating in the formal CF schemes had access to extension services. According to the representatives of these schemes, the provision of the extension services increases the financial costs of operation. These financial costs are passed on to the farmers. By employing more extension workers and partnering with the contract organizations to provide the service, these costs will be eliminated on the part of the CF scheme and the farmer.

Finally, the government should prioritize the distribution of land to women. The quantitative data suggest that despite that, the average farm size of a male farmer is twice the size of a female, the difference between the average production per acre is marginal. The data also suggests that women are less likely to have losses. According to the key informants, female farmers are more likely to follow instructions on good agricultural production and postharvest handling. However, the potential gains that could be benefitted from encouraging the participation of women are not fully maximized because of the cultural traditions that prevent women from landholding. It is recommended that the government expands its block farms programs to focus on women to allow women to hold land by bypassing the traditional norms. Also, the government should focus on creating demonstration farms that focus on women to provide training for female farmers.

## **Conclusion**

In conclusion, the results of the research suggest that farmers participating in contract farming experience fewer losses than their counterparts that do not participate — thus implying that contract farming as a market strategy offers an opportunity to increase food production and reduce postharvest losses. However, the farmers and the country are not maximizing the benefits that contract farming presents because of the prevailing socio-economic and cultural norms, regional security problems, and institutional factors in the farming communities. These factors

also contribute to postharvest losses. Therefore, to solve the problem of postharvest loss and maximize the benefits of contract farming, researchers must have a clearer understanding of the nature of the problem. Solving the loss problem requires the implementation of a combination of policies that focus on poverty reduction, gender equity, and regional security.

## **CHAPTER 1: INTRODUCTION**

This thesis looks at maize, a key staple in Africa, and examines the factors and drivers of the post-harvest loss of maize, and the impact of contract farming, as a market strategy, on reducing postharvest loss. I hypothesize that our understanding of postharvest losses has focused on macro-level issues and have ignored micro-level issues that farmers face in their day-to-day lives. I also hypothesize that by participating in market strategies such as contract farming, farmers experience fewer losses.

Maize was introduced to Africa by the Portuguese around AD 1500 (Harashima, 2007). Today, it is the most widely grown cereal on the continent, covering nearly twenty-four percent of Africa's farmed land each year (Macauley, 2015). The crop provides a source of food and livelihood for more than 300 million people living in Sub-Saharan Africa. It accounts for almost half of the calories consumed in the Eastern and Southern parts of Africa, and one fifth of the calories consumed in Western Africa (Rajpal et. al., 2016).

### **1.1 Statement of the Problem**

According to the African Postharvest Loss Information System (APHLIS), about eighteen percent of maize harvested in Ghana is lost before it is consumed (Africa Postharvest Loss Information System, 2017). These losses have been attributed to poor infrastructure, labor shortages, harvesting methods, and marketing policies (World Bank, 2011).

The magnitude and pattern of maize loss vary across the food supply chain, as illustrated in Figure 1.

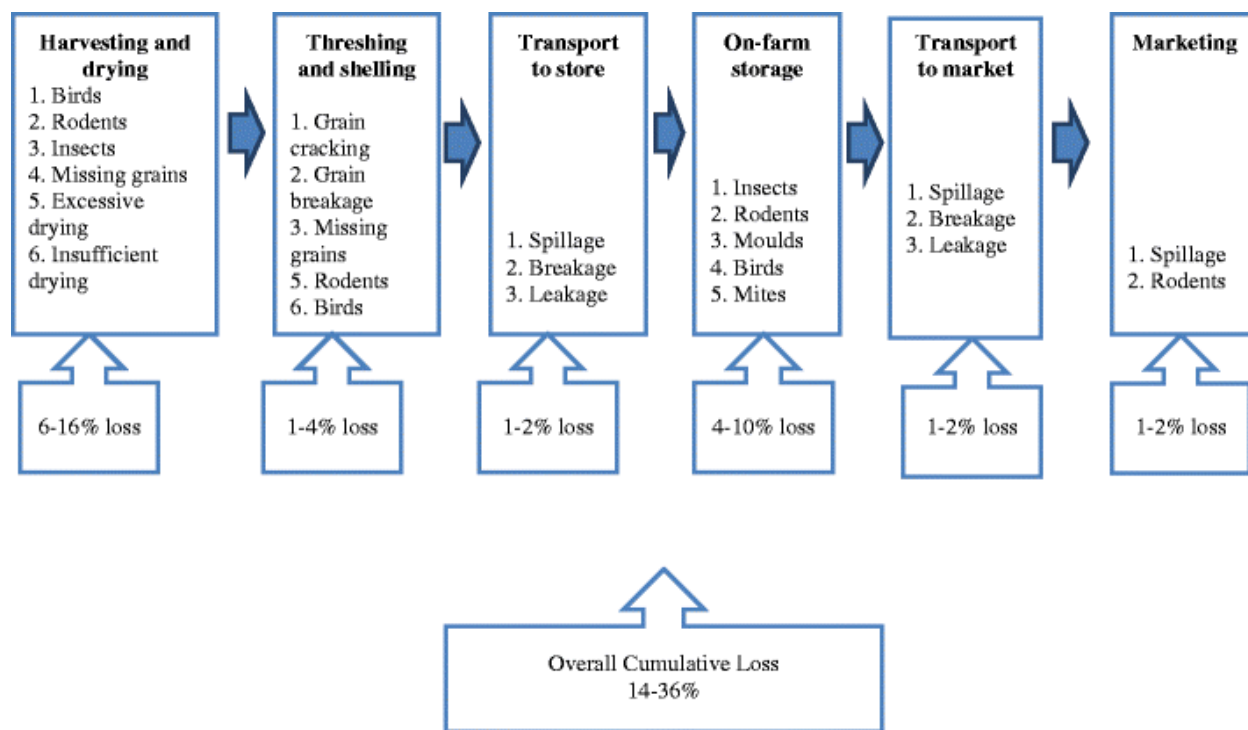


Figure 1: Maize post-harvest chains of activities showing several stages at which losses of grain can occur by means of different causal agents (Source: Tefera, 2012)

## 1.2 Postharvest Loss of Maize in Ghana

According to APHLIS estimates, about six percent of maize grown in Ghana is wasted at the harvesting and drying stages. At the harvest and drying stages, if harvesting occurs too early it will contribute to increased moisture content, making the commodity vulnerable to mold growth and invading insects. It would also increase the costs of drying (Baloch 2010). Harvesting too late exposes the crop to birds and rodent attacks, and losses caused by natural disasters (Baloch 2010). Sun drying also exposes the commodities to pests such as birds, rodents, insects, and other domesticated animals. Often, when mechanical dryers are used, the grains are not dried efficiently. This leads to broken grains.



The traditional practice of harvesting crops by hand, using hand-cutting tools such as sickle, knife, scythe, and cutters as adopted by many smallholder farmers in Africa, has contributed to the loss of food crops at the harvesting stage (Kumar and Kalita, 2017). Often, the manpower required for manual labor is inadequate because of increasing rural-urban migration, the prevalence of HIV/AIDS, and political conflicts. This has resulted in farmers delaying harvesting and crops being exposed to pests such as birds (Paulsen et. al., 2015). Furthermore, because of inadequate drying methods, most African farmers harvest their crops at physiological maturity, that is, when the moisture content is about 20-30 percent. The moisture content at physiological maturity makes the crops more vulnerable to pest attacks, mold growth, and other fungal contamination (Boxall, 2002). Another four percent loss occurs during the drying phase. Harvested crops are usually sun-dried in developing countries. Sun-drying is limiting because it is labor-intensive and weather-dependent. This creates the possibility of cereals being contaminated by stones, animal waste, insects, and dirt thereby reducing their market value. Three percent of the harvest is lost during transportation because of the long distances between rural farms and the urban markets. Very often, rural farms are located in regions that have poor road infrastructure and farmers do not have access to mechanical transportation. Therefore, they must rely on other modes of transportation such as bicycles, animal drawn carts, and trailers. Food crops are also lost at this stage due to heat exposure, damage from pests, and theft (Ganpat and Isaac, 2015).

Inadequate storage facilities contribute to a four percent loss of maize crops in Ghana (World Bank, 2010). This insufficiency is a result of the lack of extension services (Abass et. al., 2014, prohibitive costs of acquiring modern storage technologies particularly by small holder farmers (Tefera et al., 2003), and lack of information about the existence of modern technologies (Doss,

et. al., 2003). In West Africa, grains are stored mostly in the farmer's home, on the field, on bare floors in the open, within conical structures, on raised platforms, in clay structures, in jute or polypropylene bags, or in baskets (Hell et al., 2000). In Eastern and Southern Africa, grains are stored in bags and covered with cow dung ash, in wood and wire cribs, pits, metal bins, wooden open-air or roofed cribs, and in raised platforms and roofed iron drums enclosed with mud (Wambugu et. al., 2009). These traditional storage methods expose the crops to insects and pests such as maize weevils - *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae), the larger grain borer - *Prostephanus truncatus* Horn (Coleoptera: Bostrichidae), angoumois grain moth - *Sitotroga cerealella*, Oliv. (Lepidoptera: Gelechiidae), and the lesser grain weevil - *Sitophilus oryzae* Linne (Coleoptera: Curculionidae) (Tefera et. al, 2011). These insects can also be the result of holding grain in shared in communal storage systems.

Two percent of harvested maize is lost during threshing and shelling processes. In developing countries, threshing is done through the traditional methods of manually trampling or beating the harvested crop to detach the grains from the panicles. Grain spillage, incomplete separation of the grain from the chaff, and grain breakage due to excessive striking are some of the major reasons for losses that occur during the threshing process (Kumar and Kalita, 2017). Loss could also occur when the grain is exposed to atmospheric and biotic factors during the process (Sawicka, 2019).

Losses could accrue across the value chain wherever non-standard measures are used. These non-standard measures could be bags or containers not intended for or approved for agricultural storage. Reporting quantity losses using these nonstandard measures affects the quality of quantitative postharvest loss data on postharvest loss. For example, a bag of maize is equivalent to 40 kg, a non-standard measure would not yield the same measure. Due to the discrepancies between these loss estimates figures, there is inconclusive evidence about the extent of food loss.

Affognon et al. (2015) attribute the challenges encountered with reducing postharvest loss to the lack of a clear understanding of the exact quantification of losses. Also, as they are not designed for agricultural storage, non-standard bags could lead to loss of grain quality by permitting exposure to moisture, insects, and contaminants.

Another cause of postharvest loss of grain in Africa is Mycotoxin contamination. Mycotoxins are “substances produced by fungi that are poisonous or ‘toxic’ to mammals” (Fletcher and Blaney, 2016). These fungi can contaminate commodities before, during, or after harvest. Mycotoxins occur globally and have been recognized for centuries. According to Stein and Bulboacă (2017), there are over 500 known mycotoxins. Only a few of these are regulated or tested for routinely, and new ones are being discovered frequently. Plant metabolism can produce mycotoxins that may not be identified with known characterization methods (Anfossi et al., 2016). According to Wu et. al., (2014), some of the most popular mycotoxins that affect agricultural commodities include aflatoxins, fumonisins, trichothecenes, ochratoxins, sterigmatocystins (STCs), and zearalenones (ZEAs). Aflatoxin is considered the most dangerous group of mycotoxins because they increase the risk of liver cancer and affect the growth of young children (Kimanya et. al., 2012).

About 25 percent of all agricultural commodities are affected by mycotoxin (Bryden, 2007). It is estimated that approximately 25% of world cereal production is contaminated with mycotoxins (Rachoń, 2016).

Mycotoxins have serious economic effects and have adverse impacts on human and animal health (Haschek and Voss, 2013). Human and animal exposure to the fungi through contact, ingestion, or inhalation is known to cause diseases such as akakabio-byo, stachybotryotoxicosis, cancer, (Patterson and Lima, 2010), and sometimes death (Sawicka, 2019). The harmful effects of human and animal exposure to food that is contaminated with aflatoxin makes it unsafe for consumption.

The cumulation of the losses across the value chain has economic impacts on the farmers and their communities. Buyers are often unwilling to pay the full price for insect-damaged and contaminated grains, or grains that are affected by mycotoxins or mold. Jones et. al. (2014) find that the market value for insect-damaged grains varies directly with the amount of damage. This can result in reduced or complete loss of income for the farmers and their families.

### 1.3 Context and Justification

The world's population is expected to increase to 9.8 billion by 2050. Africa's population is projected to increase by almost twenty-two percent or 2.1 billion during the same period (UNDESA, 2017). As population increases, there will be growing pressures on resources needed to satisfy basic human needs, particularly food, clothing, and shelter. To meet global food and biofuel demands by 2050, food supplies must increase by 60 percent (Alexandratos and Bruinsma, 2012). At its current production levels, Africa would be able to fulfill only about thirteen percent of its food needs by 2050, a situation that would lead to food insecurity, malnutrition in children, and threaten the livelihoods of about 65 percent of workers in the agriculture sector (Munang and Andrews, 2014).

In comparison with the rest of the world, Sub-Saharan Africa food insecurity and undernourishment are the highest. Therefore, reducing food waste is of utmost importance. According to the FAO, Sub-Saharan Africa remains the region with the highest prevalence of undernourishment, with about thirty-three percent of the population undernourished (FAO, 2015). Although there was some progress in reaching Target 1c of the Millennium Development Goals (MDGs), i.e., reducing by one-half the prevalence of malnourishment, this progress has been uneven.

A total of 18 of Africa's 53 countries reached the MDG hunger target (FAO, 2015). The factors that hampered the other countries from reaching this target included rapid population growth, low productivity of agricultural resources, poor institutions, political instability, and the inability of farmers to cope with adverse weather conditions. As a follow up to the MDGs, the United Nations (UN) announced a goal of halving worldwide food waste and substantially reducing global food loss by 2030 as part of its Sustainable Development Goals (SDG) agenda. Heads of States in Africa also recognize the need to reduce postharvest losses to ensure food security. At the 23rd Ordinary Session of the AU Assembly in Malabo, African leaders "resolved to halve the current levels of post-harvest losses by the year 2025" (African Union, 2014).

Scaling back postharvest loss would have far-reaching implications for national and international food security. Finding a solution to postharvest loss and food insecurity is imperative because the population of the African continent is expected to account for more than half of the global population growth between 2015 and 2050. More than 28 of the poorest and most food insecure African nations are projected to double or increase their population by a multiple of five by 2100 (UNDESA, 2011).

As population grows, demand for food will also grow and when this is not met, it could result in political instability and unrest. Johnstone and Mazo (2011) concluded that food insecurity was one of the factors behind the wave of political protests that swept through Northern Africa in 2011. According to Kuhn (2012), the Arab Spring was a response to rising caloric demands, food prices, and the inability of the government to meet these demands. In addition to this, food insecurity would also increase migration, as people seek better opportunities for food. Similarly, ongoing conflicts and insurgency situations may be driven by the inability of terrorist

organizations to “win the hearts of the people” through the provision of basic needs such as food and security (Mooney and Hunt, 2009).

Furthermore, food loss has far-reaching consequences on the environment. When food is discarded in a landfill and decomposes anaerobically, it yields methane emissions, a gas more than 25 times as potent as carbon dioxide at trapping heat (FAO, 2013). The FAO ranks food wastage third after the United States and China in the global rankings of methane emissions.

Postharvest food losses are a missed opportunity by the affected communities. They lose out on the full benefits that agricultural products can offer in the form of nutrition, health and wellbeing, and the use of plant products as an alternative to fossil fuels in energy generation. The use of “food” as biofuels continues to grow and may represent another demand factor adversely affected by food loss through wastage.

In addition, reducing food waste could contribute to meeting the Sustainable Development Goals (SDGs). The agricultural sector accounts for about 65 percent of jobs on the African continent (OECD/FAO, 2016). Agriculture is also a predominant sector of the economy, accounting for 25 percent or more of gross domestic product (OECD/FAO, 2016). A reduction in postharvest loss increases household income and enables households to provide better education and healthcare for their families.

#### 1.4 Research Questions.

The central research question in this study is "do farmers in contract farming arrangements have less postharvest losses in comparison with farmers not participating in contract farming?" This study also investigates the differences among the contract farming schemes in postharvest loss reduction. Finally, this research investigates the micro-level factors that contribute to loss.

### 1.5 Location of the Study

I conducted the study in Ghana primarily because it is one of the few African countries that has a government that has resolved in reducing postharvest losses. Therefore, it will be easier to examine and access existing government policies and programs on loss reduction. I also selected Ghana because of the abundance of different contract farming schemes in the country, including Africa's largest contract scheme, Masara N'Arziki. Finally, Ghana was favorable because of the political and economic peace and stability in the country.

### 1.6 Limitations of the Study

The timing of this study coincided with the start of the planting season in Northern Ghana. As a result, I could only collect the results from the preceding year's planting season. Given that these data were not previously recorded by the farmers, the information I collected was based on the ability of the farmer to recollect all that happened in the previous year.

### 1.7 Summary and Organization of the Study

This thesis seeks to investigate the underlying causes of postharvest losses and examine the impact of market-based approaches, particularly contract farming as a loss reduction strategy. The results of this study have the potential for influencing the development of government and other stakeholder policies aimed at postharvest loss reduction.

There are five other succeeding chapters. The next chapter is a literature review of postharvest loss, and the policies, and strategies that have been adopted in reducing losses. This chapter also identifies the gap in the postharvest loss literature and how this study aims at addressing this gap. Chapter 3 discusses the research methodology and the data collection methods. Chapter 4 analyzes the results of the research, followed by a detailed discussion of the results in Chapter 5.

The concluding chapter proffers recommendations for reducing postharvest losses and improving contract farming in Ghana.



## **CHAPTER 2: LITERATURE REVIEW**

### **2.1 Global and African Food Insecurity Burden**

To meet the increasing global food demand and ensure food security, studies have suggested that there is a need to ‘close the yield gap’ between the increasing demand for food and the diminishing supply of food (Godfray et. al., 2010; Parry and Hawkesford, 2010; Pradhan et. al, 2015). This paradigm has also influenced recent international discussions on food security. In 2008 at the United Nations High Level Conference on World Food Security, Ban Ki Moon, then Secretary-General of the UN, and Jacques Diouf, Director-General of the FAO, expressed the need to double the current levels of agricultural productivity (FAO, 2008).

A strategy that has been adopted in the past to ensure that global food demands are met include the introduction of bio-engineered seeds. In effect, in the light of shrinking availability of farmland in the face of competing uses of land, farmers need to increase the output from the same or less land (Godfray et. al., 2010). For example, the Green Revolution introduced rice, maize, and wheat disease-resistant and high-yield varieties, allowing farmers to “to grow much more per acre” (Conway, 2003). However, the adoption rates of these seeds remain low (Mabaya, et. al, 2015; Falck-Zepeda, et. al., 2013).

Changes in the climate patterns may prove a challenge to Africa’s ability to increase its food productivity (OECD/FAO, 2016). Changes in rainfall patterns are altering the timing, availability, and quality of water resources (World Bank, 2010). In addition, rainfall affects the moisture content of maize after harvest. Many African farmers depend on the sun for drying their grains. Late or excessive rainfall would result in improper drying, leading to mold growth and increased postharvest loss (Tefera, 2012). Climate models suggest that sustained increases in

CO<sub>2</sub> emissions would lead to reduced crop yields in Africa (Rosenzweig and Parry, 1994). A meta-analysis of crop yields in response to climate change in the fourth assessment report of the Intergovernmental Panel on Climate Change finds that maize yields would decline with every additional 2 °C of warming (Easterling et. al., 2007). A field study conducted by Lobell et. al (2011) find that maize yield decreases by one percent for every 1°C in temperature if the plants are receiving enough water, and by 1.7 percent in drought conditions. It is predicted that at temperature increases above 3°C, maize yield in Africa would decrease by around 20 to 40 percent (World Bank, 2008). Coupled with climate change is the challenge of declining agricultural productivity caused by soil degradation (Tully et. al, 2015). According to the World Bank (2008), about 75 percent of African farmland is affected by soil degradation. However, simply increasing productivity may not be enough to meet these demands (Aulakh, and Regmi, 2013). Scaling back on food loss is important in ensuring food security.

## 2.2 Postharvest Loss of maize in Africa

In the 1970s and 1980s, conventional wisdom offered modernization through technology adoption as the solution to reduction of global postharvest loss (Lipton, 1982). It was assumed that postharvest losses in cereals were higher with smallholder farmers that adopted traditional agricultural methods, and that to reduce the losses, farmers needed to adopt modern agricultural practices such as mechanization and biotechnology (Lipton, 1982). This belief is based on the successes recorded by the Green Revolution in Asia and Latin America that suggested that global increases in food production and supply were the result of technology adoption and transfer (Evenson and Gollin, 2003). It is believed that by adopting high yield varieties (HYVs) of seeds, combined with fertilizers and irrigation, farmers could change from practicing subsistence

farming to commercial agriculture thus leading to surplus food production (Bazuin, Azadi and Witlox, 2011).

A literature survey of academic journals on postharvest loss in Africa using the Web of Science journals database shows that there are 73 journal articles on the study of postharvest loss in Africa. Table 6 in Annex1 provides a tabular representation of the authors of these publications, the years of publication, the crops in the study, and the focus of the study. Most of the studies focused on storage technology interventions in reducing postharvest loss.

However, the success of these technology interventions is inconclusive. Some studies have concluded that postharvest loss is reduced with technology adoption. In a comparative study of postharvest loss of cereals in developed countries (especially the USA and the UK) and in less developed countries (LDCs) in sub-Saharan Africa, it was found that mechanized agriculture in developed countries have contributed to lower levels of postharvest loss compared with the losses experienced by farmers in developing countries (Hodges, R., Buzby, J., & Bennett, B. 2010). Figure 2 shows the results of the study. The authors find that mechanized agriculture in developed countries has contributed to lower levels of postharvest weight loss compared with the losses experienced by farmers in developing countries. According to the authors, farmers that adopt agricultural technologies at each stage of the agricultural value chain are more likely to suffer lower postharvest losses. For example, during the drying stage, farmers that adopt the traditional sun-drying of crops have estimated losses of 3-5 percent of the crops harvested while those that adopt mechanized drying record between 1-2 percent losses. Also, farmers that store their crops in the open record between 5-10 percent losses, while farmers that adopt technologies like sealed storage systems record about 1-2 percent losses. In the milling process, farmers that adopt the traditional milling by hand, feet or mortar and pestle record losses of about 20-30

percent of their crops while farmers that mill their cereals with commercial milling technology record about 5-30 percent loss.

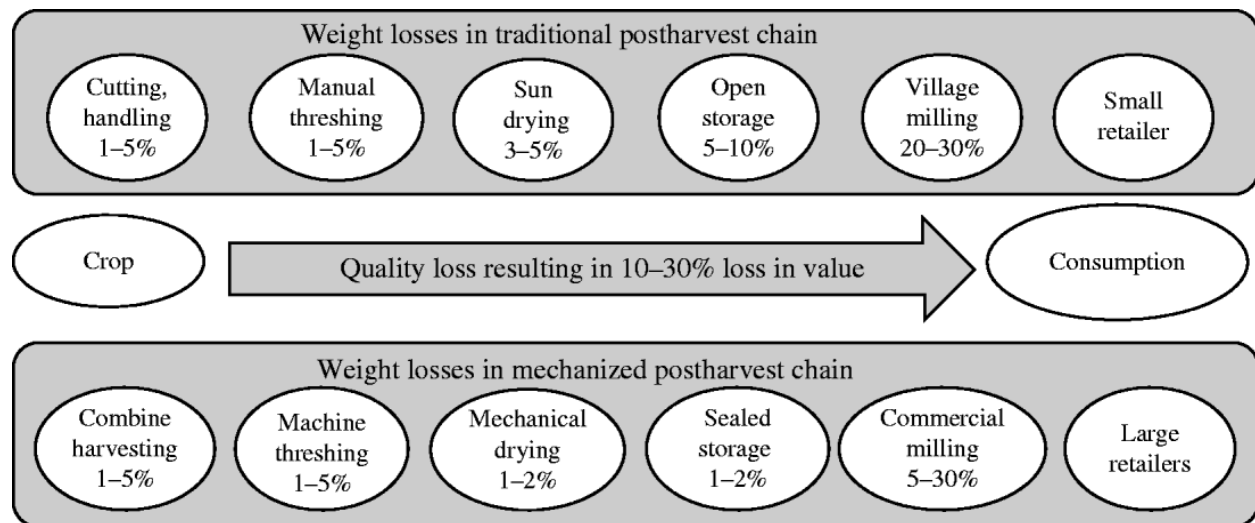


Figure 2: Crop Weight Loss Contribution to Post Harvest Losses. (Hodges et. al., 2010).

The World Food Program (2014) in a study conducted on the effectiveness of Postharvest Loss technology interventions by farmers in Uganda and Burkina Faso found that by adopting harvesting, drying, threshing and storage technologies over 90 days, farmers recorded about 1-2 percent losses of their maize crops. In comparison, farmers that adopted the traditional storage methods recorded a 60 percent loss over the same period. Affognon et. al., (2015) study of technologies developed to reduce postharvest loss found that losses encountered during the storage of cereals, particularly maize, can be reduced by about 81 percent if farmers adopt storage technologies.

In contrast, other studies have suggested that technology adoption and transfer does not reduce postharvest loss. Instead, increasing food productivity has led to a market surplus, and, given the low adoption of storage technologies, the surplus product resulted in increased losses (Greeley, 1982).

A recent study of postharvest losses of wheat, rice, pearl millet, and maize in India found that despite the availability of storage technologies in the country, farmers recorded enormous losses of crops because of unfavorable government policies that regulated food prices (Mallory and Baylis, 2012). Kitinoja et. al., (2011) also found that the impact of technology adoption on reducing postharvest loss in developing countries is inconclusive. This is because prior research on postharvest loss mitigating technologies have not accounted for the costs and financial benefits the farmers accrue from adopting these technologies. They also found that in many instances, the absence of local capacity or spare parts to repair these technologies when they break down hinders the gains that could have been derived from technology adoption.

The World Bank (World Bank, 2011) also acknowledges that despite an increase in technology options for reducing postharvest losses, there have not been many success stories in Sub-Saharan Africa because technologies “too often proved to be financially unsustainable, ill-aligned with farmers’ economic incentives to store and better protect food, or too short to pay off” (Kaminski and Christiaensen, 2014).

Aulakh and Regmi (2013) found that when using technologies such as mechanization and precision agriculture, farmers would record a reduction in the losses they experience. However, technology adoption, particularly mechanized harvesting and winnowing, could also contribute to the losses. They also identified weather conditions, particularly precipitation and the country’s existing infrastructure as contributing factors.

## 2.3 Making a case for Contract Farming

Considering these uncertainties with technological solutions in Africa, market-led approaches and interventions to reducing postharvest loss are becoming mainstream in the postharvest loss literature. Some market-led strategies include assuring demand from anchor buyers, purchasing from smallholder farmers through links created with processors and traders, reducing the distance between smallholder farmers and the markets, and creating alternative markets for excess production (Deloitte, 2015). Contract farming is a form of the market-led approach that has been proposed as a potential solution for reducing postharvest loss. (Global Knowledge Initiative, 2014, Rockefeller Foundation, 2018; International Finance Corporation, 2017).

### 2.3.1 *Contract Farming*

Contract farming has a long history. Hektemoroi or "sixth partners", is a form of contract farming that originated in ancient Greece where tithes, rents, and debts were settled with specified percentages of crops (FAO, 2001). In the late nineteenth century, the Japanese colonial state employed contract farming in Taiwan to guarantee supplies for sugar production (Little and Watts 1994). Since then, contract farming practices have spread in many developed and developing countries. For example, in the 1930s, contract farming was introduced to Africa in the fruit and vegetable canning sectors (Little and Watts, 1994). During that period, contract farming was also introduced in the United States in the poultry industry (Gisolfi, 2006).

Countries in Latin America promoted contract farming as a way to implement import substitution programs (Little and Watts, 1994). Increased global demands for fruits, nuts, and vegetables in the 1960s saw an increase in contract farming arrangements. During that period, multinationals in North America, Europe, and Australia entered into contracts with farmers in Asia, Africa, and South America for the supply of these commodities (FAO, 2001). According to

the United Nations Conference on Trade and Development (UNCTAD, 2009), as of 2009, “contract farming activities by TNCs (Transnational Corporations) are spread worldwide, covering over 110 developing and transition economies, spanning a wide range of commodities and, in some cases, accounting for a high share of output.”

Contract farming is

*“contractual arrangements between farmers and other firms, either oral or written, specifying one or more conditions of production and/or marketing of an agricultural product” (Roy, 1963).*

The FAO defines contract farming as

*“an agreement between farmers and processing and/or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices” (FAO, 2001).*

It is also defined as

*“an intermediate mode of coordination, whereby the conditions of exchange are specifically set among transaction partners by some form of legally enforceable, binding agreement. The specifications can be detailed, covering provisions regarding production technology, price discovery, risk-sharing and other product and transaction attributes” (Da Silva, 2005).*

Prowse (2012) defines contract farming as

*“a contractual arrangement in which a farmer and a firm make a verbal or written agreement before production begins for the firm to provide material or financial resources to the farmer in exchange for farm produce over a specified period of time.”*

These definitions provide insight into the elements of a valid agriculture contract. First, valid contracts can be oral or written agreements between the parties. As the name implies, written

contracts are usually written and formal agreements between the parties. While the oral arrangements may be informal, they could still be valid and can be legally enforceable if the contracts meet other requirements for a valid contract. Second, a valid contract would have a clear definition of the parties, the rights, and obligations of the parties. The obligation of the party's clause would include the type and quality of the crop that will be delivered, the production and marketing practices, and the means of delivering the crops. Also, contracts will contain a duration clause that spells out the lifetime of the contractual arrangement. In practice, most agriculture contracts are valid for one year and are subject to annual renewal. Also, a contract would include a dispute resolution clause that prescribes the dispute resolution options and mechanisms that are available to the parties when the need arises. Finally, a consideration clause is an essential feature of an agriculture contract. The consideration clause will state the price of the commodity and payment that is expected during the lifetime of the contract. Payment could be in the form of money or something that the parties consider valuable. In agriculture contracts, consideration would include money or commodities.

Figure 3 is a framework of an agriculture contract. There are two parties to a contract, namely the farmers and the sponsors. The principals manage and administer the contract for the supply of a commodity (the project). The success of the project and production performance is influenced by factors such as contract monitoring, political stability, land tenure, and the provision of training services for the farmers. Finally, there is a continuous feedback loop between the farmers and the sponsors, which includes conversations about the contract amendment.



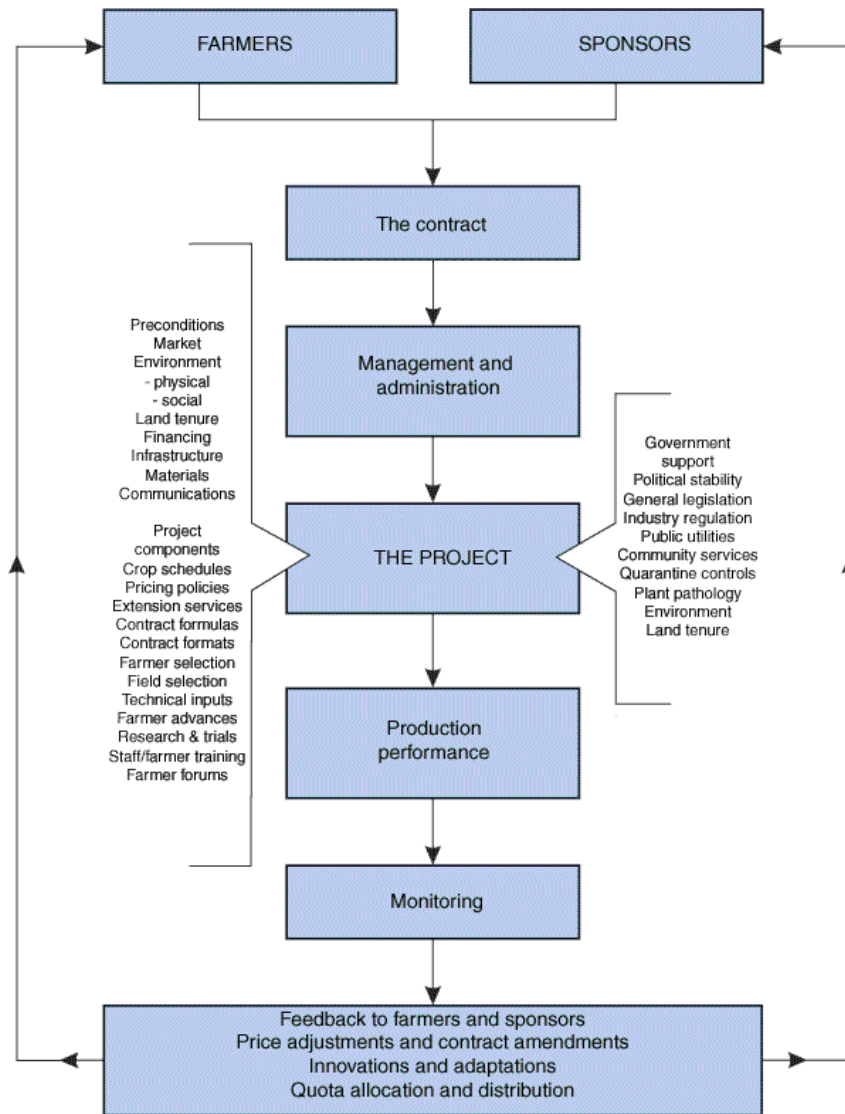


Figure 3: Contract farming framework (Source: FAO, 2001)

### 2.3.2 Contract Farming in Ghana

Contract farming in Africa has its roots in the policies and strategies of the colonial years. Jaffee (1994) traces the earliest forms of contract farming in Kenya to the period during World War II when the British began developing infrastructure for supplying vegetables to British troops. Over time, contract farming gave way to plantation agriculture when colonial governments

appropriated large expanses of land for growing export crops (Smalley, 2013; Corey, 2014). In Ghana, colonial governments set up plantation farms for the cultivation of cocoa, palm oil, and rubber.

Following the independence of many African nations in the 1960s, there was resistance to plantation farming among the rural farming communities because of complaints of displacement. In addition to this, there was a desire to increase employment, and to modernize and mechanize the agricultural sector. This led to many governments promoting nucleus estate schemes with smallholder farmers (Watts and Little, 1994). Kwame Nkrumah's<sup>1</sup> desire to create state farms created the organization of smallholder farmers into state-sponsored nucleus estate schemes that produced sugar and tobacco (Hill, 1977). However, these state farms failed for reasons such as the low productivity of the staff, and "rapid and erratic increases in food prices in rural and urban Ghana" (Hill, 1977).

In the late 1960s and early 1970s, many newly independent African nations obtained loans for infrastructure development. The oil shocks of 1973 which led to high interest rates, recessions in industrial countries and weak commodity prices, made it impossible for these developing countries to meet their loan obligations. A decade later, the International Monetary Fund (IMF) and the World Bank set up macroeconomic and structural adjustment policies to help these countries reduce their balance of payment deficit. African governments were encouraged to diversify their exports and develop non-traditional exports<sup>2</sup>. Contract farming was one of the strategic policies for developing the non-traditional exports (Watts, 1994).

<sup>1</sup> Kwame Nkrumah was the first president of Ghana. He ruled from 1957-1966.

<sup>2</sup> Non-traditional exports are defined by the Ghana Export Promotion Council (GEPC) as all products other than cocoa beans, logs and lumber, unprocessed gold and other minerals and electricity. They

Contract farming was also seen as a means of reducing the overarching role that the government played in providing inputs, technical services, and commodity marketing. The government interventions did not produce the expected results due to unstable macroeconomic environments, weak legislative frameworks, inadequate political commitments and institutional capacity, and public policies that did not favor agriculture and rural development (Kidane et. al, 2006).

Contract farming was a way to encourage the private sector to reduce the inefficiencies in the agricultural sector.

The government of Ghana has promoted contract farming as an agricultural policy to improve the income of peasant farmers, grant smallholder farmers access to international markets, and to increase the production of export commodities (Daddieh, 1994). Evidence of this is seen in the Rubber Outgrowers' Plantation Project (ROPP), a multipartite contract scheme supported by the Government of Ghana, the Ministry of Food and Agriculture (MoFA), Agricultural Development Bank of Ghana (ADB) the Agence Française de Développement (AFD), Germany's Reconstruction Credit Institute (KfW) and the World Bank.

## 2.4 Theoretical Framework

The research employed the new institutional economic theory to organize the understanding of contract farming and postharvest loss. This framework is described below.

### 2.4.1 *New Institutional Economics Theory*

New Institutional Economics (NIE) theory offers a wealth of knowledge in understanding and describing the factors, values, and conflicts that influence contract farming and postharvest loss.

include horticultural products, fish and seafood, prepared food and beverages, handicrafts and other manufactured items.

NIE operates within the framework of classical economics but introduces institutions and transaction costs as an additional layer of constraints of a market. Classical economics assumes that in a perfect market, firms are rational and have a goal of maximizing profit. On the other hand, the NIE theory assumes that property rights are not always clearly defined, and information asymmetries lead to bounded rationality and increased transaction costs (Williamson, 1979). Transaction costs are the costs associated with organizing human interactions and carrying out exchange. These costs can be ex-ante, for example the costs associated with negotiating contracts the cost of information search, bargaining, and decision costs, and costs of negotiating. Costs could also be post-ante, for example the costs associated with monitoring, and enforcing contracts (Coase, 1937; Williamson, 1985; Ormann and King, 2007). According to Sykuta and Chaddad (1999), all human interactions involve some transaction costs that are influenced by social, legal, political or economic institutions. To reduce these transaction costs, NIE theorists argue that there is a need for institutions that constrain human interactions. North (1991) defines institutions as humanly devised constraints that regulate human interactions. In other words, institutions are rules, both written and unwritten, that reduce uncertainties in human interaction (Ménard and Shirley, 2005) and provide a stabilizing factor for societies. According to NIE theorists, institutions are important in determining economic performance, efficiency, economic growth and development of every society (Williamson, 1975; Stiglitz, 1985; Kherallah and Kirsten, 2002).

Institutions can be formal or informal (North, 1991; Acemoglu and Robinson, 2013). Formal institutions are “... are openly codified, in the sense that they are established and communicated through channels that are widely accepted as official ... informal institutions are socially-shared rules, usually unwritten, that are created, communicated, and enforced outside of officially

sanctioned channels” (Helmke and Levitsky, 2004). Examples of formal institutions include legislative norms. Informal institutions would include institutions such as customary norms passed through oral traditions, patterns of clientelism, corruption, and patrimonialism.

Agricultural practices in many parts of Africa, and particularly in Ghana, can be explained through the institutional theory lens. The uncertainties associated with agriculture production may increase the transaction costs and encourage farmers to adopt opportunistic behaviors.

Transaction costs in Africa arise from information asymmetry for several reasons including (a) not all the participants in the markets have full access to production information; (b) costs and returns of participating in the transaction; (c) market failures in the provision of inputs and services for farmers in rural areas; and incomplete and imperfect credit, insurance, labor and land markets (Delgado, 1999). For example, farmers often lack access to information about the cost of inputs, whom to sell, and the price to sell. Information asymmetry also occurs in contract farming where contract agents lack the full information about the assets, liability and credit worthiness of a farmer, and where the farmers have inadequate information about the purchase price of their harvested products. There are also bargaining costs when the principal must bargain with many agents.

The NIE theory also provides insights into the making, monitoring, and enforcement of farming contracts that eventually determine the economic path of a society of farmers. The ease of making contracts and the types of contracts would depend on several factors including the level of the transaction costs involved, the societal norms and customs, and the social capital expended (Hubbard, 1997). These factors would either increase the transaction costs, making it difficult for contract making, monitoring, and enforcement, or they could also reduce transaction costs, making it easier for contract making, monitoring, and enforcement. Contractor agents with

formal contracts would be more reluctant to engage farmers in a society with higher costs of contract enforcement, thereby resulting in the proliferation of informal contracts. According to North (1990), the inability of states to develop effective, low cost means of enforcing contracts is one of the factors of underdevelopment. Williamson's (1993) contribution to the theory on the concepts of bounded rationality and opportunistic behavior would also explain the experiences of the contract agents with regards to farmer behaviors such as adverse selection, moral hazard, cheating, shirking, and other forms of strategic behavior. In some instances, contracts may be self-enforcing, at other times, third parties are needed to enforce the contracts. Third party enforcement involves the use of a state apparatus in the settlement and enforcement of contracts. The absence or weakness of a government entity further promotes opportunistic behavior on the part of either party to the contract.

African agriculture is often characterized by the low rates of adoption of Green Revolution technologies such as high yielding crop-varieties, irrigation, and micronutrient fertilizers (Spencer, 1996; Feder and Savastano, 2017). Institutional theory could offer some perspectives on this phenomenon. Inappropriate land tenure, patriarchal land inheritance systems, and ineffective government regulation of land use have been attributed as the cause of small land ownership in the continent (Kasirye et. al, 2013). Small land ownership is broadly described as farmers on less than ten hectares of farmland (Samberg et. al., 2016). Smallholder farmers are often described by their resources, e.g. 'small-scale', 'resource poor' and sometimes 'peasant farmers' (Gininda, Antwi, and Oladele, 2014). In effect, because of resource constraints, smallholder farming discourages investment in expensive technologies because the farms are not large enough to produce large outputs (Jayne, Mather, and Mghenyi, 2005). Some studies have

shown that non-mechanization of farm operations leads to higher postharvest loss (Hodges et. al., 2010).

The state of agricultural practices in Africa could also be interpreted through the political dimension of the New Institutional Economic theory. In many African countries, government interventions occur frequently in the agricultural sector. For example, it is commonplace for governments to provide subsidized loans and inputs to farmers. However, some of these interventions are allocated based on familial, ethnic, and or political affiliation. Bates (1989) argues that “lying behind the economic theory of institutions...is a political story . . .while many kinds of institutions may provide enhanced efficiency in markets . . . those will be created that favor ‘special interest’.” In effect, these political practices promote rent seeking behavior among rural farmers on the one hand and government officials on the other.

Agency theory is concerned with the relationship between the parties to the contract and aims determining the most efficient form of contract, given the information asymmetry and the transaction costs. The theory recommends two best possible contract outcomes; behavioral based and outcome based. In behavioral-based contracts, the principal rewards the agent for good behavior, while with the outcome-based contract, the agent is rewarded based on the intended outcome of the agreement. To determine the optimal reward structure, the principal must weigh the cost of measuring the agent’s behavior against the cost of measuring the contract outcome (Rehber, 2000; Eisenhardt, 1985).

## 2.5 Types of Contract Farming

There are two types of farming contracts namely marketing and production contracts. With marketing contracts, the principal guarantees to purchase the agent’s crop at a set price. There

are three common forms of pricing arrangements in marketing contracts (Hall and Langemeier, 1999). These include the following:

- a. Forward sales contracts where the principal guarantees to buy a commodity at a set price and a later time.
- b. Price setting after delivery where the price that would be paid will be determined by the grade and quantity of the commodity.
- c. Pre-harvest pooling arrangements. In this arrangement, the harvested crops of many growers are collected together. The payment due to each producer is the average price of the total price of the commodity that is sold.

In production contracts, the contract specifies the quantity and quality of inputs that the principal will provide to the agent, the quality and quantity of the commodity that will be produced, and the compensation that the agent will receive for his services. In deciding the model of contract farming that would be adopted, the principal must define the managerial responsibilities, the pricing structures and the set of technical specifications that directly regulate production are important decisions that go into the drafting of an agriculture contract. Three options are available to the principal in making this decision (Kohls and Uhl, 2002). These include the following:

- a. Market specification

Market specification contracts are pre-production agreements that set out the quality standards that are to be adhered to and the rules for marketing the commodity. In this type of contract, the principal provides minimal inputs to the farmers. This type of arrangement is commonly seen in informal contracts.



b. Resource providing

In this type of contract, the principal provides the agent with inputs such as seeds and fertilizers and provides financial resources. This type of contract is used when there is a strict requirement to produce the commodity that will be delivered.

c. Production management

Farmers in production management contracts agree to adhere to specific and strict production standards.

## 2.6 Business Models of Contract Farming

There are five broad types of contract models. The contract farming model to be adopted depends on the crop, the objectives and resources of the sponsor, and the experience of the farmers (Eaton and Shepherd, 2001). Models are usually differentiated based on the intensity of vertical coordination, the type of product, and the number of key actors involved. These schemes are discussed next.

a. *The centralized model.*

In this contract farming business model, the principal agrees to purchase predetermined quantities of a commodity from the agent, which are usually local smallholder farmers. The delivery date for the commodity is also predetermined. To ensure that the commodity meets the expected quality standards, the principal would offer inputs, services, and technologies at different stages of the production process. Figure 4 is a pictorial representation of the centralized model. The farmers retain ownership of their land while the principal (sponsor) offers management and administration of the farm operations, land preparation, inputs (such as seeds and agrochemicals), harvesting services, marketing, and technical support to the agent (farmers)

with the expectation that the farmer's commodities meet strict quality standards. The success of the project is dependent on factors such as climate, the quality of management provided, the quality of technologies adopted, the financial incentives offered, and government support.

This business model is commonly used in tobacco, cotton, sugar cane, coffee, and cocoa contracts (Eaton and Shepherd, 2001). Outgrower schemes, popular in Africa, are a form of the centralized model. The outgrower scheme operated by the Ghana Rubber Estates Limited (GREL) was considered the most preferable model for cultivating rubber because of the social benefits that the farming communities received from the company, and because the company contributed "virtually no investment costs required to ensure and maintain the volume and regularity of raw material supplies for GREL's processing factory" (Paglietti and Sabrie, 2012).

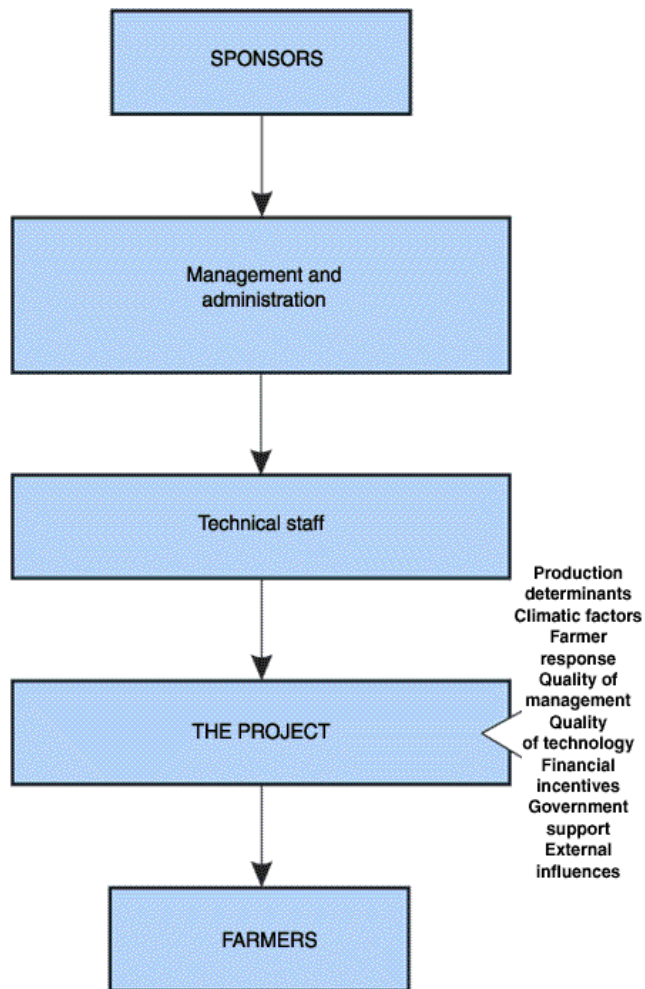


Figure 4: Centralized Model (Source: FAO, 2001)

b. The nucleus estate model.

In this model, the sponsor provides the inputs and technologies that are needed for cultivating the commodity. The sponsor also owns and manages an estate plantation that is usually attached to a processing plant. The commodities produced on the plantation guarantees an all year supply of the commodities for the processing plant. This model is common with tea, coffee, fruits, and vegetables.

*c. The multipartite model.*

The multipartite model is a joint-venture agreement among several parties. This model is typically among government agencies, statutory bodies, and private companies jointly participating with farmers. In some instances, this model could also involve separate organizations that provide credit facilities, technical support, input, management services, processing, and marketing. In some instances, a national development bank is a party to the contract and provides growers with credit facilities for purchasing inputs (Glover and Kusterer, 1990). According to Little and Watts (1994), there has been an increase in the number of multipartite schemes since the 1980s, a period associated with the implementation of market liberalization policies in many developing countries (Cotula et al., 2008). This growth was also driven by support from international donor and aid agencies (Oya, 2011). The multipartite scheme is common in cultivating rubber and oil palm in West Africa.

Figure 5 is an example of the Guinness Sorghum Project in Ghana that is set up following the multipartite model. In this arrangement, TechnoServe (TNS), a non-profit business organization initiated the project and selected the value chain and nucleus farmers in the arrangement. Ghana Guinness Breweries Limited (GGBL), as the final buyer, provides the market for harvested sorghum that meets quality specifications. Savannah Agricultural Research Institute (SARI), a Ghanaian government agency, provides agronomical support, input, credit facility, warehouse operators and cleaning services (Paglietti and Sabrie, 2012).

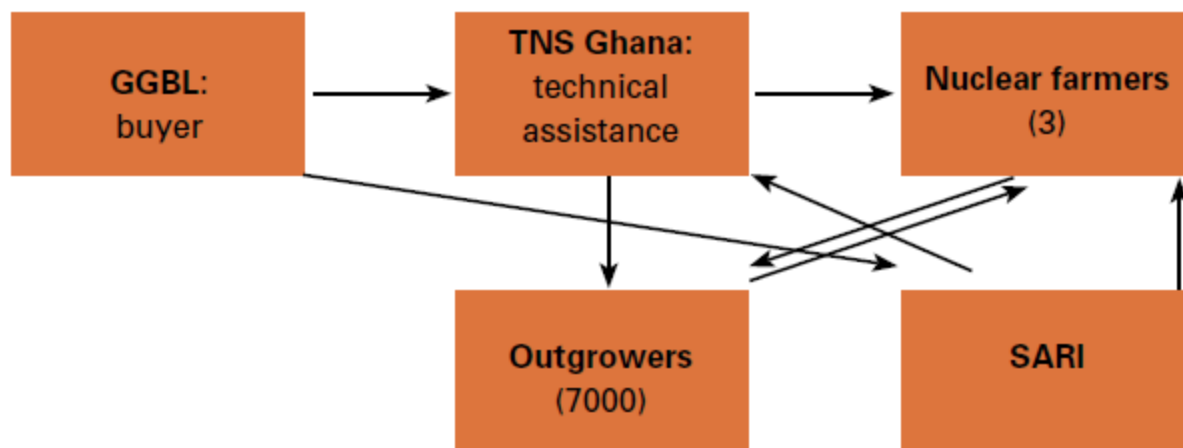


Figure 5: Multipartite Model (Source: Paglietti and Sabrie, 2012)

*d. The informal model.*

The parties in the informal model are individual entrepreneurs or small companies and farmers. There are two distinguishing features of this model. First, the contracts are informal (very often oral agreements) and second, the contracts are made on a seasonal basis. The principal in this model primarily provides inputs in the form of seeds and basic fertilizer although in some instances, limited technical advice on grading and quality is offered. Financial investment by the principal is usually minimal. The informal model is commonly adopted for crops such as fruits and fresh vegetables (FAO, 2001). The breakdown of input supply arrangements in Africa has encouraged the proliferation of the informal business model.

*e. The intermediary model.*

In the intermediary model, there is an intermediary or middleman that serves as a linkage between the farmers and the company (Anh et. al, 2019). The company maintains a formal subcontract arrangement with the intermediary while the intermediary maintains an informal

arrangement with the farmers. It is commonly used in Southeast Asia in the production of staple foods such as rice. Throughout Southeast Asia, the formal subcontracting of crops to intermediaries is a common practice. In Thailand, for example, large food processing companies and fresh vegetable entrepreneurs purchase crops from individual "collectors" or from farmer committees, who have their informal arrangements with farmers. This model has formal subcontracting by companies to intermediaries (collectors, farmer groups, NGOs) and the intermediaries have their own (informal) arrangements with farmers.

## 2.7 Advantages of contract farming

Arguments in support of contract farming suggest that there are mutual benefits for all the parties in a contract farming arrangement. One argument in support of contract farming is that the principal is assured of a supply of the commodities under contract. On the other hand, the agent is assured of inputs needed for production, a market for their commodities, technical knowledge, and a steady income (Boadu, 2016). Also, the increase in global demand for agricultural commodities has corresponded with increases in private international standards for regulating the quality of commodities (Kleemann, 2016). Contract farming allows the principal the opportunity to control the production process to ensure that the commodity meets international quality standards. Obtaining a certification that the commodities adhere to international standards is expensive for smallholder farmers. However, farmers in contract farming arrangements have these costs covered by the principal (Kleemann, 2016). The assurance of the production and supply of commodities that adhere to quality standards also has an impact on the agro-processing and manufacturing sector of the local economy.

Contract farming offers the opportunity to close the information asymmetry gap by sharing production and marketing information with the farmers. According to the World Bank (2017),

“in the absence of pricing information and standard quality assessment tools, smallholder farmers often accept lower prices because they do not know whether they deserve better.” Also, many contract farming arrangements offer an opportunity for the principal to share technical and business skills with the agent (Delgado, 1999).

In addition, contract farming affords smallholder farmers the opportunity to access services such as extension, credit, cleaning and storage facilities through contract farming. Contractual agreements usually have clauses for the supply of production inputs and or the provision of services (such as land preparation, extension, credit, insurance, and processing). In many parts of Africa, access to these services are beyond the reach of farmers because of the upfront costs to the farmers and other institutional inefficiencies. These services provided through contract farming enable the farmers to increase their production and adopt mechanization (Rehber, 1999; FAO, 2013) and also reduce production costs (Watts, 1994).

Furthermore, for multinational corporations (MNCs), contract farming can serve as a tool for public relations and political drivers. According to Oya (2011), by integrating smallholder farmers into global value chains through contract farming, MNCs are able to convince consumers that smallholder farmers were treated fairly in sourcing the raw materials that were used in formulating the final product. Creating a good public image becomes important in the face of criticisms that MNCs face about ethical trading. In the late 1960s, following the independence of many African countries, African governments resorted to contract farming to quell resistance to the plantation system and foreign multinationals faced the risk of expropriation. Contract farming became the platform to promote private sector investments (Cowen, 1981). In some other instances, contract farming serves as a political tool for maintaining government legitimacy and population control (Oya, 2011).

In light of the failure of government interventions in improving the livelihoods of farmers in rural Africa, contract farming has been suggested as an alternative for increasing farmers' income and other positive multiplier effects for impoverished rural economies. It is expected that with a ready market for their commodities, farmers would increase their production, and this would lead to increased employment and income (Kirsten and Sartorius, 2002).

## 2.8 Disadvantages of contract farming

Contract farming has been criticized as a production system. For example, farmers in contract farming arrangements very often lose total control of the decision-making process that is part of their agricultural production (Rehber, 1999). This results in the disruption of traditional structures and support systems (Kirsten and Sartorius, 2002), and increased levels of family conflict (Watts, 1994). Also, the supply of the required quantity and quality is dependent on good managerial practices, all coming at a cost to the principal (Rehnber, 1999).

In addition, the expectation that the farmer must meet with a supply quota encourages the farmers to increase their investment in expensive production assets, default on repayments, input diversion, and they may also engage in dubious activities (Royer, 1995). As a result, the sponsor must make investments in monitoring the farmers. In developing countries, the main disadvantage associated with contract farming is the high transaction costs. Very often, the costs are driven by the challenges with monitoring many smallholder farmers that are dispersed in remote locations, and the costs of enforcing the contracts in the event of default (Barry et. al., 1992).

[question: is there any economic inequality or exploitation by virtue of the unequal information, resources, and power controlled by the principal?]



## 2.9 Literature Gaps

The literature on contract farming as a tool for development is situated within the agronomy, economics, and development disciplines (Baumann, 2000). The agronomy commodity-based literature focuses on the efficiencies of smallholder farmers in producing export commodities under contract farming arrangements (Netting, 1993, Beets, 1990 and Binswanger and Rosenzweig, 1986). This literature argues that selecting the ‘classical’ export crop is dependent on the production conditions and labor regimes. The development literature focuses on contract farming as a model for modernization and development through trade liberalization, and skills and technology transfer (Baumann, 2000).

Another focus of the development literature is the study of the welfare of farmers under contract farming arrangements. These studies focus on conducting evaluations of donor spending in agribusiness. The results of the impact of contract farming on farmer welfare is mixed. The Food First school of thought led by Lappe and Collins (1977) criticizes contract farming for its exploitative nature (Glover and Kusterer, 1990). Watts (1990) also concludes that contract farming is a “system for self-exploitation of family labor replete with company manipulation and abrogation of contracts.” In a comparative study of farmers’ experiences of contract farming in Nigeria and South Africa, Porter and Phillips-Howard (1997) also find that contract farming poses problems for many farmers in rural communities because it reduced farmers without land to laborer status. Glover (1984) argues that while contract farming arrangements are often exploitative, there is a significant increase in living standards among farmers participating in outgrower schemes. Bellemare (2018) finds that participating in contract farming deprives families of the ability to divest their income by engaging in non-agriculture related activities.

On the other hand, there are also studies that suggest that contract farming has positive effects on farmers. Awotide et al. (2015) find that farmers in contract farming had increased output, and per capita income than farmers that did not participate. Mabe et. al. (2019) also concludes that farmers' participation in contract farming correlated with increased output, fertilizer usage, and they had greater access to extension services. According to Barrett et. al. (2012), by participating in contract farming, famers are able to take advantage of demands from "better off or more distant markets.

Similarly, the development literature, the economic literature has studied contract farming through the methodological individualism and political economy frameworks (Oya, 2011). These studies examine contract farming from a historical and power relations perspective. Agency theory and transaction costs are two concepts used in analyzing contract farming (Grosh, 1994; Kherallah and Kirsten, 2010).

A review of the literature on postharvest loss and reduction approaches identified the introduction of economic or market-based approaches in reducing postharvest loss. While there is an abundance of literature on postharvest loss, there are no studies that have investigated contract farming as a policy for postharvest loss reduction.

Research and interventions focused on reducing postharvest loss have primarily examined the macro level and made certain global assumptions that neglect to consider the real-life experiences of small-holder farmers. For example, researchers assume that postharvest loss will be reduced significantly by simply introducing better farming technology, warehousing, transportation, and distribution networks. In reality, it may be that none of those factors, alone or together, will make a significant difference to mitigating the amount of PHL.

## **CHAPTER 3: METHODOLOGY**

### **3.1 Research Overview**

Increasing food productivity has been a major focus of agriculture policy because it would increase food supply and ensure self-sufficiency in Africa (Sumberg, 2012; Snyder et al., 2016). Some of the policy recommendations that have been adopted to close the supply gap in food production in Africa have focused on increasing production (FAO, 2009; Van Ittersum, 2016). Historically, increasing food production in northern Ghana has been accomplished through the use of fertilizers, hybrid seeds, and irrigation (Al-Hassan and Poulton, 2009). Since the 2000s, the focus has shifted to assisting farmers in accessing global markets (Mangnus and van Westen, 2018). It is expected that this will result in the provision of extension services, improvement in quality control and standards, and better agri-business organization (Mangnus and van Westen, 2018).

However, increasing productivity has not translated to increased supply to meet the growing food demands in Ghana. To make up for the supply gap, Ghana has turned to maize imports from Argentina and South Africa (USDA, 2018). Table 1 shows Ghana's maize imports over four years starting in 2014. While maize production increased during this period, it can be seen that food imports also increased. The increase from 2014/15 to the next year was enormous.

*Table 1: Ghana Food Imports 2014-2018 (Data source: FAO, 2012)*

Year	Imports
2014/15	2,356MT
2015/2016	98,880MT
2016/2017	52,000MT
2017/2018	100,000MT

Food importation has financial implications for the country. In 2018, Ghana's Minister of Finance, Mr. Ken Ofori-Atta, reported that food imports cost the government an annual bill of US\$2.4 billion (Adombila, 2018). This bill was about four percent of the country's Gross Domestic Product (GDP). This drain on the national foreign currency reserves displaces funding for critical investments in infrastructure or other macroeconomic inputs necessary for development and long-term economic growth.

### 3.2 Hypotheses

Increasing food productivity in Africa has not been positively correlated with reductions in food imports. Further, postharvest loss estimates suggest that a significant percentage of food produced is eventually unavailable for consumption. As such this research hypothesizes that reductions in postharvest loss will contribute to increases in food supply. Furthermore, technological solutions have been inconclusive in reducing loss. Therefore, contract farming is proposed as a policy intervention for postharvest loss reduction. This research focuses on

contract farming arrangements as the basis of analysis because studies have suggested that such arrangements may be effective at reducing market inefficiencies which contribute to postharvest losses (Rockefeller Foundation, 2018; International Finance Corporation, 2017).

*3.2.1 Hypothesis 1: Farmers participating in contract farming experience lower postharvest loss rates than do farmers who do not participate in contract farming.*

The literature on postharvest loss suggests that contract farming is beneficial to farmers because it offers them access to inputs, technologies, services (such as extension and insurance services), and a ready market (demand) for their harvest (Bellemare and Lim, 2018; Anh et al., 2019). A corollary to the hypothesis is that access to inputs, technologies, and services, increases production, while access to the market for the commodities reduces waste.

I developed a conceptual framework to test the hypothesis. The framework is outlined in the figure 6. To solve the problem of postharvest loss and food insecurity in Ghana, resources would be invested. These resources include financial, organizational, human, and community resources. The outputs are the activities or interventions that are needed to solve the problem, while the outcomes are the expected results. I investigate whether the interventions provided through contract farming (output) in the logic model can lead to the desired outcome (postharvest loss reduction)

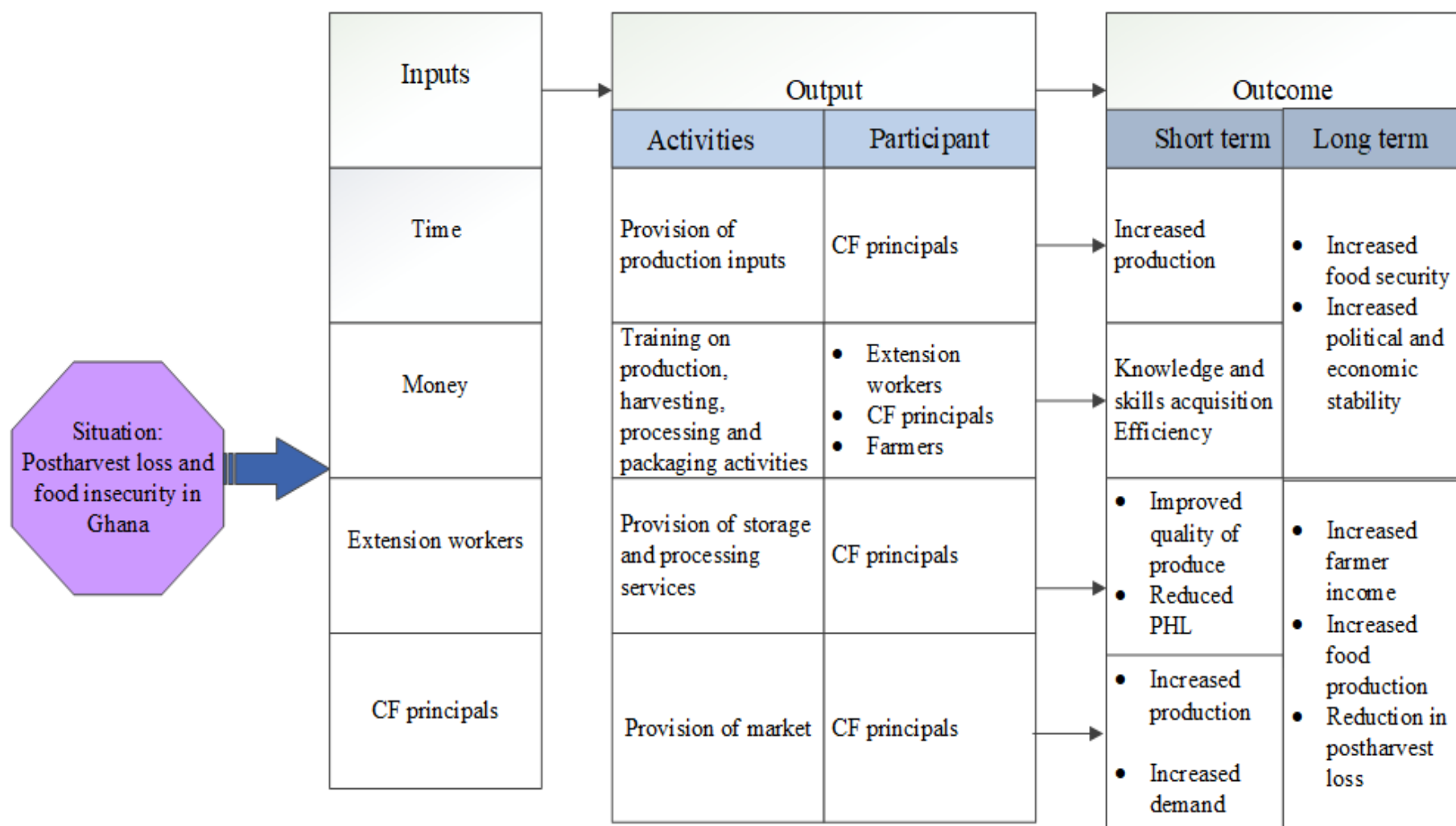


Figure 6: Conceptual Framework for contract farming (CF) strategy in PHL reduction (Source: Author)

*3.2.2 Hypothesis 2: Research and interventions for reducing postharvest loss have primarily focused at the macro level and made certain assumptions that neglect the real-life experiences of small-holder farmers.*

As stated in the previous chapter, efforts aimed at reducing food insecurity in Africa have focused on increasing food production and the provision of storage technologies. However, the effectiveness of these interventions has been inconclusive in Africa because of low technology adoption rates, and mixed results on the impact of these technologies on food production and loss reduction. I hypothesize that other socio-economic, political, and institutional factors contribute to postharvest losses. As such, to improve our understanding and governance of PHL, researchers must move from the macro-theoretical level to also consider the micro-practical level and examine other unanswered, ignored, and unaccounted-for social and policy issues that drive postharvest loss.

I test this hypothesis by adapting the food systems map developed by Nourish Life (2014). Berkes et al. (2003) describe the food system as a complex interaction of the biophysical and social factors linked through feedback mechanisms. It is also the “social, economic, and political environments that determine how food system activities are performed (food system drivers). These activities lead to some social and environmental outcomes, as well as a certain level of food security” (Tendall et al., 2015). In Figure 7, I hypothesize that the interaction between the social, institutional, economic, and technology systems could lead to unintended consequences, including postharvest loss. The inductive logic is the basis of this hypothesis. Following the focus group sessions and key informant interviews, I identify the factors described in figure 7 as the factors that contribute to postharvest losses in Northern Ghana.

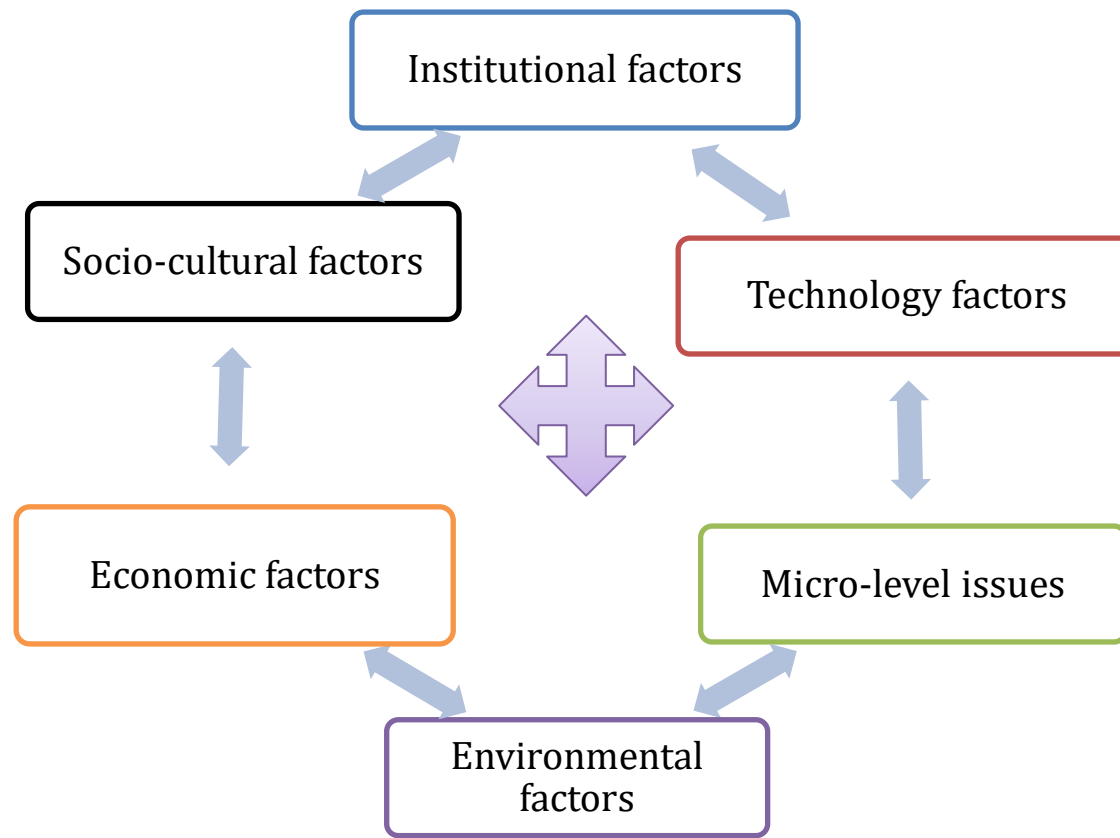


Figure 7: Conceptual framework for factors that contribute to PHL (Source: Author)



### 3.3 Research Methods

The inductive and deductive reasoning approaches were used in forming the research design. These methodological approach and hypotheses are suitable for explaining the variations in outcomes among farmers participating in contract farming arrangements. I adopt the mixed methods methodology approach for data analysis. Johnson and Onwuegbuzie (2007) define this method as the use of qualitative and quantitative data to gain a broad understanding and depth of the studied phenomenon. Akimowicz et al., (2018) find that while the mixed methods approach is not commonly used in agriculture research, the approach helps overcome the weaknesses of one method with the strengths of others. In particular, they find that the detailed information provided by their qualitative data offers better explanations for the causal relationships observed in their quantitative analysis.

The second hypothesis follows the inductive logic. Following the focus group interviews and key informant interviews, I code the identified causes of postharvest losses and identify the most occurring identified causes. The causes are described in figure 7 and discussed in detail in Chapter 4.

### 3.4 Case and Site Selection

Maize was selected for research because it is an important food crop in Africa. It accounts for almost half the calories consumed in the Eastern and Southern parts of Africa, and one-fifth of the calories consumed in Western Africa (Kornher, 2018). According to Macauley (2015), “the central role of maize as a staple food in SSA is comparable to that of rice or wheat in Asia.”

To understand the correlation between participation in contract farming arrangements and postharvest loss, the study examined the data on postharvest loss of maize on the continent.

Country criteria such as the existence of contract farming arrangements, institutional capacity, infrastructure, and political stability were employed to identify the country that would be used to conduct the case study.

Initially, South Africa was selected because of the availability of government-generated data on postharvest loss, and because South Africa experiences the highest postharvest losses of maize.

Also, the country has a well-developed statistical office and an abundance of open-source government data. To improve the robustness of the findings, I also selected Ghana for its wide range of public and private contract farming arrangements. In the last decade, Ghana has gained a reputation for its political stability, good governance, and institutions (Hague et. al., 2015).

Ghana and South Africa are similar in that the United Nations places both countries in the medium rank of the human development index (HDI), and maize is a staple food crop in both countries. However, South Africa was ultimately dropped because of the challenges encountered in conducting on-site research.

In May 2019, general elections were held in South Africa. The Economic Freedom Fighters (EFF), a major political party, campaigned on the promise to expropriate farmland from the white farmers without compensation and redistribute it to the black farmers (BBC, 2019). While consulting with South Africans living in Atlanta and an agricultural equipment manufacturing company that has its African headquarters in South Africa, it was advised that visiting the country and speaking to farmers just before the elections could be a safety hazard. This left Ghana as the sole option for the case study. Also, Ghana had fewer entry restrictions and less of a language barrier, because English is the national language.

In Ghana, the Upper West and Northern regions were selected because of their reputations as the ‘food basket of the nation.’ Also, both regions allow good comparison of postharvest loss and

contract farming. The two regions share similar climate patterns, maize production, education attainment, and poverty rates. However, according to government sources, the “Northern Region is the largest contributor (of postharvest loss) with 20,411 tonnes... the Upper West Region is one of the least contributors with 778 tonnes” (Myjoyonline, 2017). Also, the regions were selected because of the relative ease of logistics. The localhost in Ghana has an existing relationship with the farmers in the Tolon district of Northern region, Daffiama Bussie Issa district, Wa East, and Wa West districts of the Upper West region. Additional information on the description of the regions and farming villages is provided in Annex 2.

Villages in the Upper West region were selected primarily because of the established presence of Masara N’arziki farmers association- the largest contract farming company in West Africa. The Northern region village of Tiboggo was selected because of the presence of Heritage Seeds Company’s formal contract scheme. To get the perspective of farmers who previously participated in contract farming, Kpachiyilli. Dundo, Nyankpala, Tali, Kpalisogu, and Komoayili were selected for their informal contract models.

### 3.5 Population size and case selection

This research used a quasi-experimental design wherein farmers with contract farming arrangements were placed in the treatment group and the farmers without contract farming arrangements in the control group. The total population size of the study was 467. Table 2 shows the distribution of the participants in the study.

*Table 2: Breakdown of population in the study*

<b>Participants</b>	<b>Number in study</b>
Farmers	450
Representatives of contract farming organization	3
Academic community	3
Government officials	4
Officials of international agriculture organization	4
Local agriculture equipment manufacturer	1
NGO	2
Total	467

The farmers in the treatment group were randomly selected from a list of farmers provided by the different contract agents. The farmers in the control group were selected randomly from a list of farmers provided by the local farmer cooperative groups.

I use the sampling model to test for external validity. Cochran (1963) recommends that in determining a representative sample size, the formula

$$n_o = \frac{Z^2 pq}{e^2}$$

should be used where  $n_o$  is the sample size,  $Z_2$  is the confidence level (95%),  $e$  is the sampling error,  $p$  is the estimated proportion of an attribute that is present in the population and  $q$  is  $1-p$  (Glenn, 1992)

According to the Food and Agriculture Organization (2019), there are 1 million farmers in Ghana. Using this formula and establishing a 95% confidence level and a 5% margin of error, the formula will be substituted as

$$n_o = \frac{(1.96)^2 (.5)(.5)}{(.05)^2}$$

resulting in a sample size of 385. However, to account for missing data, I interviewed 450 farmers.

### 3.6 Data collection methods

I collected primary data through personal interviews and questionnaires administered from April until June 2019. The questionnaire contained structured and unstructured questions. This allowed farmers the freedom to express themselves and give additional information which might be relevant to the study. The information collected included postharvest handling practices, technology adoption, and experiences with contract farming schemes. The questionnaire also allowed the farmers to self-report general socio-economic information on farm households, postharvest activities, and other geographical related information. A well-established standardized guide was used to structure questions. This was the Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA). It is a survey instrument developed by the World Bank to collect agriculture data in “regions [that] suffer from inconsistent investment, institutional and sectoral isolation, and methodological weakness” (World Bank, 2019).

The collection of self-reported postharvest loss data has been done in previous studies (Kikulwe et al., 2018; Hengsdijk and de Boer, 2017; Kaminski and Christiaensen, 2014). One of the drawbacks of self-reported estimates is that it often under-reports the real amount of food loss or waste (FAO, 2019; Delgado, 2019) because the farmers would only report losses that are considered most important (Kaminski and Christiaensen, 2014). However, self-reporting is a desirable means of estimating postharvest loss given that the bulk of losses in Sub-Saharan Africa are concentrated on the farm (Kaminski and Christiaensen, 2014; Parfitt, et. al., 2010). Also, collecting loss data from the farmers is relatively easier than tracing the complex value chain of maize in Ghana. That chain is depicted in figure 8.

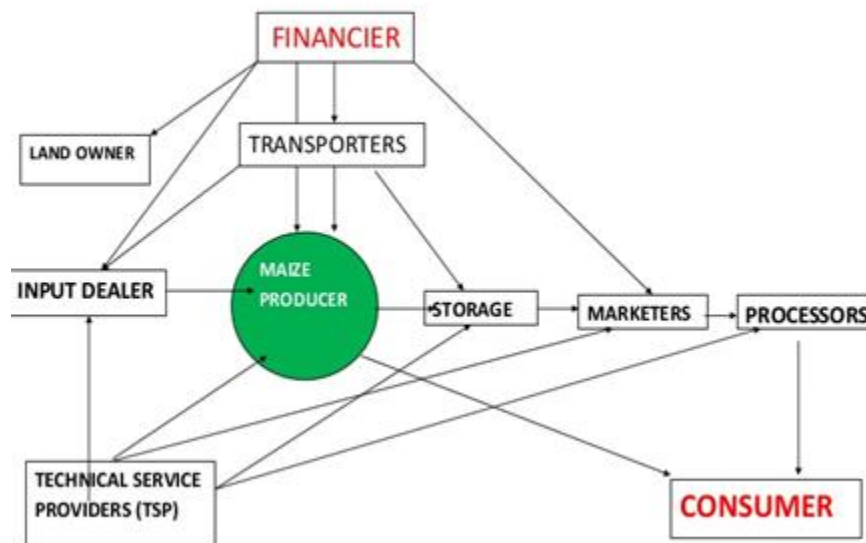


Figure 8: Maize value chain in Ghana (Source: Kwame: 2015)

## Conduct of the Field Work

The fieldwork began with a pilot study that was conducted in April. It included 40 farmers located in the Tolon District of the Northern region. These participants in the pilot study were spread between farmers in different contract farming schemes and farmers that did not participate in contract farming. The responses from the farmers that participated in the pilot data collection phase helped in reframing and reshaping the final questionnaire that was administered in June. For example, one of the changes made following the pilot study was to eliminate questions about losses during harvest and transportation. The farmers interviewed during the pilot reported that because of the difficulty in estimating and collecting data at these stages, it is not normal practice for farmers to collect these data. The final data collection took place in June. This coincided with the planting season in both regions.

To gain a better understanding of the farmers' views, experiences, and attitudes I conducted six focus group sessions with farmers spread between the treatment and control groups. A group of farmers in the control group participated in a contract farming scheme in the 2017 planting season. The objective was to have six farmers in each of the focus group sessions based on the recommended size of focus group sessions (Johnson & Christensen, 2016; Langford et al., 2002; Krueger and Casey, 2009). However, about ten farmers showed for each of the sessions. It was observed that each session appointed a member of the group to speak on their behalf. This spokesperson was, in one instance, the oldest member of the group, and in another instance, the head of the community's farming group. Although speakers within each group presented multiple perspectives, this arrangement made it difficult to get contrary opinions. Also, because

of the cultural norms in the communities that encourage gender separations, no group had a mix of male and female participants, and so the focus group in Dundo had only female participants.

Finally, face-to-face key informant interviews were conducted with representatives of the contracting companies, members of the academic community, civil society groups, and international development organizations. The purpose of these interviews was to obtain insights (that the questionnaire might not have covered) from experts who have firsthand knowledge about the community, the nature of the postharvest loss problem, and its relationship to contract farming. Also, these interviews were necessary to compare the responses of the farmers with the perspectives of the different stakeholders.

### 3.7 Study Locations

Ghana operates a decentralized government with power devolved from the central government to the regions. Power is further devolved from the regional government to the metropolitan, municipal, and district assemblies (MMDAs). Before the implementation of the Local Government (Departments of District Assemblies) (Commencement Instrument, L.I. 1961) in 2012, budgetary planning and allocation of funds received by the Regional Agricultural Development Units (RADU) and the MMDAs, and District Agricultural Development Units (DADU) were centrally controlled from Accra by the Ministry of Food and Agriculture (MoFA) (Mogues and Omusu-Baah, 2014). One of the features of the Law was the devolution of powers from the central government to the districts, particularly in the agricultural sector. Since 2012, the districts were to play more significant roles in agricultural development. For example, a new budgeting system that integrates the budgets of all of the departments in the MMDAs into the overall budget for the RADU was introduced (Resnick, 2018). Another change was that the allocation of the budget would come from the Ministry of Finance instead of from MoFA. The



Law also provides the districts with services such as extension, rural infrastructural, and small-scale irrigation. Also, the districts are now in charge of conducting research, formulating, and implementing district agricultural policies.

Surveys were administered to farmers and principals of contracts in the Northern and Upper West regions of Ghana, as shown in figure 9. In-depth interviews were conducted with farmers in both regions, and other agents who worked on the postharvest loss problem, including international organizations, civil society groups, the private and public sectors, and the academic community in the two regions and Accra, the country's capital.

This section gives a detailed description of the regions and the contract farming groups that participated in the study.



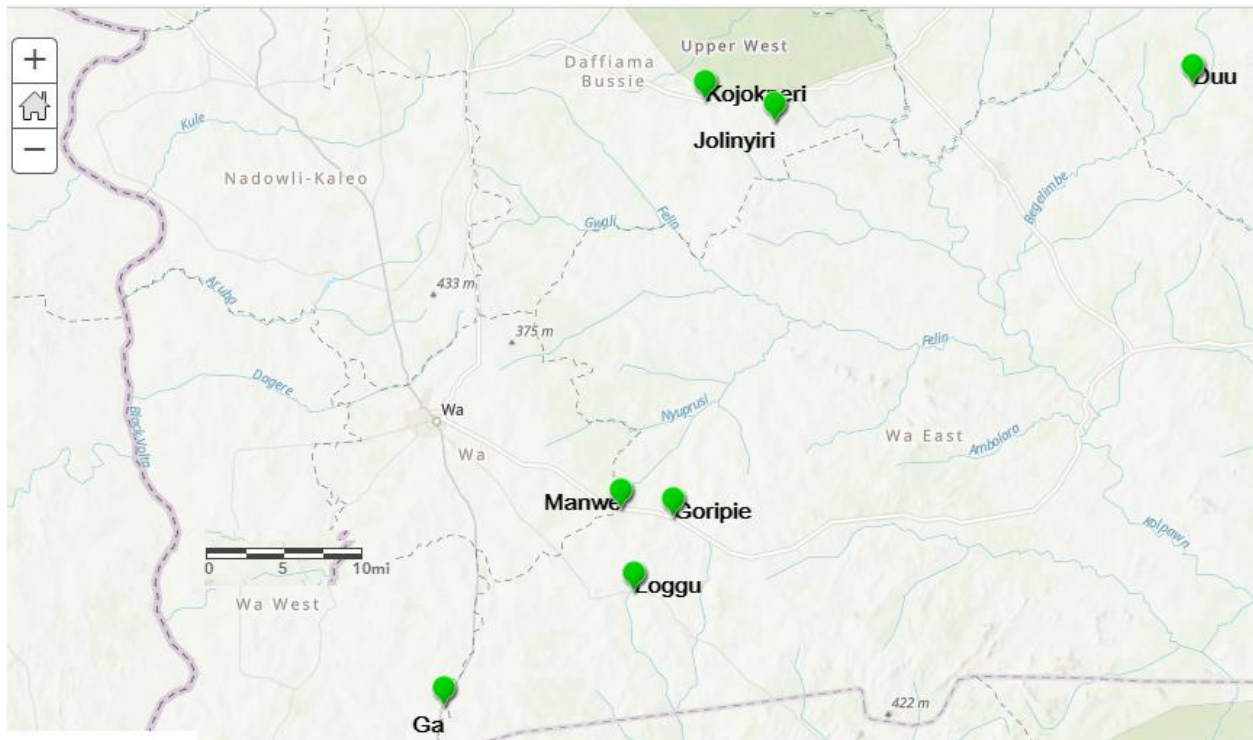
Figure 9: Map of Ghana showing the regions with the Northern and Upper West study regions highlighted in blue

### *3.7.1 Upper West Region*

The Upper West Region is located in the north-western part of Ghana. It covers a geographical area of 18,478 square kilometers, about 12.7 per cent of the total land area of Ghana. It is bordered on the North and West by the Republic of Burkina Faso, on the South by the Savannah Region, and on the east by the Upper East and North-East Regions. The Region is divided into 11 autonomous administrative districts. The highlighted districts in Figure 10 shows the districts that I studied. Figure 11 shows the location of villages in the region where I conducted the study.



Figure 10: Upper West Region (Districts in the study are highlighted).



*Figure 11: Location of Villages in the study: Upper West Region*

The region is located in the Guinea Savannah agro-ecological zone characterized by light undergrowth and scattered drought-resistant trees such as the baobab, shea, and neem. The region has a tropical climate with an average temperature of 73°F and maximum of 104°F. There are two seasons, dry and wet. The wet season, sometimes called the rainy season, starts in early May and ends in September. The average annual rainfall in the region is 800–1,200 mm/annum (Choudhary et. al, 2015). The dry season or the harmattan season starts in November and ends in March.

Agriculture is the main economic activity of the region. 72.2 percent of the economically active group are engaged in agriculture or related activities (Ghana Statistical Service, 2013). Food crops predominantly cultivated include maize, yam, guinea corn, millet, rice, groundnuts, and

beans. Cotton and shea nuts are the two main cash crops. Many households in the district raise livestock such as cattle, sheep, goats, pigs, and poultry. The region has a unimodal rainfall distribution that determines farming decisions and practices. The Upper West Region is the sixth largest maize producing region of the country (Angelucci, 2012). Sowing season in the Upper West region typically starts in June, when the rains have been established, through August. However, climate change increased weather variability, and low climate adaptation capacity is a threat to food production in the region (Lawson et. al, 2019, UNDP, 2015). Harvesting commences in October and continues until the end of November. Humidity is higher during the wet season, with levels ranging from 70 to 90% and dropping to 20% during the dry season (Ghana Health Service, 2017).

According to the Ghana Health Service (2017), the region has the smallest number of kilometers of tarred [*paved*] roads. “Only two of the district capitals are linked to each other and the regional capitals by tarred road. The roads linking the region to other regions are untarred, and during the rainy season traveling out of the region by road sometimes becomes a nightmarish experience.”

### *3.7.2 Northern Region*

The Northern region is located in the north-eastern part of Ghana. Until 2018, the region was the largest in the country in terms of landmass. In December 2018, the Northeast and Savannah regions were carved out of the Northern region. It previously covered a geographical area of 70,384 square kilometers, about 31 percent of the total land area of Ghana. It is bordered to the north by the North-East region, to the South by Oti region, Togo to the east, and to the west by the Savannah region. The region is divided into 16 autonomous districts that are shown in Figure 12. The fieldwork was conducted in Tolon District, highlighted in figure 12. I conducted

fieldwork in the villages of Kpachiyilli, Tiboggo, Dundo, Nyankpala, Tali, Kpalisogu, and Komoayili shown in Figure 13.

The Northern region lies within the Guinea savannah agro-ecological zone with a typical formation of shrub-grassland vegetation. It has a tropical climate with an average temperature of 72.68 °F during the wet season and a maximum of 96 °F during the dry season. The rainfall pattern is unimodal, with an annual average of 900–1100 mm, with the rains starting in May and ending in November. Farming is the predominant occupation in the region, with about 75 percent of the population participating in the agricultural sector (Ghana Statistical Service, 2010).

Livestock, such as cattle, goats, and chickens, are predominantly kept by the farmers. Food crops predominantly cultivated include maize, yam, guinea corn, millet, rice, groundnuts and beans.

The region ranks as the fifth-highest maize producer in the country (MoFA, 2017). Farmers in the Northern Region rely heavily on rain-fed agriculture (Abdoulaye et al., 2017). Rising temperatures, reducing, and erratic rainfall patterns pose a threat to food production in the region (Dumenu and Obeng, 2016; Kuwornu et. al, 2013).



Figure 12: Northern Region District in the study highlighted



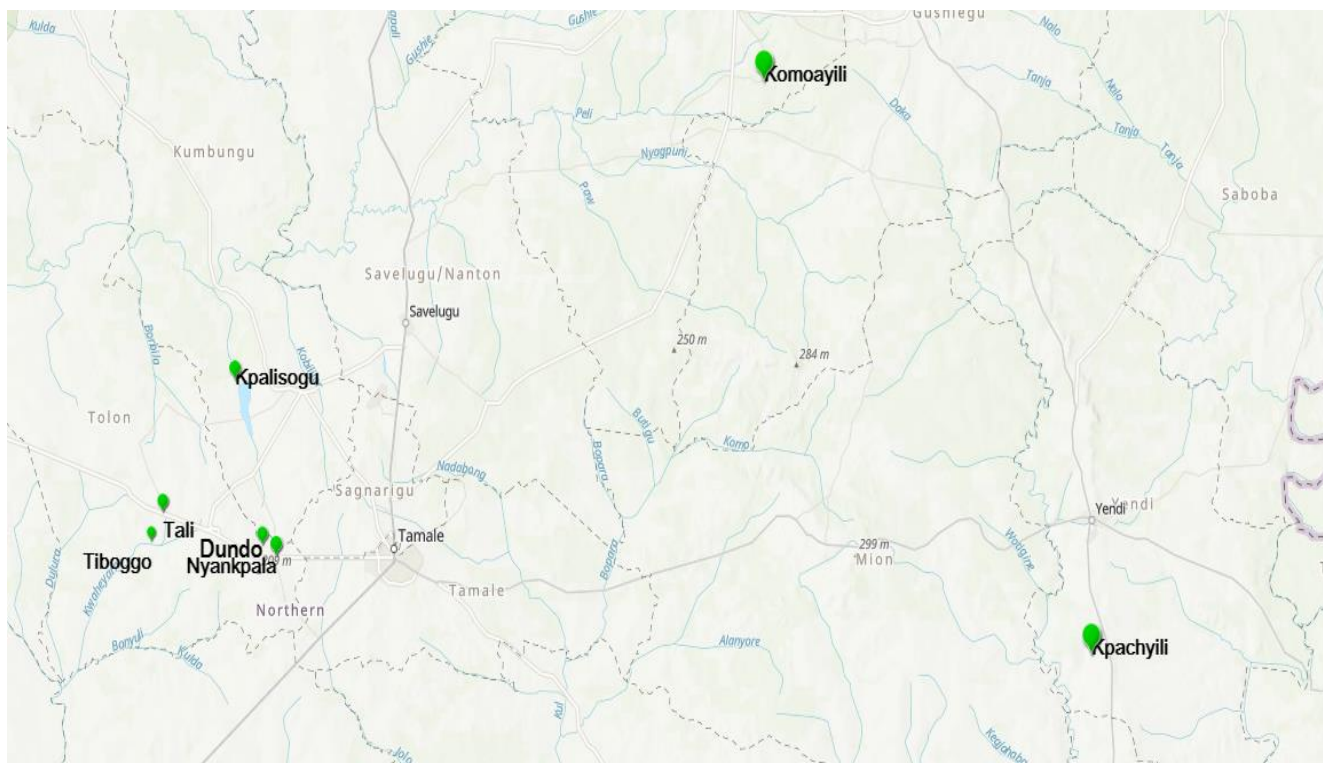


Figure 13: Location of Villages in the study: Northern Region

### 3.8 Description of the contract schemes

This section gives a detailed description of the contract schemes the farmers belonged to. These contract schemes include three forms of informal contracts, and three formal contract schemes, including Masara N'Arziki Farmers Association, the Millennium Development Authority (MiDA), and Heritage seeds. These formal schemes follow the centralized business model.

#### *3.8.1 Masara N'Arziki Farmers Association*

In 2010, Yara Ghana, a fertilizer company of Norwegian origin, and Wienco Ghana, a local agricultural commodity trading company set up a partnership to help small and medium-scale farmers in Ghana adopt good farming practices such as good land use and management, and the

adoption of technology (Wienco, 2010). The partnership, named Masara N’Arziki (meaning “Maize for Prosperity” in the local Hausa language) Farmers Association, has a goal of promoting maize growing as a source of prosperity in the impoverished Northern region (Guyver and MacCarthy, 2011). The company has its headquarters in Tamale, the capital of the Northern Region, and has a membership of about 10,000 maize farmers in the Brong Ahafo, Northern, Upper East, and Upper West Regions. According to Ragasa et. al. (2018), while Masara is financially self-sustaining and is currently registered as a non-profit organization, the company is considering converting into a for-profit status.

Masara N’Arziki provides lines of credit in the form of imported hybrid maize seed varieties that are estimated to produce yields up to 15 to 60 percent higher than the local hybrid variety (Fosu et. al, 2018). The company also provides fertilizers, herbicides, insecticides, spraying equipment, crop protection, and innovative farm implements to the farmers before the planting season. To qualify for the credit line, the farmer would need to be a member of a group of between eight to ten farmers and agree to repay all that is borrowed (Alidu et. al., 2016). Before 2015, all the members of a given group were jointly liable for the default. However, this rule was changed to reduce attrition rates (Ragasa, 2018).

### *3.8.2 Heritage Seeds Company*

Heritage Seeds Company was established in 2010 by a retired high school teacher as an out-grower scheme. It was established to encourage local production of hybrid seeds and to increase access to these seeds by local farmers. The company started with 35 farmers at inception and has grown to 1700 farmers in 2019. It specializes in the marketing, sales, and production of certified cereal and legumes seeds. The company works predominantly with women farmers in the

Northern region to produce three drought-tolerant maize seed varieties. The farmers are selected from a pool of farmers who can meet strict requirements for planting hybrid seeds.

The company offers loans to farmers in the form of foundation seeds and fertilizers. Crop insurance is provided to the farmers through a local agricultural insurance company. Threshing and storage services are also provided to ensure the purity of maize seeds. According to the key informant at the company,

*“weed control and plowing are provided by the farmer because we always want the farmer to feel like it is a joint enterprise.” (Key informant, Heritage Seeds Company)*

Repayment of the loan is in kind, using their maize produce. The company offers to purchase all that is left after the loan repayment, usually at double the market price. According to the key informant, the farmers prefer to sell to the company because of the price incentive the company offers to the farmers. Also, government regulations preclude unlicensed seed agents from seed trade; as a result, many farmers cannot participate in the seed trade business.

Funding for farmers’ training is provided through collaboration with international organizations such as Care International, Action Aid, the International Institute of Tropical Agriculture (IITA), and the DFID Market Development Programme for Northern Ghana (MADE). Most of the seeds produced by the company is sold to the government.

### *3.8.3 MiDA*

Millennium Development Authority (MiDA) was created in 2006 to administer the Millennium Challenge Account (MCA), a fund set up by the Millennium Challenge Corporation (MCC) and the Government of Ghana. MiDA’s goal is to reduce poverty in the country by focusing on agriculture, transportation, and social infrastructure.

In the agricultural sector the goal is “to increase the production and productivity of high-value cash and food staple crops in the Intervention Zones and, second, to enhance the competitiveness of Ghana’s high-value cash and food crops in both local and international markets” (IMPAQ International, 2011).

Farmers participating in the MiDA contract in this study received loans in the form of input and tractor services from MiDA in exchange for repayment after harvest with their produce.

#### *3.8.4 Informal Contracts*

Informal contracts between farmers on the one hand, and buyers or input dealers on the other, are common in the Ghanaian agricultural sector (Interis et. al., 2016). The principal could be an input dealer, an affluent member of the community, traders, or members of a farmer’s family. The principal provides loans to the farmers in the production process with the expectation that the farmer repays with his produce. Examples of loans provided include land ploughing, seeds, fertilizers, and agrochemicals. The principal sells the collected produce in the open market and to food processors (Azumah et. al., 2016) to recoup his costs and get returns on the initial investment.

It is crucial to state that the farmers participating in the informal contract schemes had participated in the formal schemes in previous years. However, the formal schemes abandoned the farming community due to low productivity and high default rates.

### **3.9 Conclusion**

In conclusion, government policies and private sector investment in agriculture drive contract farming in Ghana. Growing demands for high-quality grains by multinational companies operating as food processors is one of the driving factors for private sector investments in

contract farming. Contract farming is attractive in the study locations to both the farmers and the principals of the CF schemes. It is appealing to the farmers because of the guarantee of participating in the farming season, given the inputs they receive. Also, farmers participating in CF have the assurance of a market for their produce. For the principals of the CF schemes, contract farming is attractive because of the guarantee of supply of high-quality grains.

To guarantee a supply of high-quality seeds, CF schemes invest in training farmers on the best agricultural practices. I hypothesize that these investments result in loss reduction among participating farmers.

Furthermore, while inadequate storage and transportation infrastructure may contribute to postharvest losses, the socio-economic features of the farming communities suggest that there may be other factors that contribute to losses.

## **CHAPTER 4: RESULTS**

Over the course of the fieldwork in the Northern and Upper West regions of Ghana, I conducted interviews with 13 key informants and collected quantitative and qualitative data of the 2018 farming season from 450 farmers. The summary of the observations is presented in Table 2. 66 percent of the farmers in the population were surveyed in the Northern Region, and 34 percent were surveyed in the Upper West Region. 54 percent of the farmers participate in a CF scheme, and 46 percent do not participate in a CF scheme. In the survey, three farmers reported that farming decisions were jointly with their wives. I recoded these farms as owned by men because of the small number of these farmers, and also because in practice, decisions are primarily made by men.

Table 3: Summary of observations

Average Production per acre		11 bags (84kg bags)		
Average number of employees		10		
			CF	Non-CF
Total Number of farmers surveyed		450	247	203
<b>Regional breakdown of respondents</b>				
Region	Total Number	% of total	CF	Non-CF
Northern	299	66%	116	183
Upper West	151	34%	131	20
<b>Educational Status</b>				
No Formal Education	312	69%	176	136
Primary School Education	34	8%	22	12
Post-Primary School Education	83	18%	42	41
Polytechnic/University Education	20	4%	9	11
<b>Gender</b>				
Male	355	89%	208	147
Female	95	11%	40	55

#### 4.1 Contract Farming and Production

Previous studies, as discussed in the literature review, suggested that increasing production increases postharvest loss but reduces food insecurity. Hence, greater postharvest loss is the tradeoff for reducing food insecurity. This section discusses the results of contract farming participation among the farmers in the study population.

The study results found that production increased with increasing farm size, and that farmers who participated in contract farming consistently produced more than those who did not participate in contract farming. This difference held steady independent of farm size as depicted in figure 14. This section will further explore factors that may contribute to this observed difference between contract farming participants and farmers not participating.



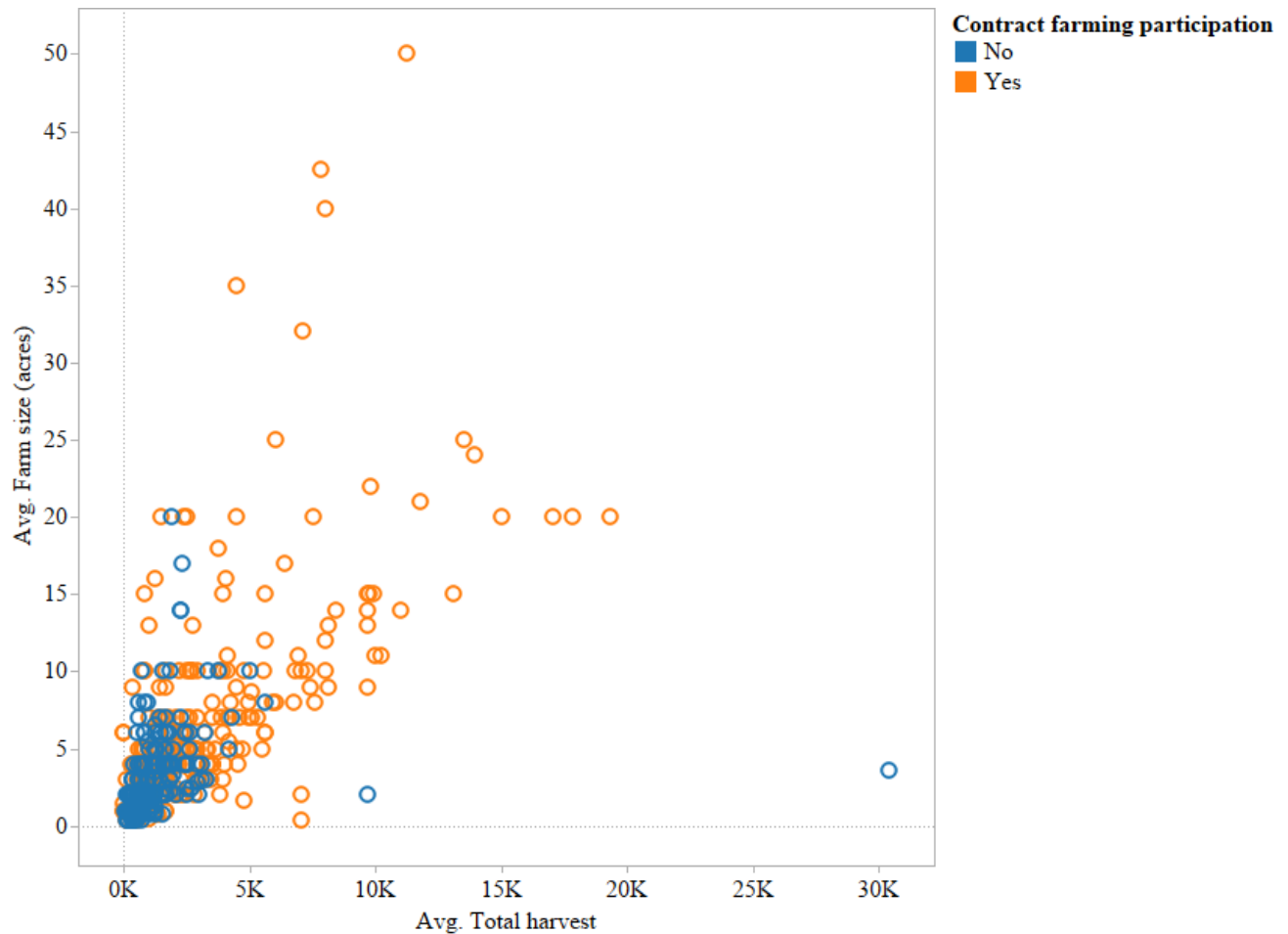


Figure 14: Average total harvest vs. average farm size (acres). Color shows details about contract farming participation by individual farmers.

Figure 15 shows that male farm owners are more likely to participate in CF schemes. This is to be expected given that the male farmers own more land and make the decisions about the administration of the farms including those owned by women. However, according to a CF scheme operator, women were better participants than men because they are more invested in following the recommended agricultural practices.

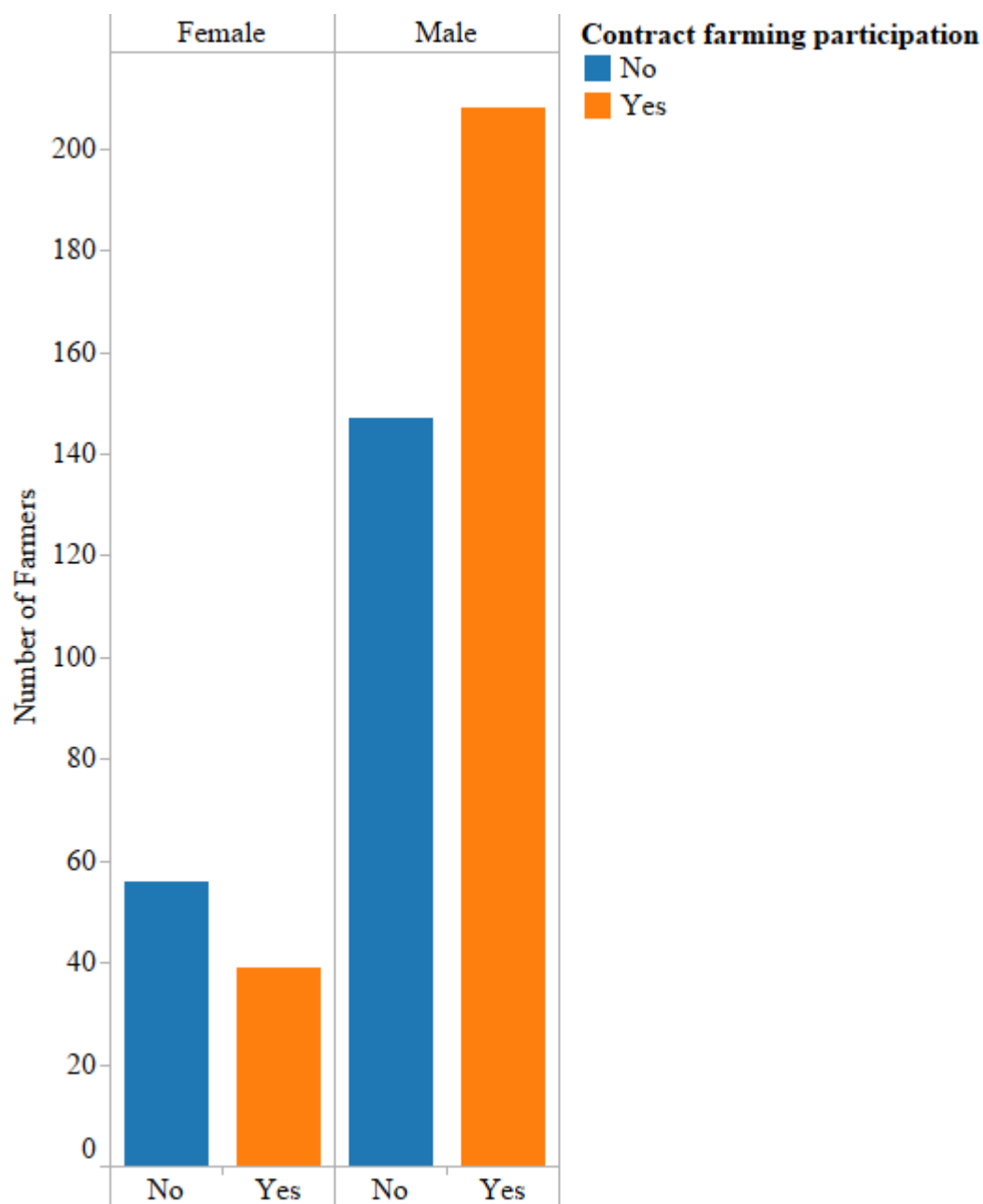


Figure 15: CF participation by gender

Figure 16 shows that farmers in contract farming schemes on average produce three times the total production per acre than those in non-CF farmers. According to the key informants in the

CF schemes, the CF schemes provide the farmers with hybrid seeds that are expected to produce more than the local variety grown by non-CF farmers.

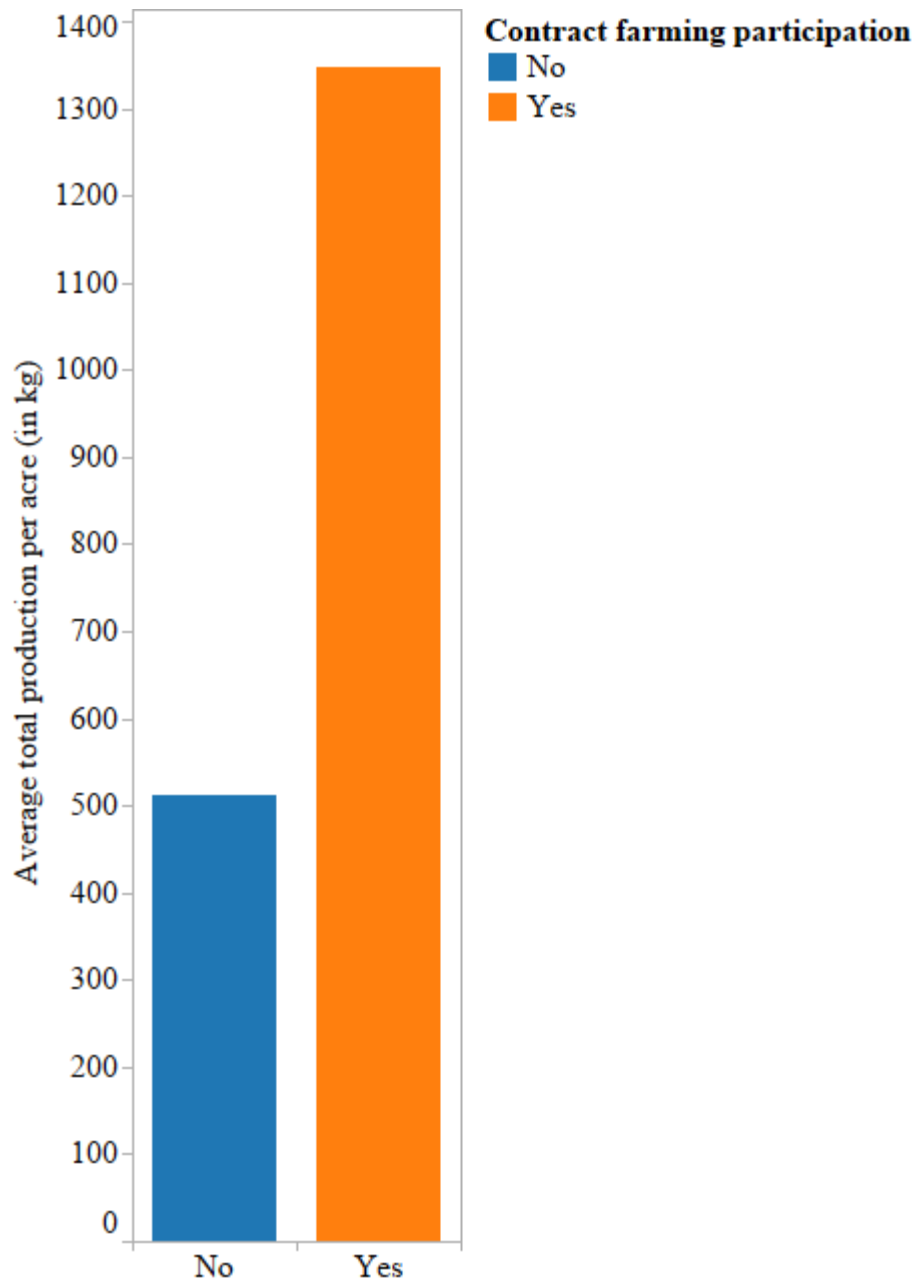


Figure 16: Average total harvest for each contract farming participation category. Color shows details about contract farming participation.

Figure 17 shows that in comparison with farmers in informal CF schemes, farmers in formal CF schemes produce on average double the total production per acre. This could be as a result of the type of seeds (hybrid) planted by the farmers in contract farming and the training received by the farmers in the formal CF schemes.

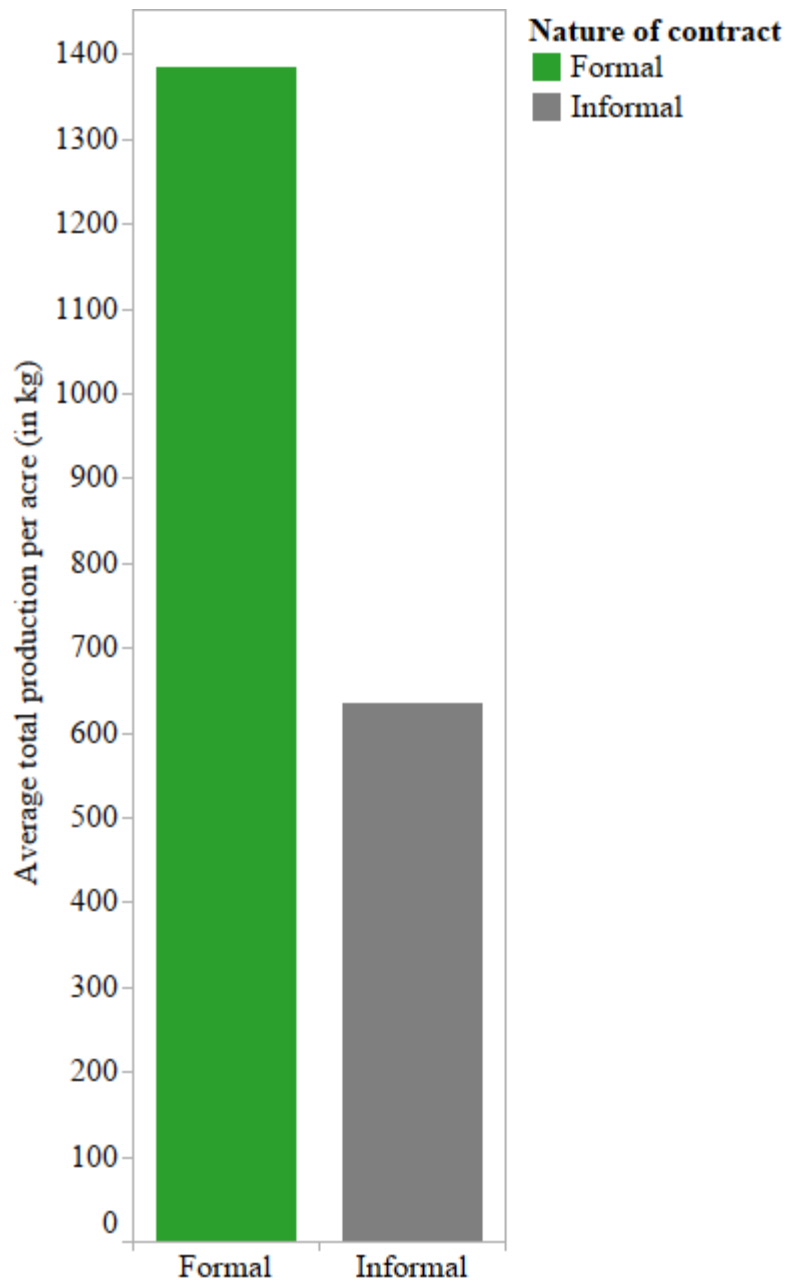


Figure 17: Average total harvest for each nature of contract farming. Color shows details about the nature of contract.

Figure 18 shows that farmers in CF schemes produce more per acre than non-CF farmers across all levels of education. The bar-chart also shows that the majority of the farmers in the population had no formal education, and fewer farmers had a polytechnic or college level

education. On average, the farmers with polytechnic or college level education produced less per acre than the other farmers. Also, this graph shows that farmers no formal education that participated in formal contract schemes produced more than their colleagues that did not participate in any CF scheme.

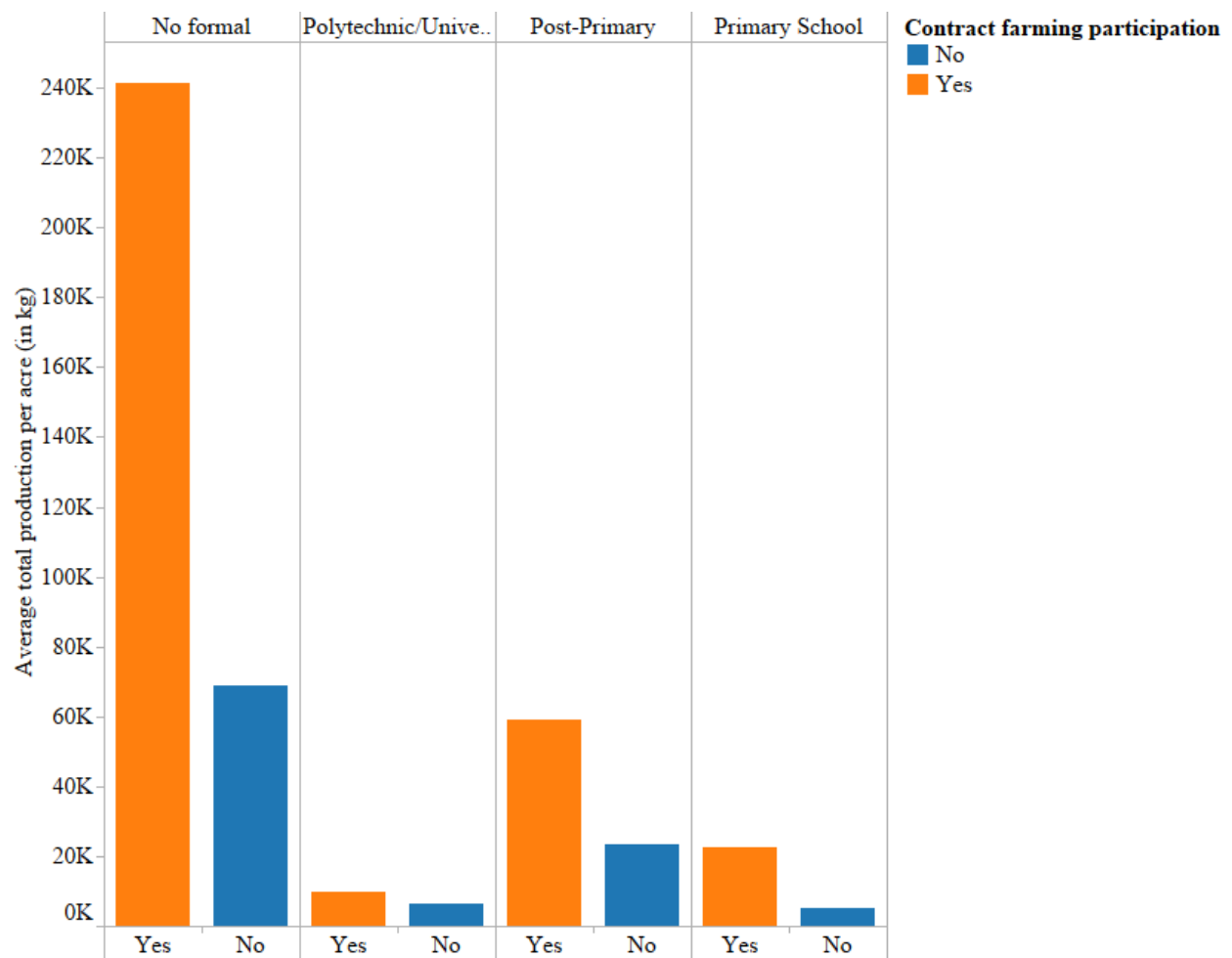


Figure 18: Average total production per acre for each contract farming participation broken down by education attainment. Color shows details about contract farming participation.

Figure 19 shows the details for each farmer's total production and self-reported losses. The trendline suggests that postharvest loss increases with increased production. It can be seen that many of the farmers reported zero losses given that self-reported losses are under-estimated, and farmers report only losses that they consider as most important.



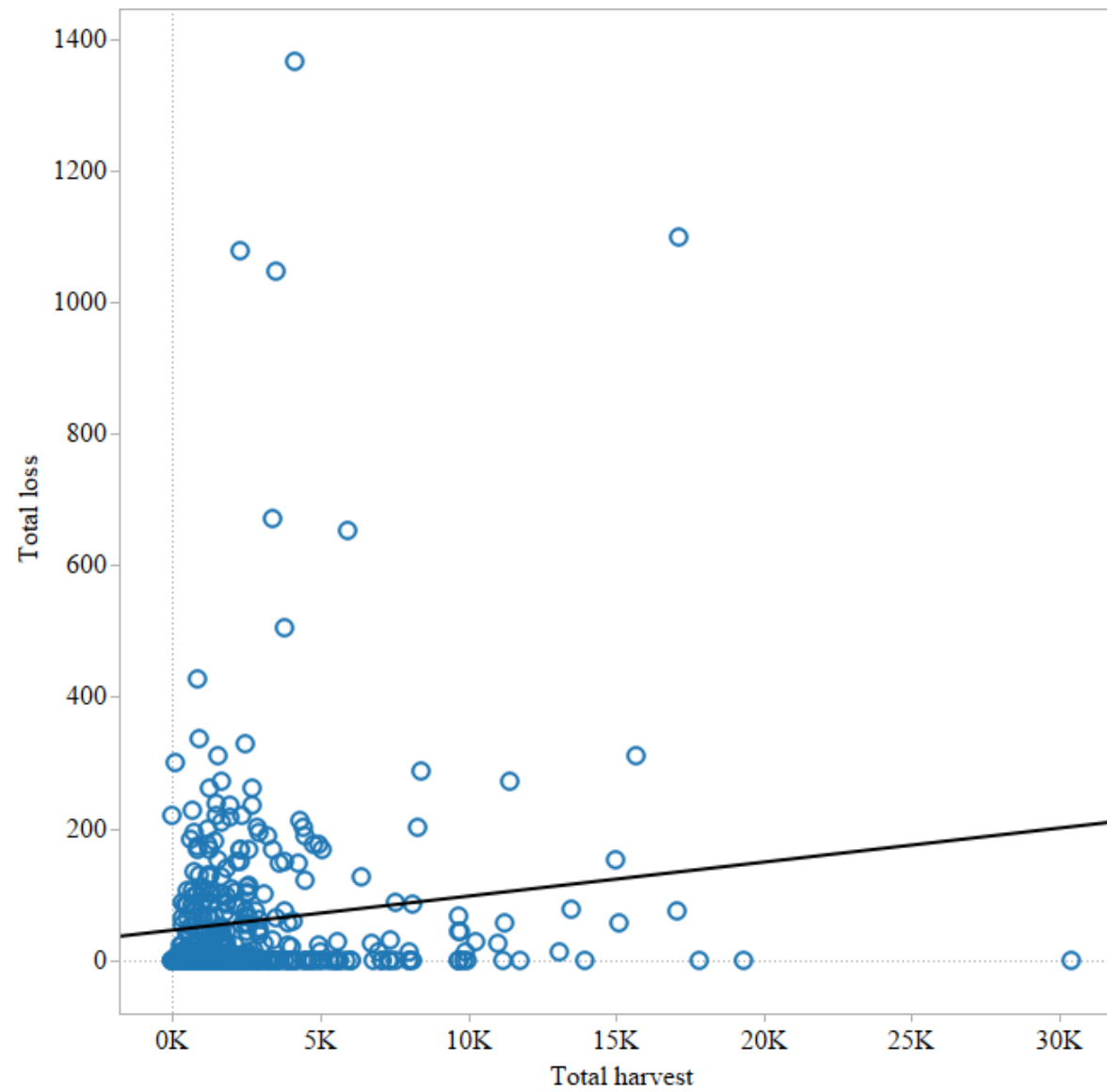


Figure 19: Total production and total loss. Details are shown for the individual farmers in the study.

#### 4.2 Hypothesis 1: CF farmers lose less than non-CF farmers.

As discussed in the previous chapter, postharvest loss could also be qualitative in nature, in other words, loss could manifest as a change in the physical appearance of the commodity. In the case of maize, loss of quality will include unfavorable change in the physical appearance of maize grains as a result of mycotoxin, mold, loss in nutritional value of maize, and presence of animal waste. For the dependent variable, I consider both the quantity and quality of maize by collecting loss data starting from harvest until storage. I aggregate the total losses from mold, animals, at the shelling, storage, and drying stages respectively.

Next, I predict the quantity of postharvest loss of maize that a farmer experience. The dependent variable is a count variable- the count of the postharvest loss of maize in bags. I consider a generalized linear model (GLM) and use the negative binomial model for the analysis given that the data has an inflated variance (Kremelberg, 2014).

Table 3 presents the results of the negative binomial model. The explanatory variables include

- a) Gender of the farmer. The farmers can either be male or female
- b) Years of ownership. This is the total number of years a farmer has owned the land. This variable is a proxy for the farmer's farming experience,
- c) Total harvest. This is the total maize quantity of maize (in kg) a farmer harvested in the 2018 planting season.
- d) Education. This variable is the education level a farmer has completed. A farmer with no formal education is one that has not attended any formal educational institution. A farmer with primary school education has completed six years of formal elementary education. A farmer with post-secondary education has completed up to nine years of formal

education. A farmer with a polytechnic/university education has completed at least two years of post-secondary education.

- e) Number of employees on the farm. This variable is the number of people employed to work on the farm full time.
- f) Participation in contract farming. This variable depicts a farmer's participation in a CF scheme. A farmer could participate in an informal scheme, a formal scheme, or not participate in any scheme. A farmer can only be in one of the three categories.

Holding all other variables constant, a female farmer is predicted to decrease the log of the expected loss by 1.18 in comparison to the male farmer. In other words, in comparison with a male farmer, the odds of PHL for a female farmer reduces by 31 percent.

In comparison to a non-CF farmer, a CF farmer in a formal CF scheme is predicted to decrease the log of the expected loss by 0.60 holding all other variables constant. In other words, in comparison with a farmer participating in a CF scheme, the odds of PHL for a farmer that does not participate in a CF scheme increases by 55 percent.

In comparison to a non-CF farmer, a farmer in an informal contract scheme is expected to increase the log of expected loss by 0.53 holding all other variables constant. Said differently, in comparison with a farmer participating in an informal CF scheme, the odds of PHL for a farmer not participating in a CF scheme reduces by 30 percent.

Holding all other variables constant, a farmer with a polytechnic/university education is expected to decrease the log of expected loss by 2.26 in comparison to a farmer with a primary school education. In other words, in comparison with a farmer with a secondary school education, the odds of PHL for a farmer with a polytechnic/university education reduces by 10 percent.

For every additional person employed on the farm, the log of expected loss increases by 0.41 holding all other variables constant. In other words, holding all other variables constant, for every additional person employed on the farm, the number of bags of maize lost is expected to increase by a factor of 1.04. This result is contradictory to the existing literature on postharvest loss that suggests that labor shortages contribute to postharvest losses (Kuyu et. al., 2019)

Table 4: Binomial regression predicting count of bags of maize that is lost postharvest

Parameter	B	EXP(B)	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
				Lower	Upper	Wald Chi-Square	df	Sig.
(Intercept)	3.90	49.23	0.27	3.37	4.42	213.07	1	p < .001
Number employed	0.04	1.04	0.01	0.02	0.06	21.42	1	p < .001
Years ownership	-0.004	1.00	0.01	-0.02	0.01	0.25	1	0.62
Total harvest	-0.01		0.01	-0.01	0.01	0.33	1	0.57
<b>GENDER</b>								
[Gender=Female]	-1.18	0.31	0.17	-1.51	-0.85	49.25	1	p < .001
Male: Reference Category	0 <sub>a</sub>							
<b>EDUCATION</b>								
No formal education	-0.07	0.93	0.23	-0.53	0.38	0.10	1	0.76
Polytechnic/University	-2.26	0.10	0.36	-2.96	-1.56	39.85	1	p < .001
Post-Primary	0.28	1.32	0.26	-0.23	0.79	1.14	1	0.29
Primary School: Reference Category	0 <sub>a</sub>							
<b>NATURE OF CF PARTICIPATION</b>								
Formal CF	-0.60	0.55	0.13	-0.87	-0.34	20.16	1	p < .001
Informal CF	0.53	1.70	0.24	0.05	1.01	4.76	1	0.03
No CF: Reference Category	0 <sub>a</sub>							
(Scale)	1 <sub>b</sub>							
(Negative binomial)	1 <sub>b</sub>							
Dependent Variable: Total loss								
Model: (Intercept), Gender, Education, Nature of contract, Number employed, Years ownership, Total harvest								
a. Set to zero because this parameter is redundant.								
b. Fixed at the displayed value.								

#### 4.3 Hypothesis 2: Assessment of PHL Drivers

Hypothesis: Research and interventions focused at reducing postharvest loss have primarily focused on the macro level and made certain global assumptions that neglect to consider the real-life experiences of small-holder farmers.

To test this hypothesis and obtain an understanding of the experiences of the farmers with regards to postharvest loss, I transcribed and analyzed the qualitative data collected during the focus group sessions and the key informant interviews using a thematic analysis. Braun and Clarke (2006) recommend this analytical method because of its flexibility in identifying, analyzing, organizing, describing, and reporting themes found within a data set (Nowell et al., 2017). The six-step strategy for analyzing qualitative data recommended by Braun and Clarke (2006) was followed to identify the common themes on the farmer's experiences of postharvest loss. These themes will be discussed below by expanding on the conceptual framework (see figure 7).

#### 4.3.1 Institutional factors

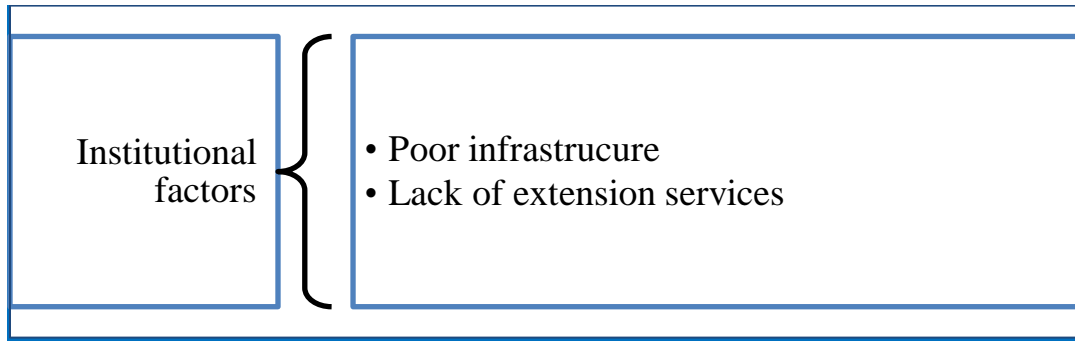


Figure 20: Institutional factors contributing to Postharvest Loss

Figure 20 shows the details of the institutional factors that contribute to postharvest losses. One of the institutional factors contributing to postharvest loss is the poor and inadequate transport infrastructure. According to the farmers in the Northern region, many farmers farm across riverbeds because of the opportunities the rivers provide during the long dry spells the region experiences. Bridges and roads are often washed away following the rains making travel to the farms difficult. As such, the farmers claimed that they wait until the waters recede and the roads are safe before they can harvest their produce. During this waiting period, they claimed that insects and rodents attack the maize crops. Also, during this period, the farm path is overgrown with weeds, creating a safe breeding space for dangerous reptiles that prevent farmers from accessing their farms during harvesting. Bad road conditions were another cause of loss cited by the farmers. According to them, if harvest coincides with the rains, the tractors or tricycles get stuck in the mud, such that by the time they are able to get alternative modes of transportation, the grains would have developed mold or started germinating.

Furthermore, the farmers revealed that they encountered losses because they lacked access to information and training on the type of seeds to plant and the right time to harvest their crops.

According to one of the farmers,

*“Last season, I lost all of my maize farm. Before the planting season, I bought a maize variety that I did not know was the early maturing variety. The harvest of this variety coincided with the raining season. I could not get to my farm because the bridge was flooded. When the water receded, all my maize was moldy.” (Spokesman for the focus group, Kpachiyili)*

According to the farmers, these losses would have been prevented if they had access to extension services. Extension services are primarily provided by the government in Ghana. A report on national farmer-extension ratio shows that the national average is 1 Agricultural Extension Agent (AEA) to 1500 farmers (FAO and ECOWAS, 2018). However, in some parts of the Northern region, the ratio is estimated at 1 Agricultural Extension Agent (AEA) to 5000 farmers (Peasant Farmers Association of Ghana, 2014). The report also added that extension workers are faced with many challenges that prevent them from carrying out their duties effectively because of institutional challenges such as lack of transportation to access farming communities and poor salaries.



#### 4.3.2 Socio-Cultural factors

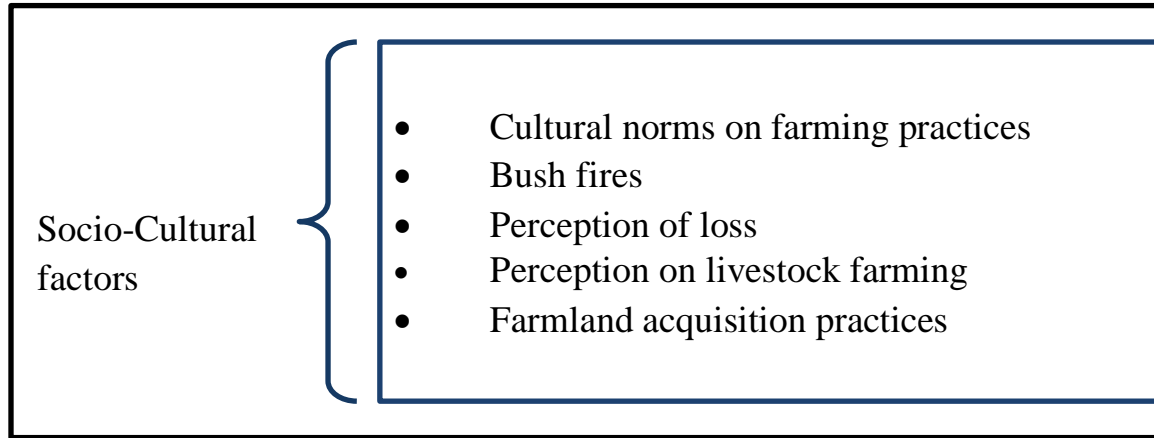


Figure 21: Socio- Cultural factors contributing to PHL.

Cultural factors that contribute to postharvest losses in the harvesting, drying, and storage stages are shown in Figure 21. The key informant interviews revealed that farmers follow a cultural practice of intentionally leaving some of their maize in the field unharvested. The farmers cite the biblical story of Boaz and Ruth<sup>3</sup> and the biblical injunctions that instruct farmers to leave some of their food produce in the fields for the poor, widows, and fatherless. The portion is left unharvested, and although the practice is not culturally prescribed, it is left to be determined by the farmer.

Maize harvest coincides with the start of the dry season in Northern parts of Ghana. Farmers in the north sometimes leave their maize in the field for about two months to reduce the moisture content in the maize. However, this practice predisposes their crops to insect, bird, and rodent infestation. Bush fires also contribute to post-harvest loss during the harvesting stage. These

<sup>3</sup> Ruth Chapter 2.

bush fires are often caused by pastoralists, hunters, or by ‘jealous farmers’ in the community. In one of the focus group sessions, a CF farmer reported that

*“Last season, I lost all my farm to a bush-fire. I do not know who started the fire. My debt to the CF scheme has been rescheduled for this year’s planting season” (Spokesman, focus group, Kojokperi).*

Another commonly used method of drying maize in northern Ghana is on-ground drying. With this method, maize is spread out in the open for sun-drying. The qualitative interviews with the farmers show that while some of the farmers spread the maize on tarpaulin, the majority of the farmers spread their maize on concrete structures because they could not afford to buy tarpaulins. Culturally, livestock farmers in Northern Ghana do not perceive livestock farming to be an integral part of their agricultural activities. As such, their livestock is left to gather food by themselves, which usually ends up being the grains left out in the open to dry. These drying practices exposes the maize to dirt and animal droppings. According to one of the key informants, commodity traders typically avoid conducting business with farming communities that are known for having dirt and animal droppings in their maize, thus resulting in postharvest loss.

To solve this problem, the government provides solar and mechanical dryers at a discounted price, but the adoption rates remain low. Some of the reasons that could be attributed to this are the bureaucratic hurdles to purchase the products. It was observed that to purchase these driers from the government, a farmer has to go through their farmer cooperative, the district and state agricultural departments, and the central agricultural department. Also, the relatively high purchase costs for smallholder farmers in contrast to the cost of the free traditional methods prohibits the farmer from adopting these technologies.

All of the farmers that were surveyed stored their grains in a sack that is kept at home. A local plant and chemicals are introduced in the bag to prevent insect infestation. According to key informants, sometimes farmers misuse the pesticides, making their grains unmarketable. A major challenge for reducing postharvest loss at the storage level is the farmers' reluctance to store their grains in public storage warehouse systems. These warehouses often provide training and moisture monitoring services to the farmers. Culturally, a farmer's wealth is perceived by their harvest. In other words, the larger the harvest, the wealthier the farmer is. Farmers typically want to protect themselves from 'jealous neighbors' by underestimating their harvest. Opit et.al. (2014) find that the practice of storing grains at home is influenced by the farmers' lack of trust in a public warehouse system where it is believed their grains will be stolen or mishandled. In the absence of alternatives to the public storage systems, farmers resort to storing their grains in their homes where the grains are susceptible to exposure, to moisture, mold, rodent, and insect infestation.

In 2017, the government launched the 'one district, one warehouse' project that focuses on reducing post-harvest losses among smallholder farmers. The project is expected to see the construction of 216 warehouses across the country. However, the farmers complained that accessing the warehouse in their district was difficult because of the long distance to the designated district warehouse.

Some farmers are engaged in programs that educate them on the use and uptake of improved seeds and implementing processes for maintaining high quality standards for their produce, with an associated significant increase in the rewards. It was observed that these farmers recorded better and higher quality yield and less loss. The motivation for abandoning their traditional

practices and adopting improved practices was driven by a desire for profit and meeting the requirements for continued participation in the out-grower scheme.

Cultural practices determine means of farmland acquisition, and these practices have resultant effects on food production and postharvest loss. Table 5 shows the distribution of farm acquisition and the average years of farm ownership. Farmland is predominantly acquired through inheritance. These inherited lands are held for an average of ten years. Four farmers, that are staff of a school, planted on school land. According to the farmers, they did not rent these lands, but have an informal agreement with the school to plant on the school land for the duration of their employment with the school.

*Table 5: Percentage of farmers and Avg. Years ownership broken down by farm acquisition*

Method of acquisition	Avg. Years ownership	Percentage of farmers
Inherited	10	74.38%
Gift	7	14.16%
Communal	5	7.42%
Rent	6	2.02%
Purchased	8	1.80%
School land	4	0.22%

Table 6 shows that the primary means through which men acquire land in both regions is through inheritance. However, women mostly acquire land as gifts in both regions. In the Upper West region, land was not acquired through purchase or communal ownership.

*Table 6: Distribution of land ownership by region, method of acquisition, and gender.*

Aquisition	Region	Female	Male	% of Total Numbe..	
Communal	Northern Region	4.23%	3.12%		
Gift	Northern Region	8.91%	0.89%	0.22%	43.65%
	Upper West Region	1.11%	3.12%		
Inherited	Northern Region	1.78%	43.65%		
	Upper West Region	4.68%	24.28%		
Purchased	Northern Region		1.78%		
Rent	Northern Region	0.22%	1.11%		
	Upper West Region		0.45%		
Rental	Northern Region		0.45%		
School land	Northern Region		0.22%		

Figure 22 shows the average farm size by the gender distribution. Farms owned by men are more likely to be three times the size of those owned by women.

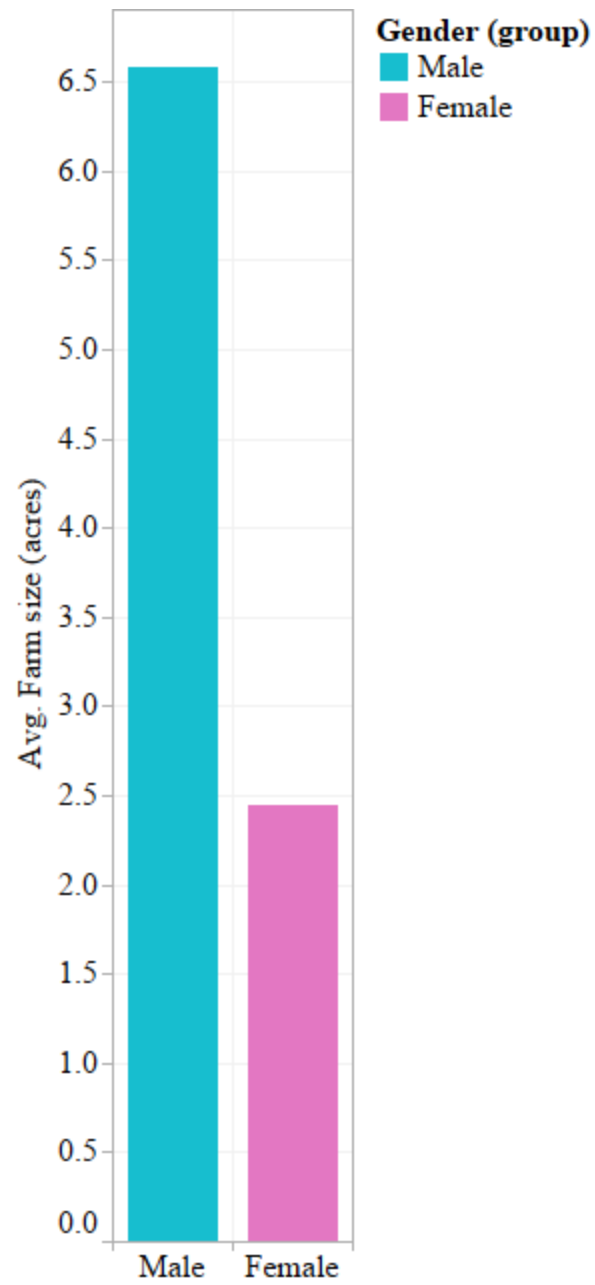


Figure 22: Average of Farm size (acres) for each Gender. Color shows details about Gender.

Figure 23 shows the average production per acre of farmland in kg. The men produce more on average per acre, this could be attributed to the fact that male-owned farms have more workers than the female-owned farms. However, the difference between the male and female production is not large.

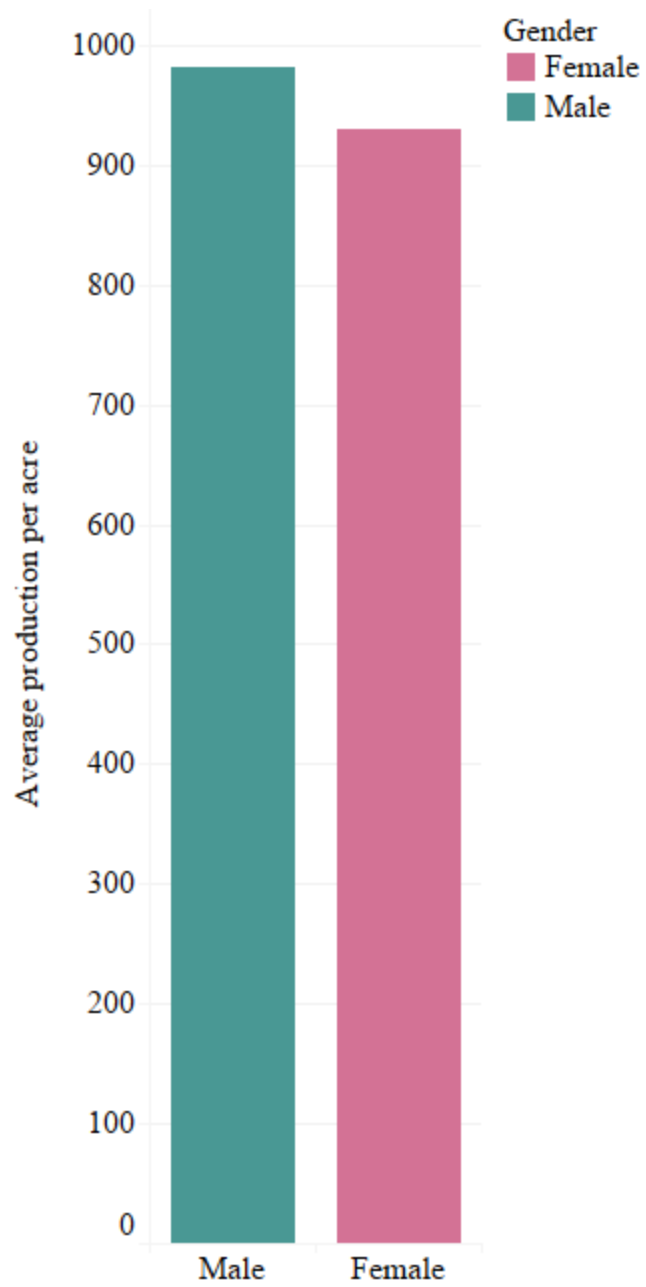
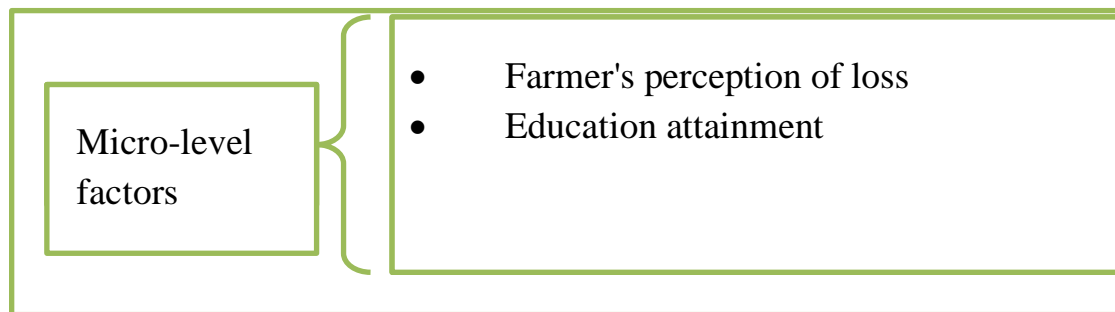


Figure 23: Total harvest by gender. Color shows details about gender.



Tribal chiefs hold the land in trust for the people in the Northern and Upper-West regions. The chiefs allocate land to men as they please, but cultural traditions prohibit the chief from allocating land to women. Women may receive land as gifts from their husband. However, according to a key-informant, women were less likely to experience losses due to their extensive knowledge of and adherence to good farming practices.

#### *4.3.3 Micro-level issues*



*Figure 24: Micro-level issues*

The interviews with the farmers and the key informants revealed that the farmers do not perceive post-harvest loss solely in economic terms. Figure 24 shows in details the micro-level factors that contribute to postharvest losses. According to the farmers, grains are not entirely lost because grains that cannot be sold due to their physical appearance are consumed by the family or left as animal feed thereby exposing them and their animals to health risks. For the farmers, increasing their farm yield was more of a concern to them than loss. This information was also restated during the key informant interviews. The key informants alluded that the farmers would

intentionally leave maize that had fallen off trucks because they do not consider the fallen maize as income lost.

Low levels of education attainment were also cited as a cause of postharvest loss. According to a key informant, the farmers with formal education were more likely to comprehend and adhere to good agricultural practices that reduce loss. For example, they were more likely to harvest at the right time and apply the recommended amount of agro-chemicals during storage. These group of farmers are also more likely to have access to hermetic storage bags. Figure 25 shows the results of reported postharvest loss by the farmer's level of education attainment. It is seen that on average, farmers with no formal education lose more than all the other farmers, while farmers with polytechnic or university education lose the least.

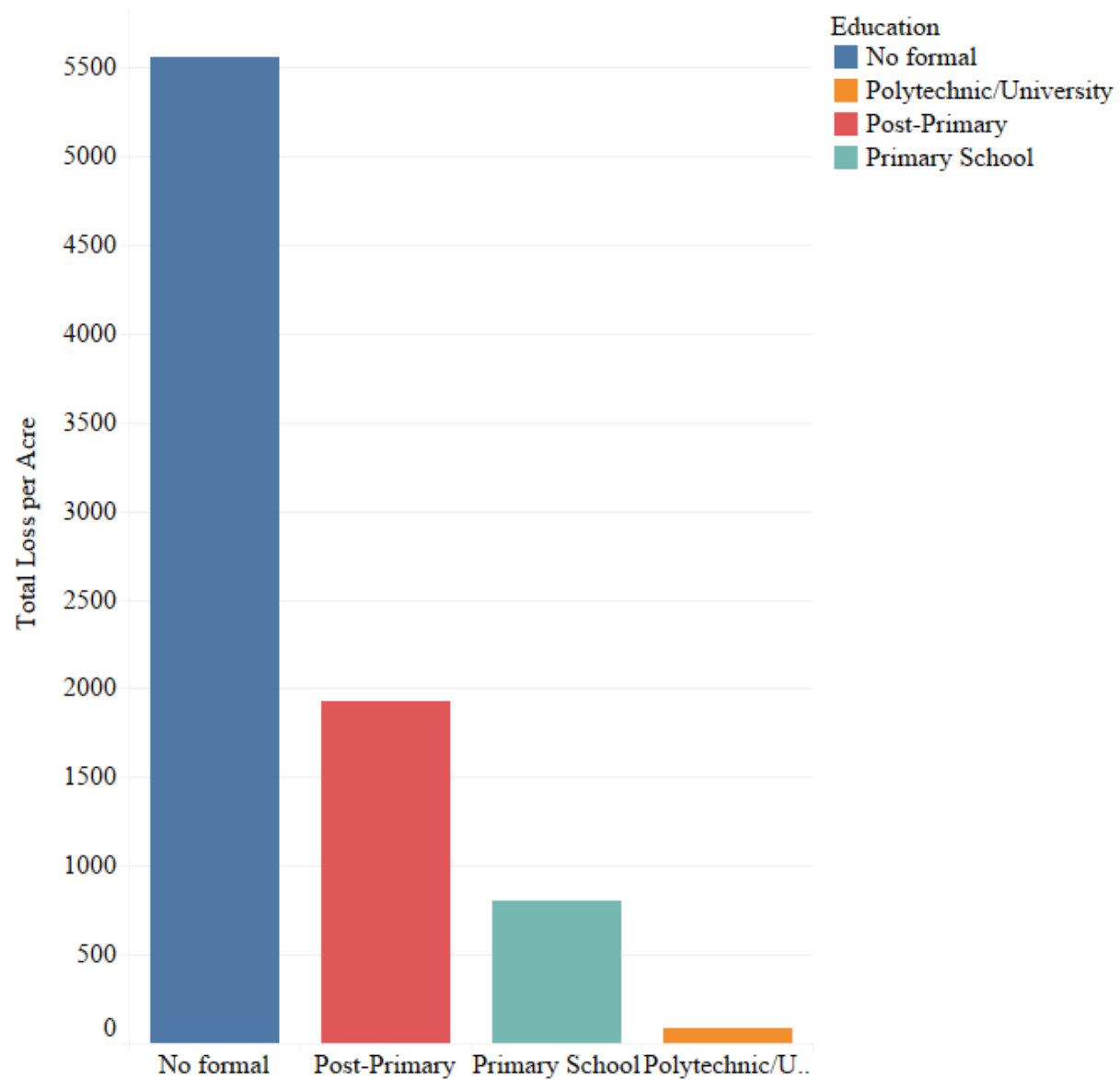


Figure 25: Education attainment and Postharvest Loss.

#### 4.3.4 Technology factors

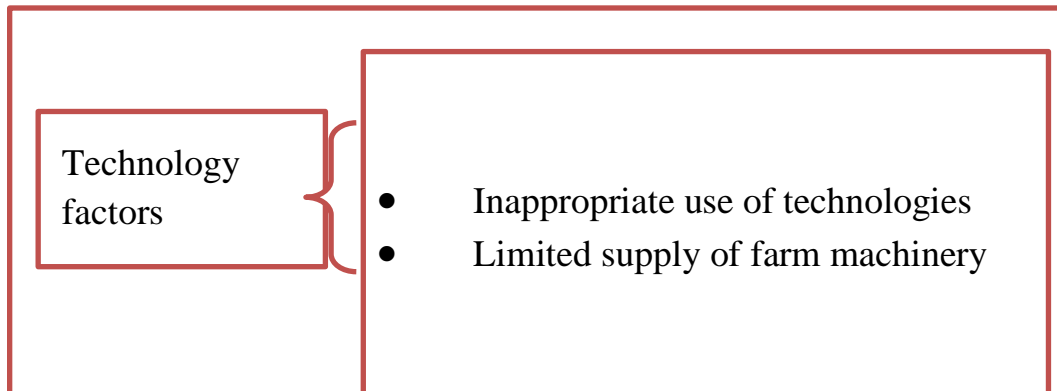


Figure 26: Technology factors contributing to PHL

The full details of the technology factors that contribute to losses in Ghana are shown in figure 26. These technology factors include the limited supply of farm machinery and inappropriate use of shelling technologies. Figure 27 shows the distribution of agricultural technologies used by the farmers. All of the farmers that use sprayers own the knapsack sprayers. 90 percent of the farmers rent tractors, ploughs, planters, harvesters, and threshers from ‘tractor contractors’ in the community. Tractor contracts are typically community members that own tractors that rent out to farmers. They could also be tractor sellers that also provide tractor rental services. Prices for tractor services are fixed by the contractors at the start of the season. However, there is a short supply of these services. As a result, the farmers experience delays particularly in the land preparation season. 91 percent of the farmers store their grains in old cocoa sacks in their homes, two percent store in baskets, less than 1 percent store in hermetic storage sacks. Less than one percent of the farmers have mechanized their planting and harvesting processes.

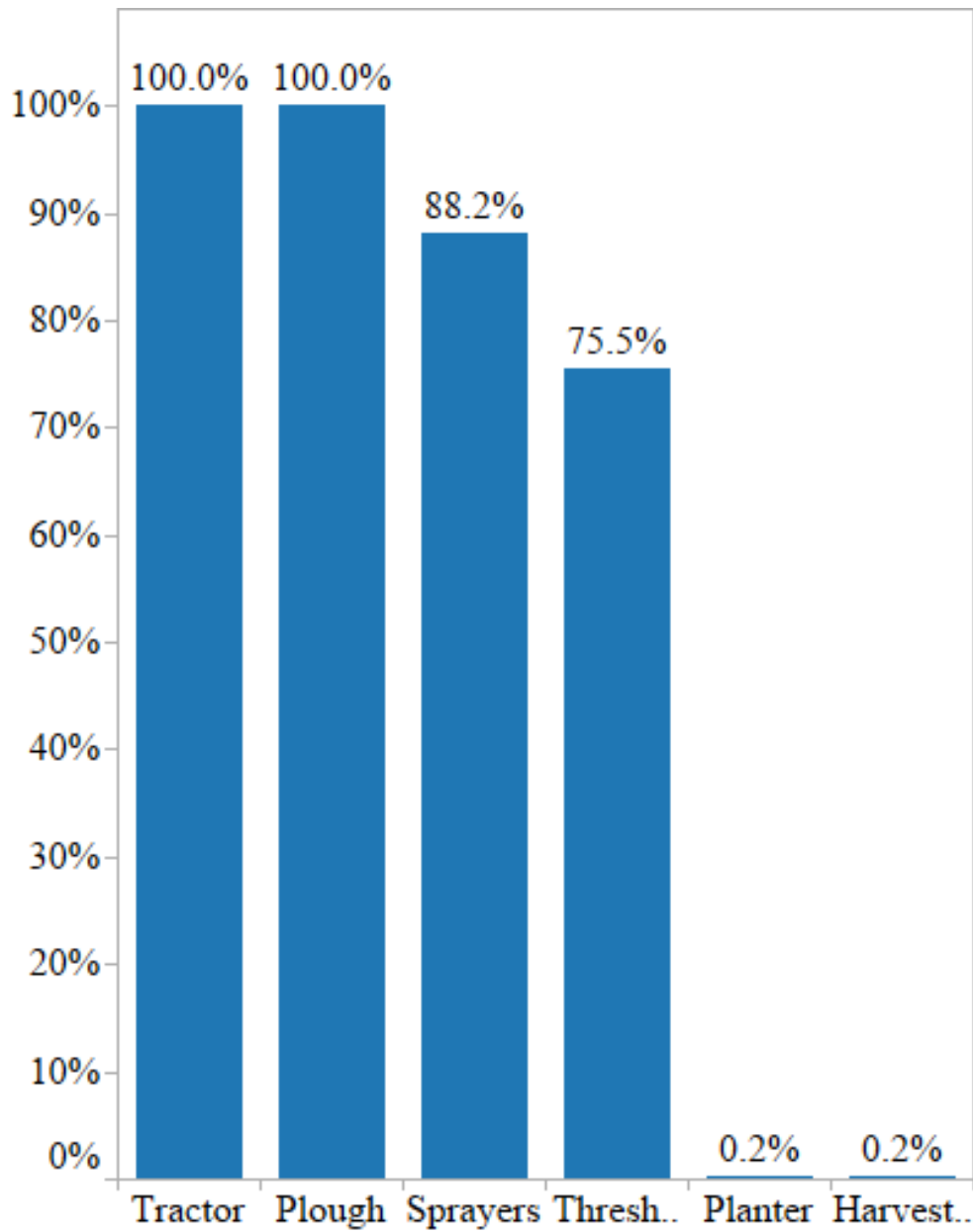
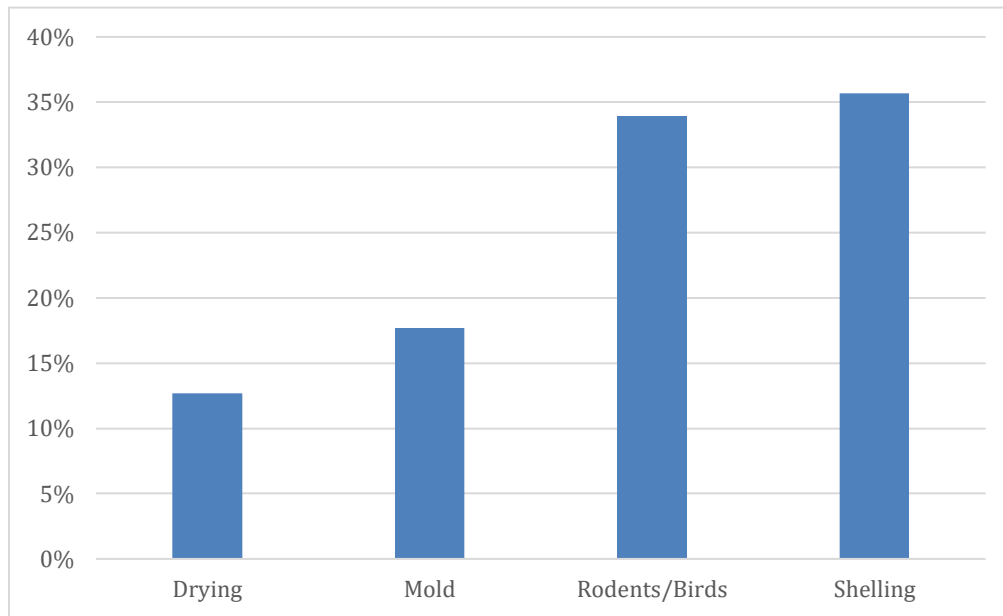


Figure 27 :Percentage of farmers adopting agricultural technologies.

While the adoption of tractors and ploughs has been on the increase since the early 2000s (Cossar and Gollin, 2018), farmers rely on manual labor for other activities such as harvesting,

drying, and shelling. Figure 28 suggests the major causes of losses are shelling and pests. It accounts for 36 percent of the cause of postharvest loss.



*Figure 28:Percentage breakdown of causes of PHL*

Figure 29 shows that the majority of the CF farmers lose the most during shelling while the non-CF farmers lose the most to rodents and other pests during storage. It is important to note that CF schemes provide shelling and storage training to their farmers.

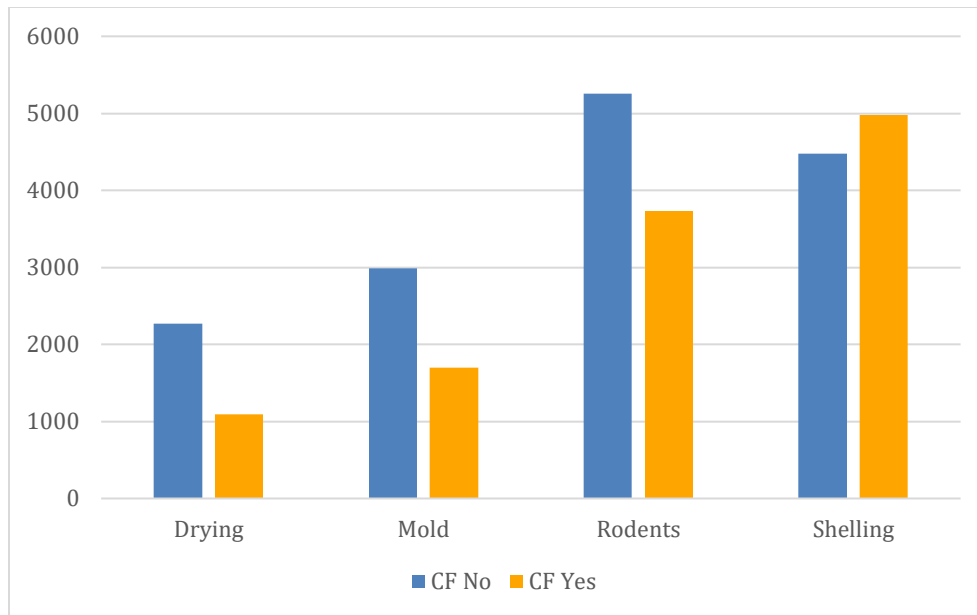


Figure 29: Total loss by cause showing a comparison between CF and non-CF farmers

While the adoption of tractors in plowing has been on the increase since the early 2000s (Cossar and Gollin, 2018), farmers still rely on manual labor for other activities such as harvesting, drying, and shelling. As a result of the labor shortages and the non-existence of alternative mechanical options, loss occurs during harvesting and shelling when the laborers rush through the process. While mechanical shellers are available in some farming communities, these shellers are shared among many farmers resulting in poor service delivery. According to a key-informant,

*“mechanical shellers are available in some farming communities, but sometimes the [shelling] contractors use defective shellers and rush through the process and end up spilling a lot of the grains. We have trained the contractors to collect the spilled grains with a tarpaulin, but they would not listen... sometimes, the contractors providing drying services want to move on to the next farm, so they increase the temperature of the dryer and damage the grains”* (Key informant

*in the NGO sector).*

Also, inappropriate use of agro-chemicals is a contributing factor to PHL. According to a key informant,

*“many of the farmers apply herbicides on the field and pesticides to the maize during storage, but in quantities that are above the recommended limits for human consumption. When that happens, the farmers find it difficult to sell or consume the maize, so they have to throw everything away” (Key informant in the NGO sector).*

Also, the majority of farmers reported that they rely on tricycles and tractors to transport their produce from the farms to their homes for storage. These tricycles and tractors are in short supply in many of the farming communities. To cope with this challenge, the farmers overload the tricycles and tractors to maximize the number of trips they would make. Overloading leads to the maize cobs falling off during the transportation process. At other times, the available tractors have holes that allow the maize to fall off during transportation.

#### 4.3.5 Environmental factors

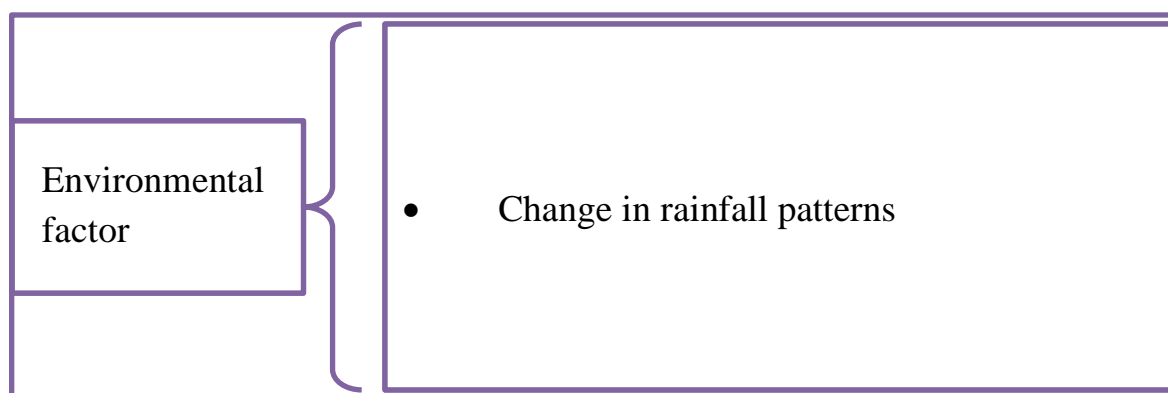


Figure 30: Environmental factors contributing to postharvest loss



Figure 30 shows that unpredictable weather patterns are the primary environmental factor that contributes to postharvest losses. About 20 percent of the responses in the questionnaire cited unpredictable weather patterns as one of the causes of postharvest loss. During a focus group session, a farmer reported that in the past, they could predict the timing of the rains based on their experiences. This allowed them to prepare and plan to harvest in the driest period of the month of November. However, in recent times, the rains have been unpredictable with rains falling until the end of November, thereby hindering the grains from drying properly.

#### 4.3.6 Economic factors

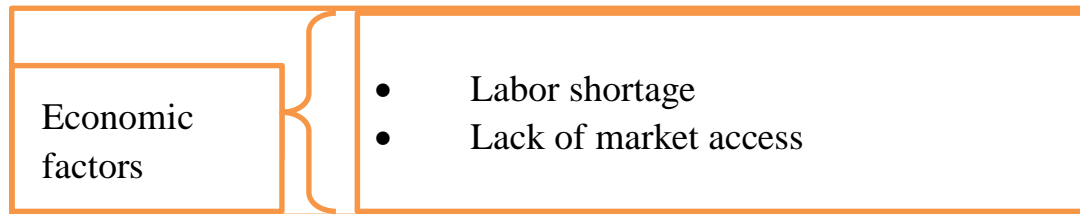


Figure 31: Economic factors contributing to postharvest loss

Figure 31 shows the economic factors that contribute to postharvest losses. Farmers also attributed postharvest loss to a lack of market access. According to the farmers in the Upper-East region, the lack of market access is a result of the absence of a major commercial center close to the farming community. This problem is compounded by the remote location of their farming community and the challenges arising from road transportation. According to the CF farmers in the Upper East region, the closest market to the farming community is located about 34 miles away in Wa. Many of the farmers cannot afford to transport their produce to Wa and rely on the market women coming to their community. The market women on their part offer to purchase the produce at a price lower than the production or market price because haggling is a cultural expectation. In the absence of good storage options, some of the farmers that decide to store their grains in anticipation for selling at a higher price lose their grains to insect infestation or mold growth. This puts farmers in a difficult situation where they have to choose between selling for a lower price and PHL.

Non-CF farmers also face challenges with market access. According to these farmers, inadequate knowledge of the market price of their grains and the delay in payment by the market “queens” encouraged them to store their produce until they were sure they could get a higher price for the

maize. The average time they have for storage was about five months. The farmers reported that the inability to market their grains after five months was higher because of over application of pesticides meant to prevent insect growth in stored grain, and unavoidable insect infestation.

Another challenge that was discussed was the effect of a decline in the percentage of people employed in the agricultural sector. An aging farmer population, rapid urbanization, and rural-urban migration were contributing factors to this decline and hence to postharvest loss in Northern Ghana. According to the Ghana government, the average age of the farming population in Ghana is 55 years (MoFA, 2011). Employment in the agriculture sector can alleviate youth unemployment problems in the country. However, youth participation in the sector is hindered by the youth perception of agriculture as jobs for the “uneducated, unskilled, and with low economic returns (MoFA, 2011).” As such, the youth population in the rural areas migrate to urban areas in search of other means of livelihood.

The farmers reported that the labor shortage was a challenge for them during harvesting and drying. According to them, sometimes, they left their crops unharvested because they could not get anyone to do the manual harvesting. At the drying stage, losses occur as a result of declining agricultural labor, gathering the grains in time before unexpected rainfall is a challenge for farmers when they dry their grains in open spaces. A farmer also reported that he lost his produce because he could not get anyone willing to be hired to gather his grains during a rainfall.

Labor shortage is further compounded by the impact of climate on the agricultural sector. As mentioned in the previous chapter, agriculture in Ghana is dependent on rain. Compared to the rest of the country, the northern parts of Ghana have a shorter wet season and a shorter time for farming. This has resulted in many farmers migrating to the south where they can have multiple planting seasons.

#### 4.4 Conclusion

In conclusion, the results suggest that while contract farming is an effective market-based approach in increasing food production and reducing losses, the often-overlooked micro-level factors can hinder the communities from maximizing the potential benefits of contract farming. For example, often overlooked factors such as lower educational attainment levels, poverty, and inequality are factors that contribute to losses. The results also suggest that the nature of contract farming a farmer participates in determines the magnitude of their production and losses.

## CHAPTER 5: DISCUSSION

This thesis set out to investigate the unanswered, ignored, and unaccounted-for social and policy issues that drive postharvest loss from the perspective of farmers' practical day-to-day experiences. Given the limited success evidence of technological solutions as a postharvest loss reduction strategy in Africa, the research also investigated the feasibility of market-based approaches, such as contract farming (CF), as an intervention strategy for reducing postharvest losses. This section discusses the results of the investigation.

### 5.1 Contract farming as a loss-reduction strategy.

The results suggest that contract farming as a market-based approach increases food productivity. This is because farmers participating in contract farming schemes were likely to adopt farm inputs known to increase production. Farm inputs include hybrid maize and other inputs, such as fertilizers.

#### 5.1.1 *Contract Farming, Hybrid Maize and Production*

Hybrid maize seeds are produced through a process of cross-pollination between two or more inbred lines. By itself, one of the inbred lines is low-yielding, but when cross-pollinated with another inbred line, it produces hybrid seeds that will result in uniform plants of high yield (Tripp and Ragasa, 2015). It is important to note that seeds produced from hybrid varieties cannot be saved and planted at the next planting season. Replanted seeds known as second-generation seeds, will provide a much lower yield or produce maize seeds that are different from the hybrid variety.

In consequence, farmers who cultivate hybrid seeds need to buy new seeds every planting season. These seeds usually cost three times the other varieties because of the high production costs (Tripp and Ragasa, 2015). The high poverty rates among farmers in Ghana causes low adoption of hybrid seeds (Ragasa et. al., 2013). Contract farming provides opportunities for farmers to obtain these seeds as lines of credit.

### *5.1.2 Contract Farming, Agrochemicals, and Production*

One of the significant challenges of agriculture in Sub-Saharan Africa is soil nutrient depletion due to the adoption of unsustainable agricultural practices such as overgrazing and excessively mechanized agriculture (Tully et. al., 2015). Changes in climate conditions, for example, drought, floods, and, in some instances, diminishing rainfall are also contributing factors to land degradation (Doso, 2014). Ghana has one of the highest rates of soil nutrient depletion among sub-Saharan African countries, with annual projected losses of 35 kg nitrogen, 4 kg phosphorous, and 20 kg of potassium per hectare (Jayne et. al, 2015). Land degradation and nutrient loss are exacerbated by human activities such as gold mining, prolonged years of intensive farming on the same piece of land, indiscriminate felling of trees for fuel, wood and charcoal production, bush burning, overgrazing, and small-scale mining (Ashaley, 2013). Soil degradation has been associated with low food production in Africa (Scherr, 1999).

Since the 1980s, development practitioners and many African governments have focused on promoting fertilizer adoption by implementing fertilizer subsidies and other targeted credit programs as a means of replenishing soil nutrition and increasing food production. (Jayne et. al, 2015; Sachs, 2008). In 2006, African leaders adopted the *Abuja Declaration on Fertilizer for the African Green Revolution* (African Union, 2006) and committed to increasing fertilizer use from

8.0 kilograms to 50.0 kilograms of nutrients per hectare by 2015. The declaration encourages African States to “target subsidies in favour of the fertilizer sector” (African Union, 2006).

However, compared to the rest of the world, the adoption rates for fertilizers have remained low in Africa (Sheahan and Barrett, 2014). Some of the reasons for this include the following: weak fertilizer distribution networks (Druilhe and Barreiro-Hurlé, 2012); relatively high costs of fertilizers resulting from tariffs; high import costs; and inefficiencies at the ports (Benin et. al., 2011; Croppenstedt et al., 2003); the lack of evidence of the impact of fertilizer use on farmland (Marennya and Barrett, 2009); and inadequate training in the appropriate utilization of fertilizers (Emmanuel et. al., 2016).

In 2008, the Ghanaian government introduced the fertilizer subsidy program that focused on increasing fertilizer usage by smallholder farmers. Before then, the fertilizer usage rate in Ghana was about 8 kg per ha, down from 21.9 kg per ha in 1978 (Oxford Business Group, 2020). The program was mainly applied to the cultivation of cash crops. The policy increased the usage rate to the 1978 level (Jayne et. al, 2015). To ensure that fertilizers are distributed efficiently, the government partners with local companies to sell fertilizers to smallholder farmers at a price lower than the market price. Women are given priority in the distribution process (MoFA, 2017). In 2013, the policy was changed. The change limited fertilizer distribution to only 2 hectares for staple-producing smallholder farmers. While the policy is credited with a usage rate that is 6 to 10 times higher in comparison with the early 2000s, (Jayne et. al, 2015), fertilizer usage remains low.

This is because many smallholder farmers still cannot afford the cost of chemical fertilizers in right quantities and qualities, regardless of the considerably lower price.: could not (Allotey et. al., 2016). Other reasons include the lack of trust in fertilizer quality, poor transportation

infrastructure to ensure fertilizer delivery (Fuentes et. al., 2011), and bureaucratic bottlenecks in accessing the fertilizers (World Bank, 2017) According to the key informant, the quality of the fertilizers was not the problem, but rather that farmers misused the available fertilizers by spreading the allotted quantity over a larger farm area than prescribed, resulting in sub-optimal yield. This contributed to the perception of the products ineffectiveness and it increased distrust. Also, high incidents of fraud have hindered the success of the fertilizer subsidy program. In 2018, non-governmental organizations indicated a highly sophisticated criminal syndicate existed that re-bagged the government-subsidized fertilizers and smuggled it to neighboring Burkina Faso or Togo for sale in the black market (Ajetunmobi, 2018). According to the Minister of Agriculture, this criminal activity costs the government \$12 million in annual losses (GhanaWeb, 2019).

The Planting for Food and Jobs (PFJ) program is another program established by the government of Ghana in 2017 to promote growth in food production and create jobs across the country. During the first year of its implementation, farmers received subsidized seeds and fertilizers. The payment for the seed and fertilizes was expected at the end of the farming season in the form of bags of harvested produce. In the opinion of one key informant, who worked with the program in 2017, fertilizer distribution was made to farmers that were loyal to the ruling party. According to the informant, this emboldened the farmers to default on the loan repayment. Farmers threatened government officials deployed to recover the debt with arrests and job losses because of their relationship to the ruling political party. Debt recovery was also difficult because some of the farmers registered with fictitious names and addresses.

Farmers participating in CF schemes have considerably more access to fertilizers than do those who have to rely on fertilizers through the government agencies. Also, they do not have to pay



upfront in cash but can receive the inputs as lines of credit. They can thereby channel the funds toward other personal financial responsibilities. According to the farmers, this serves as a positive incentive to use fertilizers and increase production yield.

### *5.1.3 Contract Farming, Farm Mechanization, and Production*

There was no observed difference in mechanization between farmers participating in CF schemes and farmers that do not. All of the farmers used tractors and plows for land preparation. 99% of the farmers hired tractor services provided by tractor operators, while one percent owned tractors. The tractor operators worked with booking agents in the communities that aggregated the demand. However, the farmers reported that the tractor operators favored the more affluent farmers and those with larger farm over farmers with smaller farms. This was also found by Mangnus and Van Westen (2008) and Diao et. al, (2014). According to a tractor operator, the decision to provide tractor and plowing services is not based on the farmer's financial endowment but on the aggregate demand that is available in surrounding areas. For example, the contractor would accept the request for 2 acres of farmland where he can provide service for 50 other farmers with the same farms nearby, as opposed to accepting the demand for a single 20-acre farm with no orders along the way.

The tractor operator also reported that because the demand for tractor services far outweighed supply, it created delays during the land preparation stages. According to the World Bank (2019), there are about five tractors per 100 sq. Km of arable land in Ghana, about 39 times less than the world average. To increase mechanization, the federal government provides subsidized tractors for sale to the farmers. According to a key informant, to access these tractors, the farmer would apply through their farmer cooperative, the District Department of Agriculture, the Regional Ministry of Agriculture, and the Federal Ministry of Agriculture. The key informant

explained that these levels of approval were instituted to prevent traders from purchasing the tractors at a discount and selling across the border. However, according to the farmers, the government-subsidized tractors were not durable enough to work on the topography of Northern Ghana, and they would prefer to have a tractor brand produced in Europe. As such, many of them who obtained the tractors could not afford to keep up with the payments - given that they spend so much on maintenance. According to a key informant in the government, the government had limited options with the tractors they supplied because they were obtained as a part of “loan and foreign aid” requirements between Ghana’s central government and the origin countries of the tractors.

According to the formal contract scheme principals, providing land preparation services would drive up the costs of production and could deter the farmers from participating in the schemes. However according to the farmers, the primary reason for participating in informal contracts, was to get access to tractor. The nature of the informal contract is such that farmers contract with a tractor operator, a wealthy member of the community, or a farmer that owns a tractor to plow their land in exchange for bags of maize after harvest time. The refund is determined by the size of the land that is plowed through the informal contract.

#### *5.1.4 Contract Farming, Grain Storage and Postharvest loss*

Farmers in CF schemes were more likely to experience lower levels of postharvest loss of maize. According to the principals of the formal contract schemes, participating farmers had an incentive to reduce losses because of the expected obligation of repaying the loan. The terms of the contract of the formal schemes specified that the farmers repay in the form of their produce. The payment structure was determined in advance and is based on the services and inputs that the contract scheme provided. Farmers that intentionally default on payment are excluded from

participating in subsequent seasons. However, if the default was due to *force majeure*, for example, if fire, pests, or flooding destroyed the farm, the loan is deferred until the subsequent planting season. For this reason, farmers make the best efforts to reduce losses.

However, the need to repay makes farmers susceptible to adopting opportunistic behaviors such as diluting the quality of produce by introducing foreign material such as dirt, to meet the required payment. Other opportunistic practices include substandard drying and shelling processes. This may cause moisture retention and aflatoxin growth, causing the grains to be rejected at the point of quality control. Some seed growers also mix other grains with seeds, which also causes rejection and loss. Before 2015, the Masara scheme navigated through this challenge by introducing a joint liability clause in the contract. This meant that if it was discovered that one farmer of the farmer cooperative was adopting opportunistic behaviors or defaulted in the loan, the scheme would reject all the grains produced by the group and eliminate every farmer in the group (Ragassa et. al., 2017). This policy was changed because it encouraged high attrition rates (Ragassa et. al., 2017).

#### *5.1.5 Contract Farming, Loan Repayment, and Postharvest loss*

Farmers in CF schemes were more likely to experience lower levels of postharvest loss of maize. According to the principals of the formal contract schemes, participating farmers had an incentive to reduce losses because of the expected obligation of repaying the loan. The terms of the contract of the formal schemes specified that the farmers repaid in the form of their produce. The payment structure was determined in advance and is based on the services and inputs that the contract scheme provided. Farmers that intentionally default on payment are excluded from participating in subsequent seasons. However, if the default is not due *force majeure*, for

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However, the need to repay makes farmers susceptible to opportunistic behaviors, such as adulterating the quality of produce by introducing foreign material such as dirt, to meet the required payment. Other opportunistic practices include substandard drying and shelling processes, which may lead to retained moisture and aflatoxin growth, causing the grains to be rejected at the point of quality control. Some seed growers also mix other grains with seeds leading to similar rejection and loss. Before 2015, the Masara scheme navigated through this challenge by introducing a joint liability clause in the contract. This meant that if it was discovered that one farmer of the farmer cooperative was adopting opportunistic behaviors or defaulted in the loan, the scheme would reject all the grains produced by the group and the elimination of every farmer in the group (Ragassa et. al., 2017). This policy was changed because it encouraged high attrition rates (Ragassa et. al., 2017).

#### *5.1.6 Contract Farming, Postharvest Loss and Economic Perception of Loss*

The interviews with the farmers and the key informants revealed that the farmers do not perceive post-harvest loss solely in economic terms. According to the farmers, grains are not entirely loss since grains that cannot be sold due to their physical appearance are consumed by the family or left as animal feed. This exposes individuals and their animals to health risks. For the farmers, increasing their farm yield was more of a concern than loss. The key informants alluded that the farmers would intentionally leave maize that had fallen off trucks because they do not consider the fallen maize as an income loss. According to a key informant for Heritage Seeds, farmers were motivated to reduce losses when they increased their production because they could see the impact of their hard work preharvest and would take steps to minimize losses postharvest. As an

incentive for the farmers to reduce postharvest losses, Heritage Seeds offers to purchase maize that is left over after repaying the loan at a cost double the market price.

#### *5.1.7 Contract Farming, Farmer Knowledge and Skill, and Postharvest Loss*

Also, the extension services offered to the farmers by the formal contract schemes could be attributed to postharvest loss reduction. Farmers in the Heritage Seeds and Masara schemes are given information on the best practices to adopt to increase yields, such as the right use of fertilizers, weed and pest control, and postharvest handling practices that reduce loss. According to the key informants in the formal contract schemes, the farmers receive at least six face-to-face training services between planting and harvesting. For example, farmers in these schemes are trained on loss reduction strategies in the storage, drying, and the shelling stages. However, it is interesting to observe that farmers participating in contract schemes reported more losses in the shelling stage. However, in comparison with farmers that do not participate in CF schemes, farmers participating reported fewer losses to mold, rodents, and during the drying stages. This could be attributed to the fact that the losses to mold and rodents occur in storage, and farmers in CF schemes do not have to store the grains because the possession of the grains is transferred before storage. The reason that CF farmers lose less at the drying stage is not clear, especially given the lack of variation in the drying methods adopted by CF and non-CF-farmers.

#### *5.2 Motivations for participating in CF schemes.*

If contract farming offers all of the opportunities for accessing inputs, increasing yield, accessing storage, and extension services, it begs the question of why some farmers do not participate in any of the schemes? One of the reasons for non-participation by farmers is the lack of contract

farming opportunities in their communities. In some farming communities in the Northern Region, the farmers reported that they participated in a formal contract scheme during the 2016 planting season, but the contract scheme had not returned since then. This cessation was discussed with a key informant with Masara, who clarified that the contract scheme left the Region and moved to the Upper East Region because the default and exit rates in the Northern Region were higher than those of the Upper East.

The informant could not explain the rationale for the disparity in the default rates. However, Ragasa et. al., (2018) argue that “the increased presence of development projects distributing free inputs or cheap credit has contributed to lower entry and higher exit from the scheme.”

Formal contract schemes have devised some strategies to reduce default incidents. For example, the schemes conduct regular visits to the farms to do yield estimates during the planting season. One is conducted at registration, another at the mid-season, and finally at harvest. According to the key informants, having the yield estimate helps the schemes to determine how much input would be offered to the farmers before the planting season. Also, the visit conducted in the middle of the planting season provides training to the farmers and also determines which farmers might have problems with repayment because of a predicted poor harvest. The key informants in the formal contract schemes reported that the estimates also help them if a farmer inflates their production numbers. According to them,

*“if a farm was estimated to produce two 84kg bags of maize and the farmer returns at the end of the planting season with three 84kg bags, we know that the farmer either got the extra bag from somewhere else or has mixed the grains with foreign materials.”( interview with key informant, Heritage Seeds Company).*

This is important for the Heritage Seeds company that produces certified hybrid seeds. Specifically, diluting the quality of the farm produce creates a negative impression of the company, so these validation and quality assurance measures are necessary to prevent lapses.

Another strategy that the schemes adopt is to contract with farmer groups as opposed to individual farmers. According to the key informants at the schemes, organizing farmers into groups promotes accountability among the farmers. Farmers who intentionally default lose their social capital within their cooperative group and are not permitted to participate in the scheme during the subsequent planting season. The drawback of this is that the contract negotiations are conducted between the representatives of the contract schemes and the leaders of farmer cooperatives. During one of the focus group sessions in the Upper East Region, one of the farmers participating in the Masara contract scheme expressed his displeasure with the price negotiation process because he did not perceive that the cooperative group leaders negotiated a fair price since all the farmers in the group did not participate in the process. According to this farmer, the contract scheme announced the purchase price before the harvest season and gave their principals little room for negotiations if the market price were to increase after the harvest season. Since the farmers do not have access to other markets in the Region, they have to sell at a lower price to the contract scheme. This observation was also made by Gage et. al. (2012).

However, while they do not negotiate with all the farmers, because of the logistics challenges involved,, they encourage the leaders of the groups to carry all the farmers along in the negotiation process. The scheme also stated that they negotiate with the representatives of the farming group on three occasions - once before planting, once after planting, and finally after harvest before the price is determined. That way, the amount they offer is comparable to the price in the open market.

It is essential to mention that while the formal contracts are made with groups of farmers as opposed to individuals, the common law doctrine of privity of contract applies. In other words, any party to the contract can enforce their rights, claim damages, and take benefits from the contract. However, the farmers reported that instituting legal action against the contract scheme is impossible because farmers do not have the financial capacity and education to institute legal action.

Risk aversion was another reason that farmers would not participate in contract farming schemes. According to these farmers, because agriculture in their Region is dependent on and vulnerable to the forces of nature, borrowing against a projected harvest would be a considerable risk. They feared that if there were a drought or a flood during the planting season, a crop failure would be guaranteed and that would result in their defaulting on the loan. They added that since these loans would be deferred until the next planting season, contract farming could keep a farmer in a perpetual cycle of debt. According to the key informants in the formal contract schemes, the schemes offer agriculture insurance to protect the farmers from the risk of crop failures resulting from droughts or floods. However, it is not clear how much the farmers know about the insurance program. Despite some of them reporting total farm losses, no farmer participating in the schemes was the beneficiary of the insurance program.

Furthermore, farmers cited the ruthless nature of the contract schemes as a reason for non-participation. According to these farmers, after harvest, you are expected to fulfill your loan obligations and sell all that is left over to the contract scheme. According to these farmers, sometimes they had nothing left to eat or sell after repaying the loan. For the farmers, this suggested that the contract schemes were not concerned about their welfare but about the maize they produced. This perspective differed from that of the key informants administering the



formal contract schemes. The key informant of the Heritage Seeds company stated that the farmers are at liberty to consume or sell any of their maize that is left over. However, the farmers prefer to sell to the scheme because the scheme purchases at a price double that of the market price, and also because the government only permits the sale of hybrid seeds by approved seed sellers. In principle, farmers participating in the Masara scheme are required to sell their excess produce to the scheme. However, this is rarely done and is not strictly enforced (Ragasa et. al., 2018).

In the survey, some farmers would not participate in CF schemes because they “*wanted to be their own boss and would not want to lose their autonomy.*” These groups of farmers maintain that by receiving inputs and services from the contract schemes, they inadvertently transfer the ownership and control of their farms to the schemes. According to one of the farmers, he would not join a contract scheme because he was not interested in planting hybrid seeds provided by the scheme. The farmers also stated that they were financially capable of cultivating their farms and conducting their business without support. The literature on farmers’ perception concludes that farmers value their independence and autonomy (Ba, 2019; Dessein and Nevens, 2007) because it creates a sense of masculinity and security (Stock and Forney, 2014). It also gives them a feeling of self-achievement and power (van Gelderen and Jansen, 2006).

Finally, some farmers reported they would not participate in CF schemes because of the delays in receiving payments for purchased produce. The farmers stated that sometimes, the contract schemes delayed payment by at least one year, thereby preventing them from fulfilling personal financial obligations and from preparing for the next planting season. To reduce the effect of the delayed payments, farmers developed a strategy of partitioning their farmland such that only a fraction of the land is cultivated with inputs or services provided through contract farming.

According to the key informants in the contract schemes, the delays are not intentional but occur as a result of the delays in payment from their customers. For example, the Heritage Seeds company reported that the government delayed the payments for seeds the company provided in the 2017 planting season. As a result, the company also delayed payments to the farmers.

According to the key informant, in the past, the contract scheme obtained bank loans to pay the farmers, but with the commercial banks' interest rate at 18 percent, and sometimes up to 30 percent, this became prohibitive.

Financing remains a critical challenge to Ghana's agricultural industry. According to the Alliance for Financial Inclusion (2018), commercial banks in the country have been reluctant to grant loans for several reasons including the following: high-risk perception of the industry and inadequate risk management options, sparse bank penetration particularly in the rural areas, and high loan default rates complicated by limited documentation of the farmers. In addition, farmers have higher illiteracy levels and commercial banks have used inappropriate financing models because of their poor understanding of agribusiness. Finally, commercial banks do not necessarily regard the agricultural sector as relevant to their activities, considering that Ghana's agriculture still has low-profit potential.

Farmers have other alternatives for obtaining financial loans. For example, the Agricultural Development Bank (ADB) was established in 1965 as "a specialized bank for the provision and administration of credit and other banking facilities in the agricultural sector" (Agriculture Development Bank, 2020). However, farmers often have challenges accessing loans from the ADB because of high-interest rates (Shafiwu et. al., 2013). Also, with the bank having 78 (Agriculture Development Bank, 2020) branches, it is not clear if the bank has enough capacity to reach farmers, particularly those in rural areas (Afful, 2015).

Rural and Community Banks (RCBs) are also alternatives for obtaining agricultural loans. They were established by the Government of Ghana in the late 1970s to provide banking and credit services to rural farming communities. These banks are the largest providers of formal financial services in rural areas and represent about half of the total banking outlets in Ghana (Mensah and Nurah, 2012). However, the relatively higher ratio of non-performing loans poses a threat to the financial future of the bank. A study found that “the proportion of the loan portfolio that was in default for more than 30 days was 16 percent, compared with 3 percent for banks in their global peer group” (Kloeppinger-Todd and Sharma, 2010).

The discovery of oil in commercial quantities in 2007 (Reuers, 2019), has been correlated with declines in financing for agriculture and the number of people employed in the agricultural sector (Ackah, 2016). Limited access to funding has ripple effects on the adoption of mechanization by farmers and food production capacity in Africa (Daum and Birner, 2019). Experiences from many countries, including from neighboring Nigeria, suggest that the combination of the discovery of natural resources and limited agricultural financing results in poor economic performance in the long term (Sala-i-Martin et. al., 2012; Ackah, 2016).

### 5.3 Challenges of formal CF schemes in Ghana.

Besides the financial challenges, high transaction costs are the other challenge that CF schemes in Ghana face. Opportunistic behaviors exhibited by farmers introduce transaction costs such as contract management, managing and monitoring the farmers, and other personnel of the contract scheme. As discussed earlier, some of the opportunistic behaviors that farmers in CF schemes exhibit include side-selling, falsifying the harvest numbers, introducing dirt and other foreign materials into the maize bags to make up for the required payment, breach of contract agreement such as refusal to adopt the CF scheme’s recommended agricultural practices, misuse of the

inputs provided by the CF scheme, and intentionally refusing to repay the loans. The frequent farm visits by the formal CF schemes to monitor farmers increase the transaction costs.

Contract enforcement and dispute resolution in CF also increases transaction costs. While CF contracts include dispute resolution clauses, in practice, contract enforcement and dispute resolution remain a challenge because of costs and time considerations (Rodríguez, 2015). The key informant at Masara stated that enforcing contracts through the formal legal system presents peculiar difficulties. According to the informant,

*“we cannot institute legal actions against defaulting farmers because we will never get anyone to register with our scheme in the next planting season. Word will go around that we [Masara] are troublesome people” (Key informant, Masara)*

In African communities where social capital is essential (Arhinful, 2003), the contract schemes would instead protect the relationship with the farmers. As a result, the farmers do not have any incentive to abide by the contract terms knowing full well that no legal actions will be taken against them. Also, instituting legal measures against a farmer may not be worth it in the long run, given the time, financial, and human resources investment. Considering that most farmers are poor, even if a judgment is given in favor of the scheme, executing the legal decision might be difficult, if not impossible. The contract schemes would abandon communities with high default rates, as seen in the Masara example. This creates a challenge for farmers that depend on the inputs provided by the formal schemes. According to some of the farmers in the formal contract schemes, the only means of cultivating their land and receiving training services is by participating in the contract schemes. While it is possible to receive inputs through informal contract schemes, the results suggest that farmers have increased production and reduced losses by participating in formal schemes as opposed to informal schemes.

In the opinion of a key informant in the community, the informal schemes are better at enforcing contracts because they employ religion, usually African traditional religion, and dispense local justice to defaulting farmers. The parties to the contract swear an oath to be bound by the terms of the contract and the grave consequences for non-compliance. According to this key informant, the farmers are more intimidated by these consequences than they are of those from the formal legal system, and so have a greater incentive to abide by the contract terms. The farmers in the informal contracts also added that they would not default because of the excellent reputation and social capital that they have in their communities.

Also, the government policies on providing subsidized inputs, particularly seeds and poverty alleviation interventions from development agencies, could have adverse impacts on the formal contract business models. As explained earlier, the government subsidizes the price of imported hybrid seeds as a means of increasing food production. However, this has the potential of stifling the market for local hybrid varieties. According to the key informant at Heritage Seeds Company,

*“last planting season, we had challenges with sales. The government sold seeds to the farmers at a price lower than the prevailing market price, and it was difficult for us to match the government prices if we wanted to make a profit and pay our farmers” (Key informant, Heritage Seeds Company).*

Also, increased attrition rates in formal schemes have been attributed to the interventions of foreign aid agencies, with farmers preferring to obtain free inputs from the agencies instead of getting a loan from the contract scheme (Ragasa, 2018).

#### 5.4 Government Strategies for Reducing Postharvest Losses

In 2009, the Ghanaian government implemented the agricultural output price stabilization policy. It established the National Food Buffer Stock Company (NAFCO), an agency set up to protect smallholder farmers from financial losses by sustaining a minimum market price. It also reduced postharvest losses by purchasing excess rice, maize, soya beans, millet, cowpea, and peanuts from the farmers (Armah et. al., 2019). The company is charged with guaranteeing an assured income to farmers by providing a minimum guaranteed price and ready market, reducing postharvest losses and protecting farmers' income by mopping up, expanding the demand for locally produced food, and managing the government's emergency food security (MoFA, 2019). There are 73 Licensed Buying Agents (LBCs), appointed by the company, travel around farming communities to purchase the grains at a fixed price, determined by representatives of the Ministry of Food and Agriculture, representatives of farmer associations, and NAFCO. The collected grains are stored in a NAFCO storage facility and are intended to be sold to state institutions such as schools, prisons, hospitals, and the military. As of October 2019, NAFCO had collected 52,000 metric tons of rice, millet, groundnut, and cowpea for the free senior high school program (Abdul-Karim, 2019). The officials of the company at the Northern Region office informed the author that they did not have any data on the maize they had collected since the inception of the program. Also, the farmers reported that they had never seen any representative of the LBCs in their communities, a sentiment also expressed by farmers in the Eastern Region (GhanaWeb, 2019). This could be due to the adverse road conditions that make some of the farming communities inaccessible.

One of the successes claimed by the program is the construction of forty 100,000 metric tonnes capacity warehouses under the federal government's "one district, one warehouse" initiative. The

initiative, established in 2017, focuses on reducing post-harvest losses among smallholder farmers during storage by constructing 216 warehouses across the country. However, the farmers complained that accessing the warehouse in their district was difficult because of the long-distance, and sometimes because of the adverse road conditions to the designated district warehouse. In the opinion of these farmers, the policy would be more effective if the warehouses were constructed in each farming community and if they were consulted in the decision-making process. According to a key informant, politicians use the agriculture sector as a political and campaign tool to endear the citizens. According to this informant, the construction of the warehouses is

*“proof to the farmers that the government cares about them and investment for securing votes from their constituents” (Key informant, member of the academic community).*

## 5.5 Implications for Governance, Policy and Future Research

The conclusions of this study have multiple implications for governance, policy-making, and future research. The existence of various criteria responsible for the success of farming requires a coordination point to harmonize efforts and sustain the implementation of measures aimed at resolving the challenges posed by these factors. Specific factors such as harvesting, drying, shelling, transport, and storage were identified in this study as being primarily responsible for losses. These issues require harmonizing technology and market approaches to solve the problem. A governance structure tasked with coordinating both sides of the solution would ensure that maximum benefit is derived cost-effectively. Although, NAFCO contracts with Licensed Buying Agents to mop up excess produce from farmers, this is not implemented widely enough to be deemed successful. Factors that would enhance post-harvest loss prevention include investments in technology to prevent losses in harvesting, drying, shelling, transport, and

storage. This should be supported by extension workers educating farmers on the appropriate use of these technologies, and providing information in the postharvest context to best engage farmers.. It is important to note that the absence of a coordination agency will lead to a fractured system where related postharvest loss control efforts are spread across different arms of government.

This agency would be tasked with reviewing, evaluating, and updating existing policies such as predatory contracts and lending in agriculture. Predatory practices that drive farmers to incur losses are not uncommon, particularly regarding contracts where a provider of goods or services defers payment, in the form of farm produce, until after harvest. In many cases, the value of produce demanded is in multiples of actual services received. These arrangements also create financial pressure on the farmers and limit their abilities to utilize appropriate means in carrying out postharvest processes, which leads to the abandonment of the grains and quantitative losses. This financial pressure also makes farmers susceptible to opportunistic behaviors such as degrading the quality of produce by introducing foreign material such as dirt, to meet the required payment.

Also, there is a need to prioritize the training of extension workers not only on the deployment of existing technologies but also on the need to be responsive to the cultural barriers that contribute to postharvest losses. Closely related to this is the need to include the technical educational institutions in the manufacturing of cheap and locally available materials and machines, including more effective drying technologies that are affordable for the farmers.

## 5.6 Implications for Programmatic Interventions

The high default rates in the first year of the Planting for Food and Jobs (PFJ) program points to the need for having more dialogue on the social factors that drive farmer participation in



development programs, particularly those aimed at addressing post-harvest loss. For example, the perception of loss seemed to vary among different farmer groups. Some consider postharvest loss and its impact as a production issue; specifically, the solution lies in increasing the volume of production. Another group of farmers perceives loss as an inevitable part of the farming process. Practices such as gleaning, abandoning, and delaying harvesting till very late in the season with its accompanying losses are viewed as normal for cultural and practical reasons, and these losses are not considered problematic but rather are seen as inevitable. Therefore, no effort is made to curtail them. Another group of farmers, particularly those whose produce is subject to strict quality control standards, incur losses further downstream at the point of quality control. According to a key informant in the community, grains are rejected by food processors for poor quality such as high moisture content, and by consumers when insects damage the grains. These tend to view losses as driven by whatever factors lead to degradation in quality, be it retained moisture, growth of aflatoxins, or impurity of seeds (for those in seed cultivation programs). Efforts to reduce loss by this group are centered around maintaining the quality of their produce. These groups of farmers, though different in their perceptions of loss, share a standard view- that is loss is anything that has a financial impact.

Another social conversation that is important to have about addressing the post-harvest loss problem is the perception that development aid or assistance is free of charge and without obligation. This perception stands in contrast to government aid programs that expect recipients to either reciprocate, meet specific quality standards, or fulfill certain obligations as part of the program. The risk, as was seen in the PFJ program, is the tendency for recipients to object to these requirements by either defaulting, compromising on quality, or seeking other ways to undercut the program or escape the obligations required of them. There is a variance in

perception wherein the donor that provides inputs and resources expects the recipients to view their programs as cooperative ventures with an anticipated return on investments and benefits accruing to both sides, while the other views these programs as acts of kindness. This difference in perception must be factored into the conceptualization, development, and implementation of interventions aimed at addressing post-harvest loss.

After the first year of the PFJ, there was a restructuring of the program to accommodate for default. Payment for the subsidized input was made upon receipt of the input as opposed to at the end of the harvest season. Issues such as this must be taken into consideration in policy development.

### 5.7 Gender, Cultural Practices, and Postharvest Loss

Gender disparities in land ownership need to be considered in framing policies that have the potential to reduce post-harvest loss. While women supply 80 % of the labor in agriculture, it is estimated that only about 10% of women in the country are farm owners (SEND Foundation of West Africa, 2019). There are three types of land ownership in Ghana. First, there is public land that is acquired by the State for its administrative and development functions and is held in trust by the president on behalf of the citizens. Also, vested land that the government takes over and administers on behalf of indigenous communities. Finally, tribal lands that belong to families, clans, ethnic, or tribal groups. As such, 18% of land in the country is public land, 80% of Ghana's land is held under cultural ownership, and 2% is vested land (Higgins, and Fenrich, 2011). The native laws and norms govern rules around individual land acquisition under tribal ownership. Some of these native norms limit women's ability to acquire land through inheritance. For example, patrilineal succession, as is the norm among some tribes in the Northern Region, excludes women from inheriting property. Some of these customs also prevent

the chiefs from allocating land to women. In instances that allow land allocation to women, they may be given marginal land or over-cultivated land because of the perception that women cannot prepare and till the land (Higgins, and Fenrich, 2011). Often, women can acquire land through marriage. Women are gifted land by their husbands after marriage. However, the woman is only able to own the land as long as she remains married to her husband. In communities with high rates of polygamy, it is common practice for the husband to redistribute the land each time a new wife is joining the family. In addition to working on their farms, women also carry the obligation of working on their husbands' farms (Higgins and Fenrich, 2011). Although women can acquire land through purchase, low-income levels, and inadequate access to credit facilities prevent them from purchasing (Aban et. al., 2016). As such, the decision on agricultural activities is left to the male members of the household or community. They may not necessarily be more experienced, given that they spend less time on the farms.

Also, there are disparities between male and female access to extension services due to gender imbalance in the population of agricultural extension agents (AEA). One factor responsible for this is the low enrollment rates of females in agricultural colleges despite a government policy allocating a 30% quota for women (Adjei, 2019). This makes it challenging to employ females with training in agriculture and extension. For example, it is reported that no female students graduated from agricultural programs at the University of Cape Coast in 2018 (Adjei, 2019).

Also, retention rates remain low for female extension workers due to challenges with the transport infrastructure that could pose a risk to females traveling to remote areas.

Furthermore, some cultural factors could limit women's participation in the agricultural workforce as extension workers. Moore et. al., (2015) indicate that in some communities, women must obtain their husband's permission to work with male farmers, creating tensions within the

family. Reports suggest that women farmers in rural communities are often bypassed by male extension workers (Peasant Farmers Association of Ghana, 2014). This challenge is further compounded by the dual roles that women play as farmers, traders, and primary caregivers for their families. Working to satisfy the competing demands of these roles makes them unavailable to contribute to conversations on farming practices.

It is crucial to address the gender dimension in the creation of interventions on post-harvest loss for farming communities. There is a need to address challenges that make it unattractive for females to serve as extension workers. For example, wage incentives could be offered to women to work with female farmers in rural areas. Attention should be paid to the location and timing of assessments, training, and resource distribution components of implemented programs to ensure that they reach women farmers who comprise the central part of farming labor, especially in specific communities.

These gender disparities in land allocation create an unjust system of wage distribution when farmers participate in contract farming. As discussed earlier, while men own the land and make the day-to-day farm decisions such as participating in contract farming, labor for activities such as weeding, harvesting, and post-harvest work in grain processing is mostly supplied by women and children (Raynolds, 2002; Nyantakyi-Frimpong and Bezner Kerr, 2015; Komatsu, 2018). However, because they are not parties to the contract, women do not receive compensation for their labor. In addition to providing agricultural work on personal farms and those of their husbands, women and girls are also burdened with performing other domestic tasks. According to the FAO, in addition to providing agricultural labor, on average, “65 percent of men spend from 0 to 10 hours per week on domestic activities, 89 percent of women spend 10 hours per week or more” (FAO, 2012). These disparities in the distribution of domestic chores are more

severe in rural Ghana where “63 percent of young rural males spend between 0 and 10 weekly hours on domestic work, whereas 88 percent of young rural females spend 10 hours per week or more on domestic work” (FAO, 2012). In consequence, females are not able to take full advantage of participating in other income-generating activities or in programs to develop their capabilities, such as skills development program, and in many instances, girls are unable to get an education. This results in a gender gap in educational attainment. According to the United Nations Educational, Scientific, and Cultural Organization (UNESCO) (2020), 60 percent of women 15 years and older are illiterate, thereby creating a 20 percent gap in the literacy disadvantage experienced by women in Ghana. None of the female farmers in the study population had formal education. The FAO (2012) further described the disparity between the rural and urban parts of Ghana. In the rural areas, 71 percent of the women are illiterates, and 3 percent of women have access to secondary school education, contributing to a significant gender gap in literacy, which further worsens the social and economic challenges women face.

It is illegal in Ghana to withhold salaries because of the worker’s gender, as provided by Part IX of the national Labour Act (2003). Sections 67 and 68 of the Act provides that:

*“Subject to this Part, every contract of employment shall stipulate that the whole of the salary, wages, and allowances of the worker shall be made payable in [a] legal tender in addition to any non-cash remuneration and accordingly, a contract of employment that contains provisions to the contrary is void. Every worker shall receive equal pay for equal work without distinction of any kind.”*

However, this may not hold in practice. The women interviewed in Dundo indicated that they would like to make decisions and money on their own terms. However, establishing that there is a gender wage gap and enforcing the provisions of this Act may be difficult in the agricultural

sector where employment contracts do not exist, and participation is driven by familial ties. In consequence, protecting women under this law may be impossible.

To improve the role of women in agriculture in Ghana, it is worthwhile to consider interventions to increase their interest in participating in agriculture, improve their ability to take initiative within their own agricultural practice, and adjust the incentive structures that rewards them for their participation and decision making on the farms. In one of the formal contract schemes Heritage Seeds company committed to training women and empowering them to take the initiative on their farms. By working with their farmers' group and rewarding participation through a strong incentive structure, Heritage recorded better performance and productivity from the women farmers. Increasing the economic impact of agriculture is dependent on growing the workers' base. To do this one must create an environment for more women to enter into agriculture and reap benefits comparable to other industries where women are able to enter, get the support they need to get established, participate on their own terms, and have full access to the rewards and benefits that accrue from their participation. In Ghana, the services sector, which makes up about half of Ghana's GDP, is primarily driven by women (O'Neil, 2016). These are mostly through businesses in the informal sector trading in the markets. The potential for growing the GDP in an agriculture-based economy is thus dependent on addressing this gender gap in Agriculture. Estimates suggest that this improvement "could raise crop production by up to 19 percent, boost agricultural and overall GDP, and lift hundreds of thousands of people out of poverty" (Rodgers and Akram-Lodhi, 2019), and lift up to 150 million people out of hunger (FAO, 2011). Therefore, it makes sound economic sense, and it is a good economic policy to create an enabling environment for this to operate.

## 5.8 The implication for the legal system

The weakness of a formal legal system to protect the parties to the contract and to adjudicate contractual challenges limits the opportunities for investment in contract farming schemes. It is crucial to develop a body of laws and policies that is most adaptable for Ghanaian society. To achieve this, input needs to be obtained from farmers, local chiefs, principals of the contract schemes, and members of the Ghanaian bench and bar. The efficacy of these laws would be proven by training law enforcement officers in administering justice particularly in cases where the farmer is considered vulnerable (for example, the elderly and the extremely poor), and where the farmer is loyal to the political structure.

Also, the contract schemes would need to develop a system where farmers can deposit a collateral before obtaining a loan. As of today, all CFs count on is the belief in the existence of a social capital that the farmer considers valuable. This has not always proven to be the case.

## 5.9 The Implication for future research

Future research on post-harvest loss must consider the social factors influencing loss. This would help guide the recommendations. It would also shape the scope of a comprehensive definition of post-harvest loss, which adequately incorporates the farmer's perspective.

There is a need to develop a quantification of social issues for modeling effective policies. It is essential to create empirical standards for integrating social factors and drivers, agents, and leverage points when designing a strategy and assessing its social effects.

Given the opportunities that contract farming presents to increase production, reduce loss, and increase farmers' household income, there is room to improve on the challenges facing farmers and principals of these contract schemes.

## 5.10 Food security, Human security, and Regional Security

As discussed earlier, one of the major causes of postharvest losses is bush fires. Setting bush fires is deeply rooted in the cultural values and the traditional farming systems of Ghana (Yahaya and Amoah, 2013). It is common practice for farmers to set their farmland on fire for bush clearing, for honey extraction, and to make charcoal for cooking. As discussed earlier, bush fires are also caused by hunters to drive out game. In the dry season, this indiscriminate fire spreads faster because of the abundance of the foliage, including standing grain, high wind speed, low humidity, and low rainfall, thereby posing the risk of catastrophic loss of total crop.

Another cause of bushfires is the activities of Fulani (Fulbe) pastoralists. The Fulani people are a nomadic tribe that are spread across Mauritania, Senegal, Guinea, The Gambia, Mali, Nigeria, Sierra Leone, Benin, Burkina Faso, Guinea Bissau, Cameroon, Côte d'Ivoire, Niger, Togo, the Central African Republic, Ghana, Liberia, and in the Eastern parts of Sudan (Bukari and Schareika, 2015).

According to Tonah (2006), Fulani herders began moving into northern Ghana at the beginning of the twentieth century from neighboring Burkina Faso. Over time, they migrated from the other countries listed above. Initially, these migration patterns happened in the dry season during the post-harvest period to feed on crop residues and fertilize the land. In recent times, changes in climate patterns, desertification, droughts, and conflicts are driving herders and their cattle into agricultural areas year-round (McGregor, 2017; Yembilah and Grant, 2014). They have been blamed for totally destroying farmland and all the crops on it by setting fires to clear the land to allow for fresh grass growth for cattle grazing (Kusimi and Appati, 2012). The herdsmen set these fires to protect their cattle from pests and insects such as ticks and tsetse flies and because they believe there is an improvement in the nutritional value of the burnt grass (Nsiah-Gyabaah,



1996). These destructions have been a cause of conflict between the herders and across the West African subregion (Bukari et. al., 2018; Moritz, 2010).

Crop damage increases farmers' vulnerability to postharvest and economic losses and could have an overall impact on human security in the sub-region. It is often reported that these herders, armed with guns, machetes, and clubs, utilize them not only to protect their cattle but also as a tool for pushing back demands of farmers (Yembilah and Grant, 2014). A local news agency reports that between October 2017 and December 2019, there were 173 verified records of Fulani herdsmen destroying farms in Ghana (GhanaWeb, 2020). It is essential to mention that these destructions are not limited to Ghana, but similar attacks have been reported in Nigeria, Burkina Faso, Mali, and Niger (AFP, 2019). Terrorist groups operating in the region such as the Macina Liberation Front (*Front de Libération du Macina*, FLM), the Alliance nationale pour la sauvegarde de l'identité peule et la restauration de la justice (ANSIPRJ), and the Movement for Unity and Jihad in West Africa (MUJWA) have also been accused of recruiting and arming Fulani herdsmen to mobilize support for their terrorist agenda (Fulton and Nickels, 2017; McGregor, 2017).

The Ghana government has attempted to solve the bush-fires problem through the Control and Prevention of Bushfires Act (P.N.D.C.L. 229). The law prohibits the “uncontrolled burning of a farm, forest or grassland” (Control and Prevention of Bushfires Act, 1990). Section 11 of the Act provides the penalty for contravening the law. It states that

*“A person who contravenes or fails to comply with a provision of this Act commits an offence and is liable on conviction to a fine of not less than two hundred and fifty penalty units and not more than one thousand penalty units or to a term of imprisonment or community labour not*

*exceeding twelve months or to both the fine and the imprisonment or community labour and for a subsequent offence to a term of imprisonment or community labour not exceeding two years.*

*(2) Where a person is convicted of an offence under subsection (1) the Court may in addition to the penalty that it may impose, order the offender to make good the value of the property including the crops or trees damaged or destroyed by the fire caused by that person.”*

However, the Law has been described as being inadequate to deter perpetrators. According to an official of the Ghana National Fire Service, the Courts have typically awarded a fine of GHC10.00 (about 1.75 USD) (Frimpong, 2015). Further complicating the problem is the nomadic nature of the herdsman that makes it difficult to apprehend the offenders. Government, however, has a role to play in addressing the causes of this situation and implementing policies and laws geared towards solving the problem of bushfires and the risk it can pose for food security and human safety.

### 5.11 Conclusion

In conclusion, the results of the research suggest that farmers participating in contract farming experience fewer losses than their counterparts that do not participate — thus implying that contract farming as a market strategy offers an opportunity to increasing food production and reducing postharvest losses. However, the farmers and the country are not maximizing the benefits that contract farming presents because of the prevailing socio-economic, regional security, and institutional factors in the farming communities. These factors also contribute to postharvest losses. Therefore, to solve the problem of postharvest losses and maximize the benefits from contract farming, there is a need to gain a clear understanding of the problem based on these factors. Also, solving the problem would require the implementation of a combination of policies that focus on poverty reduction, gender equity, and regional security.

## **CHAPTER 6: CONCLUSION AND RECOMMENDATIONS**

A definition for the problem of postharvest loss was given at the outset of this study. It was observed in the literature review that attempts aimed at increasing food security have simply adopted a siloed approach of focusing on one aspect of the problem and have merely treated the symptoms or created another set of challenges. For example, attempts at increasing food security have focused on increasing fertilizer adoption and increasing access to improved seed varieties to increase food output. The deficiencies in this approach were worsened by the lack of sufficient regulatory oversight and coordination between the different actors, at the appropriate levels of government. Although the issue of postharvest loss has not been neglected, the problem persists partly because it has not been given sufficient attention. This is particularly so at the local levels of governance because of the limited resources.

The institutional theory provides a framework for conceptualizing and explaining contract farming and postharvest losses of maize in Ghana. The institutional theory argues that institutions, including government policies, legal, economic, and political institutions, determine economic performance and are essential for economic growth, (Acemoglu et al. 2002), and inefficient institutions limit economic growth. Inefficient institutions could provide some explanation for the prevailing poverty in Northern Ghana. For instance, in Ghana, cultural norms that prevent women from owning land could limit the successes of interventions aimed at postharvest loss reduction. Information asymmetry between the farmers, the market women, and contract operators contribute to losses. Also, the constraints encountered by the formal contract farming schemes in instituting legal actions against defaulting farmers result in the exit of these formal schemes and the proliferation of the informal schemes. The results from this research

show that farmers that participate in these informal schemes produce less and lose more than other farmers, suggesting that these schemes might not be beneficial for the farmers or their communities.

After collecting and analyzing both quantitative and qualitative data, it is clear from the results that postharvest loss is a symptom, and loss reduction strategies should treat the problem as such. In other words, postharvest losses do not exist in isolation but are a manifestation of the inefficiencies in infrastructure development, governance, lack of market access, cultural norms and traditions, and poverty. These inefficiencies also create interdependencies wherein inefficiencies result in postharvest loss, and postharvest loss results in additional complications. For example, when grains are rejected because of the high moisture or aflatoxin content, farmers still find a way to get the grains into the open market. This causes harm to consumers, which adds a degree of complexity to the issue.

The research has also determined that a perception gap exists between the different stakeholders about the problem of postharvest losses. For example, the conversations and other interactions with the farmers indicated they had a different understanding and perception of postharvest losses than the principals of the contract farming schemes, and a different perspective than those of the government officials. For the farmers, postharvest losses are only perceived in economic terms. In other words, the farmers would only care about postharvest losses when they could attach a monetary value to the grains. In the same vein, as long as the contract farming principals were duly supplied with the needed amounts of grain, losses incurred by the farmers on the field during processing or transportation, were irrelevant to them.

Although this study focused on losses as primarily reported by the farmers, information from the contracting schemes suggests they do not view postharvest losses as a big problem unless it

limits farmers' ability to deliver expected grain quotas to them. The contracting schemes' denial that postharvest losses are a problem (even within their own sections of the value chain), further reinforces the notion that postharvest loss is primarily viewed through an economic lens.

Specifically, losses are only considered important when they impact economic value or profit.

This is the case in spite of the missed opportunities to harness the value of the lost grain and the potential harmful effects of food loss on human health and the environment.

#### *6.1.1 Contract farming and Postharvest Losses*

The results from this thesis suggest that when farmers participate in contract farming schemes, they are more likely to use fertilizers and plant high yield and drought resistance seeds because they have easier access to these inputs. Also, farmers in contract farming schemes are more likely to receive extension services related to the best agricultural practices, which ensures maximum production and minimal losses. For example, farmers participating in contract farming schemes are more likely to store their grains in designated warehouses using hermetic storage bags. However, all these benefits are dependent on the nature of the contract scheme in which a farmer participates. Farmers in informal contract schemes have the lowest productive output among the groups of farmers investigated.

The major research question is as follows. Do farmers who participate in contract farming experience less postharvest losses than do farmers who do not participate? The findings of this research suggest that the number of maize bags attributable to postharvest losses is smaller for a farmer in a formal CF scheme in comparison to a farmer in a non-CF scheme. However, the magnitude of loss differs depending on the nature of the contract scheme in which a farmer participates. For example, farmers in formal contract schemes have fewer losses than do farmers

that do not participate in CF schemes, but farmers in informal schemes have more losses than those that do not participate in CF schemes.

Does our current understanding of the postharvest loss limit our ability to solve the postharvest loss problem? The results also suggest that the issue of postharvest loss significantly transcends the challenges of poor transportation infrastructure and storage. Instead, it also includes other factors that farmers encounter in their daily lives. These other factors must be considered when addressing the definition, perception, and resolution of loss.

## 6.1. Policy Options

There are many policy options and strategies that could be adopted to reduce postharvest losses. These strategies, their merits, and demerits are discussed in this section.

### 6.1.2 *Option 1: Maintain status quo*

This is the do- nothing option. Postharvest loss reduction strategies have huge financial implications such as the costs of training farmers, the costs of constructing infrastructure, and the costs of enforcing contracts. According to the key informants in Heritage Seeds (a formal contracting scheme studied), without the financial support from international aid agencies, the scheme would not be able to provide extension services to their farmers. One option available is to pass the cost to the farmers, who have the option of passing the costs to the consumers, resulting in higher food prices. Or, farmers could absorb the costs, which would result in lower profit margins. Postharvest loss reduction strategies could also include encouraging farmers to abandon cultural norms and traditions that have been practiced over many centuries.

However, it is clear that doing nothing has negative consequences on the environment, it reduces farmers' incomes, and could harm food security in the country.

### *6.1.3 Option 2: Encourage Contract Farming*

Given the many benefits contract farming offers by way of increasing food production and reducing postharvest losses, a recommended policy option is to encourage farmers to participate in contract farming schemes. There are two approaches that can be taken to encourage farmers' participation in contract farming.

Firstly, the government could motivate farmers to participate by offering subsidies and incentives to farmers who are members of a contract farming scheme. For example, the government could provide insurance and risk advisory services to farmers that choose to participate in CF schemes. However, the research found that government interventions in agriculture in the country has been accompanied by a process whereby farmers are rewarded for their loyalty to politicians and political parties. Thus, interventions could promote nepotism and ethnic bias while encouraging inefficiencies in the system.

To deal with these problems, it is recommended that the government establish an independent body that is charged with providing incentives for farmers who participate in CF schemes. It is recommended that the staff working in these bodies are rotated after an election to reduce clientelism.

Secondly, the CF schemes can induce farmers' participation by creating economic incentives, e.g. offering rewards to farmers that participate, deliver expected volumes, and comply with the recommended quality standards. An example is the Heritage Seeds company scheme that offers a premium price to farmers who deliver the recommended quantity and quality of grains. The



premium price is an incentive for the farmers to produce seeds that comply with the scheme's quality standards. It also encourages the farmers to minimize their losses because the more the farmers offer for sale, the more money they make. A challenge with allowing the CF schemes drive participation are cultural practices. These practices preclude women from owning land would prevent women from participating. Also, participation is not guaranteed since people could drop out for reasons such as lack of financial capability, lack of knowledge and skills, cultural practices (e.g., land use, agric taboos) and constraints (e.g., gender roles and disparities in land ownership), and lack of interest (e.g., fear of losing autonomy).

Greater participation and fairer representativeness by cooperative bodies representing the farmers is recommended as an intervention for resolving issues relating to power asymmetries between the parties in CF schemes. It is clear from the results that in the informal contract schemes, the principals had better bargaining power over the farmers. In the Masara scheme, some farmers reported "they did not feel their voices were heard in the contract negotiation process." In contrast, every farmer in the Heritage Seeds scheme reported that they felt they had equal bargaining powers in the contract. Similarly, in comparison with the other schemes, it appears that the Heritage Seeds company has a vested interest in ensuring the success of the scheme in the community.

Also, as societies develop and there is an increase in contract farming participation, there is a need to expand the existing body of laws to accommodate these changes. In developing these laws, it is recommended that the government set up an organization consisting of farmers, contract farming schemes, and tribal chiefs. This will ensure that the voices of all the stakeholders in the agricultural sector are considered in the formulation of the laws.

Today, litigation is the only remedy available for aggrieved parties of a CF scheme. Litigation can be adversarial by nature, where parties are pitted against each other and have a goal of ‘winning an argument.’ However, it is clear from the conversations with the principals of the CF schemes that litigation negatively impacts their ability to attract farmers afterward... It is recommended that other alternative forms of dispute resolution, such as mediation, arbitration, and reconciliation, are considered. The advantage of these dispute resolution methods is that, in comparison to litigation, decisions can be reached faster. Also, these alternative dispute resolution methods do not tend to create a win/lose outcome but seek a win/win outcome.

#### *6.1.4 Option 3: Improve Education Attainment and Access to Education*

The results suggest that farmers with higher levels of education experience fewer losses when compared with other farmers. One of the challenges of education in Northern Ghana is the high attrition rates during the farming season. Key informants reported that many families depend on their children as sources of labor. In consequence, many children drop out of school during the farming season. One recommendation for addressing this challenge is to offer incentives to families that enroll their school-age children and attain a minimum school attendance threshold. An example of a successful education incentive program is the *Oportunidades* program in Mexico, where the government provides financial incentives to families who enroll their children in school. A study found that the program has a positive effect on the enrollment of children, especially after primary school (Attanasio, 2012). To make this attractive in Ghana, the financial incentive needs to exceed the value gained by having the child working on the farm.

Also, the government could create an alternate education track for children so that they can to attend school while they assist their families on the farm. A change in the instruction schedule could be implemented. For example, children could be allowed to participate in school in the

evenings after completing their farm activities. However, for this option to be successful, the government would need to invest in infrastructure, particularly electricity. The government would also need to provide incentives for teachers to work in these remote farming communities. These incentives could include bonuses and accelerated professional development incentives.

#### *6.1.5 Option 4: Close Gender Gaps in Agriculture*

The results of the quantitative study suggest that women make better farmers than do men; women have fewer losses than men and produce more per acre than their male counterparts. This finding was also corroborated by the accounts of key informants in the Heritage Seeds company scheme. However, the full benefit that can be derived from women's participation in agriculture is not being achieved because of the gender barriers that exist in the agricultural sector.

One recommendation for closing these barriers is to expand the Block Farms Program (BFP) to focus on and prioritize women. The BFP was created by former President John Atta Mills in 2009. The program focused on farmers with adjacent land, farmers with land allocated by the Ministry of Food and Agriculture (MoFA), and on seed growers contracted by MoFA. BFP's objectives include generating employment among the rural poor, especially the youth—at least 60,000 farmers; improving incomes among farmers by at least 50 percent; increasing food security through the use of science and technology, leading to increased productivity and higher yields; and improving farming as a business (Johnson et. al, 2013). Farmers participating in the program benefited from subsidized credit in the form of mechanization services provided by the Agricultural Mechanization Service Centres, certified improved seeds, subsidized fertilizer, herbicide and pesticides as well as extension services. The MoFA provided these services. By bundling the delivery of credit inputs and services, it was envisaged that they would be delivered

more timely and at a lower unit cost (Donkoh et. al, 2016). Three years after the commencement of the program, MoFA reported that the program participants enjoyed several benefits “including access to low-cost credit in the form of inputs and mechanization services, which have led to greater farm productivity and high incomes (Donkoh et. al, 2016).”

By expanding the program to prioritize women farmers, the government could bypass the cultural challenges of land ownership by mandating MoFA to allocate land to women who choose to participate. This program would enable women to have access to land and capital, make the day-to-day decisions of their farm, and also guarantee a source of income.

Also, to close the gender skills gap, the government should create demonstration farms that would serve as a venue for teaching women agricultural skills. These farms would grow the staples and train the women in the use of agrochemicals and other good farming practices. The training would result in increased technology adoption and skills transfer. It may be necessary to have female extension workers on hand on these farms.

#### *6.1.6 Option 5: Improve Regional Security*

In the past, the Ghana government addressed the complaints against the Fulani pastoralists by forcefully evicting them from the country, such as the evictions starting in the late 1990s. These attempts have proven to be counterproductive because of the huge costs expended in expelling the herdsmen, and also, sometimes, these pastoralists put up resistance that eventually deepen into communal conflicts (Tonah, 2002). Also, the forced evictions disregard the Economic Community of West African States (ECOWAS) Free Movement of Persons, Residence, and Establishment protocol (ECOWAS, 1979), which Ghana is a signatory. The protocol allows ECOWAS citizens to enter, reside, and establish economic activities in the territory of other member states.

Tackling the issue of bushfires set by Fulani pastoralists would require concerted efforts of regional security agencies. This is because of their nomadic lifestyle. It is recommended that the governments in the West African sub-region set up a security initiative to track the activities and contain the movement of this tribe. One of the ways to do this is to create a mode of identification that is mandatory for all citizens and residents of the sub-region to carry. Some Non-Governmental Organizations (NGOs) have also advocated for the enactment of a Cattle Ranching Law that “will prescribe the mechanisms for breeding animals and other procedures to ensure [the] safety and protection of lives and properties of both parties during the breeding season (News Ghana, 2019). Conversations on the creation of these laws have been ongoing since 2016, but it is not clear why the law has not been enacted. One reason could be the reluctance of the tribal chiefs to grant land to the pastoralists. Pastoralist laws exist in Africa. For example, in 2002, Burkina Faso enacted the Loi d’orientation relative au pastoralisme LORP 2009-034) that creates pastoral areas within communities. However, this law was ineffective because of the government’s reluctance to enforce it and the long periods of political instability caused by military coups in the country. There are other examples of successes with grazing laws. Cameroon’s Decree No 86/755 of 24 June 1986 regulates grazing in the country. Articles 1 and 2 of the Decree permits animals to graze on all grazing land of the Country except in urban areas and by the roadsides, provided the pastoralists vaccinate their animals and pay their taxes. The success of this law has been attributed to Decree No 78/263 that provides for the procedures for settling agro-pastoral disputes (Moritz et. al., 2013).

It is recommended that in addition to a dispute resolution clause, the proposed grazing law should have provisions for the management of the grazing land. For example, because the ranch would be a public good, there should be a clause regarding who takes care of the ranch. A

suggestion would be the creation of a government agency that ensures there is a year-round supply of foliage, which would ensure that ranchers stay on the ranch. The advantage of creating a government entity is that it would provide continuity of the management arrangement.

#### *6.1.7 Option 6: Adopt a Systems Approach to Framing the Postharvest Loss Problem*

Numerous factors contribute to the postharvest loss farmers encounter in their daily life.

Therefore, in proposing solutions that reduce loss, efforts must be made to consider the social and institutional factors that contribute to losses. For example, solutions should consist of expanding the local vocational education curriculum to include courses that encourage students to develop technologies from locally sourced materials that solve community challenges.

Domestic production would guarantee that the machinery produced is designed intentionally for the people, and the peculiarities of the communities are factored in the design process. Also, machinery produced locally can be repaired easily without having to import parts. In the beginning, the machinery might be costly, but as local producers achieve economies of scale, it is expected that the production costs will be reduced.

## **6.2 Policy Recommendations**

Based on the policy options described in the previous sections, reducing losses should focus on these three priority areas. The quantitative and qualitative data suggest that these areas have the greatest impact on postharvest losses. These recommendations are discussed in order of priority that should be followed.

The results from the quantitative study show that participating in a formal contract farming scheme has the most significant effect on postharvest losses. For farmers participating in a formal contract scheme, the odds of PHL reduces by 45 percent in comparison with a farmer that

does not join. Therefore, it is recommended that the government prioritizes the growth of contract farming schemes in the country by providing a conducive environment that encourages contract farming to thrive. For example, in setting prices for subsidized inputs, the government should consult with the contract farming schemes that provide the same services. Thus, it is particularly crucial for contract farming that sells inputs as seen in the Heritage Seeds example, where the government's subsidized prices are negatively affecting the ability of the profitability of the scheme.

Also, the study shows that high transaction costs for formal contract farming organizations hinder some communities from benefitting from the gains that these organizations could potentially offer. For example, in the Masara scheme had to leave the Northern Region due to high default rates, and the inability of the scheme to pursue legal actions against defaulting farmers. To reduce these transaction costs, the government should prioritize the application of the rule of law across the country. By doing this, the justice system would be strengthened, and it would strengthen the force of contracts in the country.

Another way the government can reduce transaction costs is by reducing information asymmetry that exists between the farmers and the market women. According to the farmers in the Upper West Region, they experienced losses when they are oblivious of the prevailing market price of their produce and store at home until they can get a better offer. The government could implement a policy and program that disseminates market information to the farmers. The government could also create incentives that encourage markets to develop closer to the farmers. To do this, the government could set up infrastructure and amenities that would promote migration to and encourage people to these remote areas.

Next, the government should focus on increasing educational attainment. The quantitative data suggest that farmers with the highest educational attainment have the least losses. According to the key informants, these groups of highly educated farmers were more likely to adopt good agricultural practices to reduce losses because of their education. Closely related to this is the need for the government to employ more extension workers. According to the farmers in the two regions, the lack of training services created an information gap on the best agricultural practices. The farmers stated that only farmers participating in the formal CF schemes had access to extension services. According to the representatives of these schemes, the provision of the extension services increases the financial costs of operation. These financial costs are passed on to the farmers. By employing more extension workers and partnering with the contract organizations to provide the service, these costs will be eliminated on the part of the CF scheme and the farmer.

Finally, the government should prioritize the distribution of land to women. The quantitative data suggest that despite that, the average farm size of a male farmer is twice the size of a female, the difference between the average production per acre is marginal. The data also suggests that women are less likely to have losses. According to the key informants, female farmers are more likely to follow instructions on good agricultural production and postharvest handling. However, the potential gains that could be benefitted from encouraging the participation of women are not fully maximized because of the cultural traditions that prevent women from landholding. It is recommended that the government expands its block farms programs to focus on women to allow women to hold land by bypassing the traditional norms. Also, the government should focus on creating demonstration farms that focus on women to provide training for female farmers.



### 6.3 Conclusion

In conclusion, the recommendations above demonstrate that there are many policy options available for postharvest loss reduction and that loss reduction is far from a one size fits all strategy. Stakeholders should evaluate the distinct peculiarities of their communities and adopt the approach or a combination of strategies that work best within the community.

#### 6.3.1 *Future Work*

The results from the quantitative study suggest that farmers participating in the informal contract schemes experienced the lowest levels of productivity and highest levels of postharvest loss. This study could not explain this finding. Future studies should explore the rationale for this observation. Also, the results suggest that marginal increases in the number of people working on the farm led to an increase in postharvest losses. An additional future direction of research is to explain the inverse correlation between the two. Furthermore, understanding the stages along the value chain where additional labor could potentially increase losses will expand the body of knowledge on labor and postharvest losses.

## APPENDIX A: POSTHARVEST LOSS IN AFRICA JOURNAL PUBLICATIONS 1900-2018

*Table 7: Postharvest Loss in Africa Journal Publications 1900-2018*

<b>Authors</b>	<b>Crop</b>	<b>Focus</b>
(Adarkwah, Obeng-Ofori et al. 2017)	Cereals	Etymology; Storage technologies
(Afari-Sefa, Rajendran et al. 2015)	Vegetables	Nutrition
(Affognon, Mutlingi et al. 2015)		Measuring PHL
(Aidoo 1993)	Tropical Crops	Storage Technologies
(Ait-Oubahou 2013)	Cereals	Storage Technologies
(Ambler, de Brauw et al. 2018)	Maize, soya and groundnuts	Measuring PHL
(Asiedu 2003)	Horticulture	Agric Extension
(Bahadur, Haque et al. 2016)		Storage Technologies
(Bancroft, Aboagye-Nuamah et al. 2005)	Tubers (Yam)	Storage Technologies
(Baoua, Amadou et al. 2016)	Rice	Storage Technologies
(Baoua, Amadou et al. 2012)	Cowpea	Storage Technologies
(Baoua, Amadou et al. 2014)	Maize	Storage Technologies
(Baoua, Margam et al. 2012)	Cowpea	Storage Technologies

(Bittner, Balfe et al. 2018)	Cowpea	Storage Technologies
(Bower, Dennison et al. 2003)	Avocados	Storage Technologies; Transport Technologies
(Buchner, Kinnear et al. 2011)	Pear	Storage Technologies
(Cronje 2013)	Citrus	Storage Technologies
(de Beer and Crouch 2013)	Broccoli	Storage Technologies
(Ekanayake and Lyasse 2003)	Cassava	Storage Technologies
(Ekpa, Palacios-Rojas et al. 2018)	Maize	Storage Technologies
(Gitonga, De Groote et al. 2013)	Maize	Storage Technologies
(Gueye, Seck et al. 2012)	Maize	Storage Technologies
(Hodges, Buzby et al. 2011)		Markets, Storage Technologies, Transport Technologies,
(Holst, Meikle et al. 2000)	Maize	Etymology; Storage technologies
(Kadzere, Watkins et al. 2006)	Uapaca kirkiana (Native South African fruit)	Cause of PHL
(Kahangi 2010)	Banana	Improved Seed Technologies
(Kaminski, J., and Christiaensen, L. 2014).	Maize, Cereals	Measuring PHL
(Kamrath, Rajendran et al. 2018)	Tomatoes	Improved Seed Technologies
(Kharel, Mason et al. 2018)	Grains	Storage Technologies

(Kitinoja and AlHassan 2012)	Horticultural crops	Storage Technologies, Transport Technologies,
(Kumar and Kalita 2017)	Cerals	Storage Technologies
(Lusiba, Kibwika et al. 2017)	Rice	Mechanization
(Macheka, Spelt et al. 2017)	Tomatoes	Storage Technologies
(Macheka, Spelt et al. 2018)	Tomatoes	Transport Technologies
(Mampholo, Sivakumar et al. 2016)	Leafy vegetables	Nutrition
(Manu, Osekere et al. 2018)	Maize	Storage Technologies
(Mitcham, Crump et al. 2013)	Horticulture	Markets
(Munhuweyi, Lennox et al. 2017)	Promongranate	Fungicide use
(Munhuweyi, Opara et al. 2016)	Cabbage	Storage Technologies
(Murdock and Baoua 2014)	Cowpea	Storage Technologies
(Mutungi, Affognon et al. 2015)	Cowpea	Storage Technologies
(Mutungi, Affognon et al. 2014)	Cowpea	Storage Technologies
(Mvumi, Matsikira et al. 2016)	Banana	Markets
(Mwangi, Mutungi et al. 2017)	Maize	Storage Technologies
(Ndegwa, De Groote et al. 2016)	Maize	Storage Technologies

(Ng'ang'a, Mutungi et al. 2016)	Maize	Storage Technologies
(Nkolisa, Magwaza et al. 2018)	Tomatoes	Storage Technologies
(Ognakossan, Affognon et al. 2016)	Maize	Storage Technologies
(Ortiz, Ponrajan et al. 2018)	Maize	Milling Technologies
(Osei-Kwarteng, Gweyi-Onyango et al. 2017)	Vegetables	Markets, Transport Technologies
(Paudyal, Opit et al. 2017)	Maize	Storage Technologies
(Precoppe, Chapuis et al. 2017)	Cassava	Drying Technologies
(Rankins, Sathe et al. 2008)	Mangoes	Drying Technologies
(Rocheftort, Theron et al. 2015)	Pear	Fungicide
(Saran, Roy et al. 2012)	Vegetables	Handling Technologies; Packing Technologies; Storage Technologies; Processing Technologies
(Setamou, Schulthess et al. 2000)	Maize	Pesticide
(Setamou, Schulthess et al. 2000)		Literature Review of PHL interventions
(Setamou, Schulthess et al. 2000)	Citrus	Fungicide
(Sibomana, Workneh et al. 2016)	Tomatoes	Literature review
(Siboza, Bower et al. 2011)	Citrus	Storage Technologies

(Sola, Mvumi et al. 2014)		Pesticide
(Sowley, Osei et al. 2013)	Tubers (Yams)	Fungicide
(Ssebagala, Kibwika et al. 2017)	Rice	Literature Review
(Tefera, Demissie et al. 2013)	Maize	Improved Seed Technologies
(Tefera, Mugo et al. 2016)	Maize	Improved Seed Technologies
(Tesfaye and Tirivayi 2018)		Storage Technologies
(Tolesa and Workneh 2017)	Tomatoes	Storage Technologies
(Vayssieres, Korie et al. 2008)	Mangoes	Literature Review
(Veldman, Regnier et al. 2018)	Mangoes	Fungicide
(Venus, Asare-Kyei et al. 2013)	Tomatoes	Transport Technologies
(Williams, Murdock et al. 2017)	Sorghum	Storage Technologies
(Williams, Murdock et al. 2017)	Maize	Storage Technologies
(Xu, Doel et al. 2017)	Groundnuts, Maize, Rice, and Other Grains,	Agric Extension; Storage Technologies

## APPENDIX B: SURVEY QUESTIONNAIRE

1. District of farm location
2. Business name of farm (To be encoded for privacy)
3. Business contact of the farm (To be encoded for privacy)
4. Are you the farm manager?

*Mark only one oval.*

Yes ☐

No ☐

5. Are you able to answer questions about the management of the farm?

*Mark only one oval.*

Yes ☐

No ☐

The following questions are intended for the persons that operate or manage the farm on a day to day basis.

6. Gender of farm owner/operator

*Mark only one oval.*

Male ☐

Female ☐

Equally owned by male and female ☐

Other: ☐

7. Age of farm owner/operator (in years)

*Mark only one oval.*

18-19 ☐

20-30 ☐

31-40 ☐

41-50 ☐

51-60 ☐

61-70 ☐

Over 70 ☐

N/A (no answer)



8. Highest Level of Education Attainment

*Mark only one oval.*

No formal education ☐

Primary School ☐

Junior Secondary School ☐

Senior Secondary School ☐

Polytechnic/University/Teacher Training College ☐

9. Is farming the primary occupation of the farm operator?

*Mark only one oval.*

Yes ☐

No ☐

10. If No, what is the primary occupation?

11. What is the size of your land (in acres)?

12. How long have you managed or owned this farm (years)?

13. In what way was the farm acquired by the current owner?

*Check all that apply.*

Inherited: jointly with sibling(s)/other relatives

Purchased farm ☐

Rent farm ☐

Communal ☐

Gift ☐

Other (explain)

14. What is the current holding of the farm?

*Mark only one oval.*

Rent/Lease ☐

Hire purchase ☐

Communal ☐

Self-owned ☐

15. How many people are employed on the farm (including yourself)?

16. How many full-time employees are employed on the farm?

17. Which of these farm machinery do you currently use on your farm for your maize farming?

*Check all that apply.*

Plough

☐

Ploghing Animals

☐

Planter

☐

Sprayers

☐

Irrigation systems

☐

Harvester

☐

Thresher

☐

Mechanized Dryer

☐

Tractors (including 2-wheel tractors)

☐

Storage systems

☐

Other:

18. How do you get access to the use of the farm machinery listed in the question above? Select all that apply.

*Check all that apply.*

- |                    |                          |
|--------------------|--------------------------|
| Rent               | <input type="checkbox"/> |
| Own                | <input type="checkbox"/> |
| Agric cooperative  | <input type="checkbox"/> |
| Communal Ownership | <input type="checkbox"/> |
| NGO                | <input type="checkbox"/> |
| Free               | <input type="checkbox"/> |
| Contract Farming   | <input type="checkbox"/> |

19. What are the challenges with marketing your maize?

*Check all that apply.*

- |                                              |                          |
|----------------------------------------------|--------------------------|
| Bad quality of maize seeds                   | <input type="checkbox"/> |
| Bad quality of the maize                     | <input type="checkbox"/> |
| Unpredictable weather patterns               | <input type="checkbox"/> |
| Poor infrastructure and transport system     | <input type="checkbox"/> |
| Inadequate knowledge of market price         | <input type="checkbox"/> |
| Downturn in the economic outlook of the city | <input type="checkbox"/> |
| Lack of market access                        | <input type="checkbox"/> |
| Postharvest losses                           | <input type="checkbox"/> |
| Other:                                       |                          |

20. How do you store your harvested maize?

*Check all that apply.*

Baskets

☐

Sacks

☐

Metal Silo

☐

Mud Silo

☐

Hermetic Storage e.g PICS bag

☐

Other:

21. How do you get access to the use of the storage method?

*Check all that apply.*

Rent

☐

Own

☐

Agric cooperative

☐

Communal Ownership

☐

NGO

☐

Free

☐

Contract Farming

☐

Government owned storage facility

☐

Other:

22. How do you dry your harvested maize?

*Check all that apply.*

Solar dryers

☐

Drying stoves

☐

In-field drying

☐

Platform drying

☐

On ground drying

☐

Other:

23. Do you participate in contract farming?

*Mark only one oval.*

Yes

☐

No

☐

24. If No, why?

25. How long have you participated in contract farming (in years)?

26. How many hectares of your farm land is under contract?

27. Why do you not have all your farmland under contract? (Explain)

28. How many bags of maize does your contract allow you to

a) Pay back to the contractor?

b) Sell to the contractor?

29. What is the nature of your contract?

*Mark only one oval.*

Formal (written)

☐

Informal (oral)

☐

Other:

30. What is the name of the contract scheme you belong to?

31. Why do you participate in the contract arrangement?

*Check all that apply.*

To improve sales

☐

To get tractors and equipment

☐

To get irrigation resources

☐

To get better inputs ( e.g. seeds, fertilizers)

☐

To get better personal and family income

☐

To get better storage facilities

☐

To improving packing access

☐

To get extension service

☐

Other:

32. Is the contract farming arrangement more beneficial to you than non-contract farming?

*Mark only one oval.*

Yes

☐

No

☐

Maybe

☐

33. If yes or no, please explain why?

34. What is the

- a) Quantity (in bags) that you sold to the contractor?
- b) Price per bag that you sold to the contractor

35. What is the

- a) Quantity (in bags) that you sold in the open market?
- b) Price per bag that you sold in the open market?



### Loss Questions

- 1 What is the total number of bags you harvested at the last harvest seasob?
2. How many bags of the maize that you harvested did you and your family consume?
3. In your opinion, what is the total number of bags of maize you harvested was lost?

How many bags were eaten by eaten by rodents or insects?	
How many bags were affected by mold?	
How many bags were destroyed during shelling?	
How many bags were destroyed during drying?	
How many bags were not sold or consumed after harvest?	

## REFERENCES

- Abdoulaye, T., Bamire, A. S., Akinola, A. A., & Etwire, P. M. (2017). *Smallholder farmers' perceptions and strategies for adaptation to climate change in Brong Ahafo and Upper West Regions of Ghana Working Paper No. 207 CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)*.
- Ackah, I. (2016). Sacrificing Cereals for Crude: Has oil discovery slowed agriculture growth in Ghana?. Available at SSRN 2745904.
- Adombila, M. (2018). Food Imports Cost US\$ 2.4bn Annually. Available at <https://www.graphic.com.gh/business/business-news/food-imports-cost-us-2-4bn-annually.html> [Accessed December 12, 2019]
- Afful, C. F., Hejkrlik, J., & Doucha, T. (2015). Rural banking in Ghana and its impact on rural farmers. Case study of the Birim South District, Ghana. *Asian Social Science*, 11(25), 101–110. <https://doi.org/10.5539/ass.v11n25p101>
- AFP. (2019, June 25). The Fulani: An AFP Special Investigation. *AFP*. Available at <https://www.afp.com/en/inside-afp/fulani-afp-special-investigation> [Accessed November 21, 2019]
- Agriculture Development Bank. (2020). *Historical Milestones | Agricultural Development Bank*. Available at <https://www.agricbank.com/about-us/historical-milestones/> [Accessed July 23, 2019]
- Ajetunmobi, W. (2018, July 7). Smugglers make huge profit diverting subsidized fertilizers in Ghana - African Liberty. *African Liberty*. Available at <https://www.africanliberty.org/2018/09/07/smugglers-make-huge-profit-diverting-subsidized-fertilizers-in-ghana/> [Accessed August 25, 2019]
- Akimowicz, M., Vyn, R. J., Cummings, H., & Landman, K. (2018). An introduction to mixed methods research in agricultural economics: The example of farm investment in Ontario's Greenbelt, Canada. *Journal of Rural Studies*, 61, 162–174. <https://doi.org/10.1016/j.jrurstud.2018.04.012>
- Al-Hassan, R., & Poulton, C. (2009). *Agriculture and Social Protection in Ghana*. FAC Working Paper No. SP04 January 2009. Available at [https://pdfs.semanticscholar.org/b306/1631b4784d555fce1c52065a55acf98b5be8.pdf?\\_ga=2.82091540.329759581.1581024455-1147583729.1581024455](https://pdfs.semanticscholar.org/b306/1631b4784d555fce1c52065a55acf98b5be8.pdf?_ga=2.82091540.329759581.1581024455-1147583729.1581024455) [Accessed July 21, 2019]
- Alliance for Financial Inclusion. (2018). *Bringing Smart Policies To Life Agricultural Finance Intervention In Ghana Case Study*. Available at [https://www.afif-global.org/sites/default/files/publications/2018-12/Case%20Study\\_Agricultural%20Finance%20Interventions%20in%20Ghana\\_Final.pdf](https://www.afif-global.org/sites/default/files/publications/2018-12/Case%20Study_Agricultural%20Finance%20Interventions%20in%20Ghana_Final.pdf) [Accessed February 20, 2019]

- Angelucci F., (2012). Analysis of incentives and disincentives for maize in Ghana. Technical notes series, MAFAP, FAO, Rome.
- Arhinful, D. K. (2003). *The solidarity of self-interest : social and cultural feasibility of rural health insurance in Ghana*. African Studies Centre, Leiden.
- Armah, E., Kissi, E. A., & Fiankor, D.-D. D. (2019). The impact of the National Food Buffer Stock Company on price transmission in Ghana. In *African Journal of Agricultural and Resource Economics* (Vol. 14).
- Ashaley, R. (2013). *Land Degradation In The Upper East Region Of Ghana, West Africa*. 1–9.
- Attanasio, O. P., Meghir, C., & Santiago, A. (2012). Education Choices in Mexico: Using a Structural Model and a Randomized Experiment to Evaluate PROGRESA. *The Review of Economic Studies*, 79(1), 37–66. <https://doi.org/10.1093/restud/rdr015>
- Awotide, B. A., Fashogbon, A., & Awoyemi, T. T. (2015). *Impact of Agro-Industrial Development Strategies on Smallholder Rice Farmers' Productivity, Income and Poverty: The Case of Contract Farming in Nigeria*. Available at <https://pdfs.semanticscholar.org/ef51/2c161237e325bd26c2f0d0b4c2a9509b4464.pdf> [Accessed February 6, 2020]
- Azumah, S., Donkoh, S., & Ehiakpor, D. (2016). Examining the determinants and effects of Contract Farming on Farm Income in the Northern Region of Ghana. *Ghana Journal of Science, Technology and Development*, 4(1), 1–10. <https://doi.org/10.1093/AJAE>
- Ba, H. A., de Mey, Y., Thoron, S., & Demont, M. (2019). Inclusiveness of contract farming along the vertical coordination continuum: Evidence from the Vietnamese rice sector. *Land Use Policy*, 87. <https://doi.org/10.1016/j.landusepol.2019.104050>
- Baloch U.K. (2010) In: Lewis B, Mejia D (eds) Wheat: postharvest operations. Pakistan Agricultural Research Council, Islamabad, pp 1–21
- Barrett, C. B. (2008). Smallholder market participation: Concepts and evidence from eastern and southern Africa. *Food Policy*, 33(4), 299–317. <https://doi.org/10.1016/J.FOODPOL.2007.10.005>
- Barrett, C. B., Bachke, M. E., Bellemare, M. F., Michelson, H. C., Narayanan, S., & Walker, T. F. (2012). Smallholder Participation in Contract Farming: Comparative Evidence from Five Countries. *World Development*, 40(4), 715–730. <https://doi.org/10.1016/J.WORLDDEV.2011.09.006>
- Barry, P., Sonka, S., & Lajili, K. (1992). All sides should know pitfalls of agricultural contracting. *American Journal of Agricultural Economics*, 74(5), 1219–1225.

- Bates, R. (1989). *Beyond the miracle of the market : the political economy of agrarian development in Kenya*. Cambridge University Press.
- Baumann, P. (2000). *Equity and Efficiency in Contract Farming Schemes: The Experience of Agricultural tree Crops*. London
- BBC. (2019, April 30). Julius Malema - South Africa's radical agenda setter - BBC News. *BBC*. <https://www.bbc.com/news/world-asia-pacific-14718226>
- Beets, W. C. (1990). *Raising and sustaining productivity of smallholder farming systems in the tropics. A handbook of sustainable agricultural development*. Alkmaar (Netherlands) AgBe.
- Bellemare, M. F. (2018). Contract farming: opportunity cost and trade-offs. *Agricultural Economics (United Kingdom)*, 49(3), 279–288. <https://doi.org/10.1111/agec.12415>
- Bellemare, M. F., & Lim, S. (2018). In all shapes and colors: Varieties of contract farming. *Applied Economic Perspectives and Policy*, 40(3), 379–401. <https://doi.org/10.1093/AEPP/PPY019>
- Benin, S. M. (2013). Revisiting Agricultural Input and Farm Support Subsidies in Africa: The Case of Ghana's Mechanization, Fertilizer, Block Farms, and Marketing Programs (November 2013). Available at <https://ssrn.com/abstract=2373185> [Accessed 1 January, 2019]
- Benin, S., Johnson, M., Jimah, K., Taabazuing, J., Tenga, A., Abokyi, E., Nasser, G., & Ahorbo, G. (2011). Evaluation of Four Special Initiatives of the Ministry of Food and Agriculture, Government of Ghana Fertilizer Subsidy Agricultural Mechanization Block Farms and Youth in Agriculture National Buffer Stock Company (NAFCO). Available at <https://gssp.ifpri.info/files/2011/11/MoFA-Program-Evaluation-Report.pdf> [Accessed November 3, 2019]
- Berkes, F., Colding, J., & Folke, C. (2003). *Navigating Social-Ecological Systems Building Resilience for Complexity and Change* (1st ed.). Cambridge University Press.
- Bijman, J. (2008). *Contract farming in developing countries: an overview 1 Working Paper*. <https://library.wur.nl/WebQuery/wurpubs/fulltext/1763>
- Binswanger, H. P., & Rosenzweig, M. R. (1986). Behavioural and Material Determinants of Production Relations in Agriculture. *The Journal of Development Studies*, 22(3), 503–539. <https://doi.org/10.1080/00220388608421994>
- Boadu, F. O. (2016). Contract Farming. In *Agricultural Law and Economics in Sub-Saharan Africa* (pp. 95–113). <https://doi.org/10.1016/B978-0-12-801771-5.00003-4>
- Bryden, W. L. (2007). Mycotoxins in the food chain: human health implications. *Asia Pacific Journal of Clinical Nutrition*, 16 Suppl 1, 95–101.

- Bukari, K. N., & Schareika, N. (2015). Stereotypes, prejudices and exclusion of Fulani pastoralists in Ghana. *Pastoralism*, 5(1), 20. <https://doi.org/10.1186/s13570-015-0043-8>
- Bukari, K. N., Sow, P., & Scheffran, J. (2018). Cooperation and Co-Existence Between Farmers and Herders in the Midst of Violent Farmer-Herder Conflicts in Ghana. In *African Studies Review* (Vol. 61, Issue 2, pp. 78–102). Cambridge University Press. <https://doi.org/10.1017/asr.2017.124>
- Chapoto, A., Onumah, G. E., & Ainembabazi, H. (n.d.). *Getting More for Farmers from Post-Harvest to Market CHAPTER 6 Mulat Demeke Food and Agriculture Organization, Nairobi*. Available at [http://eagc.org/wp-content/uploads/2016/09/2016\\_AASR\\_Chapter\\_6\\_Getting\\_more\\_for\\_Farmers\\_from\\_Post\\_harvest\\_to\\_Market.pdf](http://eagc.org/wp-content/uploads/2016/09/2016_AASR_Chapter_6_Getting_more_for_Farmers_from_Post_harvest_to_Market.pdf) [Accessed February 18, 2019]
- Choudhary, V., Christenson, Garry, & Josserand, Henri. (2015). *Ghana: Agricultural Sector Risk Assessment Risk Prioritization*. Washington D.C.
- Coase, R. H. (1937). The Nature of the Firm. *Economica*, 4(16), 386–405. <https://doi.org/10.1111/j.1468-0335.1937.tb00002.x>
- Cochran, W. G. (1963). *Sampling techniques*. John Wiley & Sons.
- Control And Prevention Of Bushfires Act, 1990, Pub. L. No. P.N.D.C.L.229 (1990).
- Convention C095 - Protection of Wages Convention, 1949 (No. 95), (1949). Available at [https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100\\_ILO\\_CODE:C095](https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_ILO_CODE:C095) [Accessed January 8, 2020]
- Cotula, L., Dyer, N., & Vermeulen, S. (2008). *Fuelling exclusion? The biofuels boom and poor people's access to land*. IIED, London.
- Cowen, M. (1981). The Agrarian Problem: Notes on the Nairobi Discussion. *Review of African Political Economy*, 8(20), 57–73. <https://doi.org/10.1080/03056248108703456>
- Croppenstedt, A., Demeke, M., & Meschi, M. M. (2003). Technology Adoption in the Presence of Constraints: the Case of Fertilizer Demand in Ethiopia. *Review of Development Economics*, 7(1), 58–70. <https://doi.org/10.1111/1467-9361.00175>
- Daddieh, C (1994) Contract Farming in the Shadow of Competitive Markets: He Experience of Kenyan Horticulture, In Little, P. and Watts, M. *Living Under Contract: Contract Farming and Agrarian Transformation in Sub-Saharan Africa*. University of Wisconsin Press. Madison, Wisconsin.
- Daum, T., & Birner, R. (2019). African Agricultural Mechanization: Myths, Realities and an Emerging Research Agenda. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3500690>

- Delgado, C. L. (1999). Sources Of Growth In Smallholder Agriculture Integration Of Smallholders With Processors In Sub-Saharan Africa: The Role Of Vertical And Marketers Of High Value-Added Items. *Agrekon*, 38(sup001), 165–189. <https://doi.org/10.1080/03031853.1999.9524913>
- Delgado, L., Schuster, M. & Torero, M. (2019). Quantity and quality food losses across the value chain: a comparative analysis. Background paper for The State of Food and Agriculture 2019. Moving forward on food loss and waste reduction. Washington, DC, IFPRI. Unpublished.
- Deloitte. (2015). Reducing Post-Harvest Loss Through a Market-Led Approach. Johannesburg
- Dessein, J., & Nevens, F. (2007). 'I'm Sad To Be Glad?'. An Analysis of Farmers' Pride in Flanders. *Sociologia Ruralis*, 47(3), 273–292. <https://doi.org/10.1111/j.1467-9523.2007.00437.x>
- Deutsche Welle. (2018, September 23). Ghana: Women struggle to secure land rights. *Deutsche Welle*. <https://www.dw.com/en/ghana-women-struggle-to-secure-land-rights/a-45608607>
- Diao, X., Cossar, F., Houssou, N., & Kolavalli, S. (2014). Mechanization in Ghana: Emerging demand, and the search for alternative supply models. *Food Policy*, 48, 168–181. <https://doi.org/10.1016/j.foodpol.2014.05.013>
- Donkoh, S. A., Eliasu, A., Gershon, I., & Ansah, K. (2016). *Participation and output effect of a Block Farm Credit Programme in selected districts of Northern Ghana*. <https://doi.org/10.1108/AFR-01-2016-0005>
- Druilhe, Z., & Barreiro-Hurlé, J. (2012). *Fertilizer subsidies in sub-Saharan Africa*. Available at [www.fao.org/economic/esa](http://www.fao.org/economic/esa) [Accessed December 4, 2019]
- Dumenu, W. K., & Obeng, E. A. (2016). *Climate change and rural communities in Ghana: Social vulnerability, impacts, adaptations and policy implications*. <https://doi.org/10.1016/j.envsci.2015.10.010>
- Eaton, C., & Shepherd, A. W. (2001). Contract Farming: Partnerships for Growth. A Guide. *FAO Agricultural Services Bulletin*, 145, 1–161.
- ECOWAS (1979) ECOWAS/979 Protocol A/P.1/5/79 Relating to Free Movement of Persons, Residence, and Establishment. Available from [http://documentation.ecowas.int/download/en/legal\\_documents/protocols/PROTOCOL%20RELATING%20TO%20%20FREE%20MOVEMENT%20OF%20PERSONS.pdf](http://documentation.ecowas.int/download/en/legal_documents/protocols/PROTOCOL%20RELATING%20TO%20%20FREE%20MOVEMENT%20OF%20PERSONS.pdf)
- Emmanuel, D., Owusu-Sekyere, E., Owusu, V., & Jordaan, H. (2016). Impact of agricultural extension service on adoption of chemical fertilizer: Implications for rice productivity and development in Ghana. *NJAS - Wageningen Journal of Life Sciences*, 79, 41–49. <https://doi.org/10.1016/j.njas.2016.10.002>

FAO (2001) Contract farming Partnerships for growth. *FAO Agricultural Services Bulletin 145* ISSN 000-000. Available at <http://www.fao.org/docrep/014/y0937e/y0937e00.pdf>

FAO, IFAD, and UNIDROIT (2017). *Legal aspects of contract farming agreements. Synthesis of the UNIDROIT/FAO/IFAD Legal Guide on Contract Farming*. Rome.

FAO. (2009). *The special challenge for sub-Saharan Africa*. Available at [http://www.fao.org/fileadmin/templates/wsfs/docs/Issues\\_papers/HLEF2050\\_Africa.pdf](http://www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Africa.pdf) [Accessed September 30, 2019]

FAO. (2011). *2010-11 The State of Food And Agriculture Women In Agriculture Closing the gender gap for development*. Rome

FAO. (2012). *Gender Inequalities in Rural Employment in Ghana An Overview*. Rome

FAO. (2013). *Contract farming for inclusive market access*. Rome

FAO. (2018). *Gender Opportunities And Constraints In Land-Related Agricultural Investments Gender Opportunities And Constraints In Land-Related Agricultural Investments Synthesis Report*. FAO.

Fletcher, M. T., & Blaney, B. J. (2016). Mycotoxins. In *Reference Module in Food Science*. Elsevier. <https://doi.org/10.1016/B978-0-08-100596-5.00112-8>

Fosu, M., Karlan, D., Kolavalli, S., & Udry, C. (2018). *Comparing Yields and Profits of Seed Varieties in Northern Ghana*. Innovations for Poverty Action

Friedman, T. (2000). *The Lexus and the Olive Tree*. Farrar, Straus & Giroux. <http://www.thomasfriedman.com/the-lexus-and-the-olive-tree/>

Frimpong, K. (2015, December 11). Ghana's Anti-Bush Fire Law Is Not Deterring Enough To Stop Bush Fires – Anaglatey. *Modernghana*. <https://www.modernghana.com/news/661132/ghanas-anti-bush-fire-law-is-not-deterring-enough.html>

Fuentes, P. A., Bumb, B., & Johnson, M. (2011). Improving fertilizer markets in West Africa: The fertilizer supply chain in Ghana. *Draft for Review, International Fertilizer Development Center and International Food Policy Research Institute, Washington, DC*.

Fulton, K., & Nickels, B. (2017). *Africa's Pastoralists: A New Battleground for Terrorism*. Africa Center for Strategic Studies. <https://africacenter.org/spotlight/africa-pastoralists-battleground-terrorism/>

GhanaWeb. (2019, January 24). GHC400m subsidy for 1 million farmers. *GhanaWeb*. <https://www.ghanaweb.com/GhanaHomePage/business/GHC400m-subsidy-for-1-million-farmers-717844>



- GhanaWeb. (2019, September 5). Tonnes of Maize rot away as no buyers exist. *GhanaWeb*.  
<https://www.ghanaweb.com/GhanaHomePage/business/Tonnes-of-Maize-rot-away-as-no-buyers-exist-778610>
- GhanaWeb. (2020). DOSSIER: Fulani clashes. *GhanaWeb*.  
<https://www.ghanaweb.com/GhanaHomePage/NewsArchive/dossier.php?ID=822>
- Gisolfi, M. (2006). From Crop Lien to Contract Farming: The Roots of Agribusiness in the American South, 1929-1939. *Agricultural History*, 80(2), 167-189.
- Glenn, D. I. (1992). Determining sample size. *A series of the Program Evaluation and Organizational Development*. University of Florida, Publication date: November.
- Global Knowledge Initiative. (2014). *Reducing Global Food Waste and Spoilage A Rockefeller Foundation Initiative*.
- Glover, D. (1990). Contract Farming And Outgrower Schemes In East And Southern Africa. *Journal of Agricultural Economics*, 41(3), 303–315. <https://doi.org/10.1111/j.1477-9552.1990.tb00648.x>
- Glover, D. J. (1984). Contract Farming and Smallholder Outgrower Schemes in Less-developed Countries. In *World Development* (Vol. 12).
- Glover, D., & Kusterer, K. (1990). *Small Farmers, Big Business, Contract Farming and Rural Development* (First). THE MACMILLAN PRESS LTD.
- Government of Ghana. Local Government (Departments of District Assemblies) (Commencement) Instrument, L.I. 1961) (2009). Accra.
- Guyver, P., & MacCarthy, M. (2011). The Ghana grains partnership. *International Journal of Agricultural Sustainability*, 9(1), 35–41. <https://doi.org/10.3763/ijas.2010.0564>
- Haschek, W. M., & Voss, K. A. (2013). Chapter 39 - Mycotoxins. In *Haschek and Rousseaux's Handbook of Toxicologic Pathology* (Third Edit, pp. 1187–1258). Elsevier.  
<https://doi.org/10.1016/B978-0-12-415759-0.00039-X>
- Hengsdijk, H., & de Boer, W. J. (2017). Post-harvest management and post-harvest losses of cereals in Ethiopia. *Food Security*, 9(5), 945–958. <https://doi.org/10.1007/s12571-017-0714-y>
- Hubbard, M. (1997). The ‘New Institutional Economics’ In Agricultural Development: Insights And Challenges. *Journal of Agricultural Economics* , 48(2), 239–249.  
<https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1477-9552.1997.tb01148.x>



- IMPAQ International. (2011). Millennium Development Authority (MiDA)-Ghana Mid-Term Review Consultancy Mid-Term Review Report The Chief Executive Officer Millennium Development Authority (MiDA)
- Jaffee, S (1994) Contract Farming in the Shadow of Competitive Markets: He Experience of Kenyan HOrticulture, In Little, P. and Watts, M. *Living Under Contract: Contract Farming and Agrarian Transformation in Sub-Saharan Africa*. University of Wisconsin Press. Madison, Wisconsin.
- Jayne, T., Kolavalli, S., Debrah, K., Ariga, J., Brunache, P., Kabaghe, C., Nunez-Rodriguez, W., Baah, K. O., Bationo, A., Huisling, E., Lambrecht, I., Diao, X., Yeboah, F., Benin, S., & Andam, K. (2015). *Towards A Sustainable Soil Fertility Strategy In Ghana Report* submitted to the Ministry of Food and Agriculture Government of Ghana.
- Johnson, B., & Christensen, L. (2016). *Educational Research: Quantitative, Qualitative, and Mixed Approaches | SAGE Companion* (6th ed.). Sage Publishing.
- Johnson, R. B., & Onwuegbuzie, A. J. (2007). Toward a Definition of Mixed Methods Research. *Journal of Mixed Methods Research*, 1(2), 112–133. <https://doi.org/10.1177/1558689806298224>
- Kherallah, M., & Kirsten, J. F. (2002). The new institutional economics: Applications for agricultural policy research in developing countries. *Agrekon*, 41(2), 110–133. <https://doi.org/10.1080/03031853.2002.9523589>
- Kidane, W., Maetz, M., & Dardel, P. (2006). Food security and agricultural development in sub-Saharan Africa Building a case for more public support Main report. FAO
- Kikulwe, E. M., Okurut, S., Ajambo, S., Nowakunda, K., Stoian, D., & Naziri, D. (2018). Postharvest Losses and their Determinants: A Challenge to Creating a Sustainable Cooking Banana Value Chain in Uganda. *Sustainability*, 10(7). <https://doi.org/10.3390/su10072381>
- Kimanya, M. E., De Meulenaer, B., Van Camp, J., Baert, K., & Kolsteren, P. (2011). *Strategies to reduce exposure of fumonisins from complementary foods in rural Tanzaniam cn\_337 503..511*. <https://doi.org/10.1111/j.1740-8709.2011.00337.x>
- Kirsten, J., & Sartorius, K. (2002). Linking agribusiness and small-scale farmers in developing countries: Is there a new role for contract farming? *Development Southern Africa*, 19(4), 503–529. <https://doi.org/10.1080/0376835022000019428>
- Kleemann, L. (2016). The relevance of business practices in linking smallholders and large agrobusinesses in sub-sahara africa. *International Food and Agribusiness Management Review*, 19(4), 65–78. <https://doi.org/10.22434/IFAMR2015.0204>
- Kloeppinger-Todd, R., & Sharma, M. (2020). Edited By Innovations In Rural And Agriculture Finance *IFPRI* <https://doi.org/10.2499/0896296687>

- Kohls, R. and Uhl, J. (2002). *Marketing of agricultural products*. Upper Saddle River, NJ: Prentice Hall.
- Komatsu, H., Malapit, H. J. L., & Theis, S. (2018). Does women's time in domestic work and agriculture affect women's and children's dietary diversity? Evidence from Bangladesh, Nepal, Cambodia, Ghana, and Mozambique. *Food Policy*, 79, 256–270. <https://doi.org/10.1016/j.foodpol.2018.07.002>
- Kornher, L. (2018). *Maize markets in Eastern and Southern Africa (ESA) in the context of climate change Background paper for The State of Agricultural Commodity Markets (SOCO) 2018*. Retrieved October 26, 2019, from [www.fao.org/publications](http://www.fao.org/publications)
- Kremelberg, D. (2014). Practical Statistics: A Quick and Easy Guide to IBM® SPSS® Statistics, STATA, and Other Statistical Software. In *Practical Statistics: A Quick and Easy Guide to IBM® SPSS® Statistics, STATA, and Other Statistical Software*. SAGE Publications, Inc. <https://doi.org/10.4135/9781483385655>
- Krueger, R. A., Casey, M. A. . (2009). Planning the Focus Group Study. In *Focus Groups A Practical Guide for Applied Research* (p. 215). <https://doi.org/10.1002/j.1556-6678.2007.tb00462.x>
- Kusimi, J., & Appati, J. (2012). Bushfires in the Krachi District: The socio-economic and environmental implications. *ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XXXIX-B8, 39–44. <https://doi.org/10.5194/isprsarchives-XXXIX-B8-39-2012>
- Kuyu, C. G., Tola, Y. B., & Abdi, G. G. (2019). Study on post-harvest quantitative and qualitative losses of potato tubers from two different road access districts of Jimma zone, South West Ethiopia. *Heliyon*, 5(8), e02272. doi:10.1016/j.heliyon.2019.e02272
- Labor Act, (2003). Available at <http://www.ilo.org/dyn/natlex> [accessed 1 October 2019].
- Lambrecht, I. B., & Ragasa, C. (2018). Do development projects crowd-out private sector activities? Evidence from contract farming participation in Northern Ghana. *Food Policy*, 74, 9–22. <https://doi.org/10.1016/J.FOODPOL.2017.11.001>
- Langford, B. E., Schoenfeld, G., & Izzo, G. (2002). Nominal grouping sessions vs focus groups. *Qualitative Market Research: An International Journal*, 5(1), 58–70. <https://doi.org/10.1108/13522750210414517>
- Lawson, E. T., Alare, R. S., Salifu, A. R. Z., & Thompson-Hall, M. (2019). Dealing with climate change in semi-arid Ghana: understanding intersectional perceptions and adaptation strategies of women farmers. *GeoJournal*. <https://doi.org/10.1007/s10708-019-09974-4>

- Li, J., Rodriguez, D., Zhang, D., & Ma, K. (2015). Crop rotation model for contract farming with constraints on similar profits. *Computers and Electronics in Agriculture*, 119, 12–18. <https://doi.org/10.1016/J.COMPAG.2015.10.002>
- Little, P. D. (1994). *Living Under Contract : Contract Farming And Agrarian Transformation In Sub-Saharan Africa*. Univ. of Wisconsin Press.
- Mabe, F., Danso-Abbeam, G. and Siensso, G. (2019). Does contract farming improve rice yield In Ghana?. *Cogent Food & Agriculture*, 5(1).
- Macauley, H. (2015). *Cereal Crops: Rice, Maize, Millet, Sorghum, Wheat*. Available at [https://www.afdb.org/fileadmin/uploads/afdb/Documents/Events/DakAgri2015/Cereal\\_Crops-\\_Rice\\_\\_Maize\\_\\_Millet\\_\\_Sorghum\\_\\_Wheat.pdf](https://www.afdb.org/fileadmin/uploads/afdb/Documents/Events/DakAgri2015/Cereal_Crops-_Rice__Maize__Millet__Sorghum__Wheat.pdf) [Accessed July 3, 2019]
- Maertens, M., & Vande Velde, K. (2017). Contract-farming in Staple Food Chains: The Case of Rice in Benin. *World Development*, 95, 73–87. <https://doi.org/10.1016/J.WORLDDEV.2017.02.011>
- Mangnus, E., & van Westen, A. C. M. (2018). Roaming through the Maze of Maize in Northern Ghana. A Systems Approach to Explore the Long-Term Effects of a Food Security Intervention. *Sustainability*, 10(10), 3605. <https://doi.org/10.3390/su10103605>
- Marennya, P. P., & Barrett, C. B. (2009). Soil quality and fertilizer use rates among smallholder farmers in western Kenya. *Agricultural Economics*, 40(5), 561–572. <https://doi.org/10.1111/j.1574-0862.2009.00398.x>
- McGregor, A. (2017). The Fulani Crisis: Communal Violence and Radicalization in the Sahel. In *CTC SENTINEL* (Vol. 10, Issue 2). Available at <https://www.bmi.bund.de/SharedDocs/Pressemitteilungen/DE/2017/01/> [Accessed September 8, 2019]
- McMichael, P. (2016). *Development and social change : a global perspective* (6th ed.). Pine Forge Press.
- Mensah, O. J., & Nurah K. (2012). Factors determining access to formal credit in Ghana: A case study of smallholder farmers in the Abura-Asebu Kwamankese district of central region of Ghana. *Journal of Development and Agricultural Economics*, 4(14), 416–423. <https://doi.org/10.5897/JDAE12.099>
- MoFA. (2017). *Agriculture in Ghana: Facts and Figures 2016*.
- MoFA. (2019). *National Food Buffer Stock Company*. MoFA. Available at <http://mofa.gov.gh/site/index.php/sports/sub-vented-organization-soes/national-food-buffer-stock-company> [Accessed August 2, 2019]

- Mogues, T., Omusu-Baah, K., Ga, G. W., Assembly, W. M., Shai-Osudoku, S. O., & Assembly, D. (2014). *Decentralizing Agricultural Public Expenditures Findings from a Scoping Study at the Onset of a New Stage in Ghana's Decentralization Reform*.
- Moritz, M. (2010). Understanding Herder-Farmer Conflicts in West Africa: Outline of a Processual Approach. In *Human Organization* (Vol. 69, Issue 2).
- Moritz, M., Larisa Catherine, B., Drent, A. K., Kari, S., Mouhaman, A., & Scholte, P. (2013). Rangeland governance in an open system: Protecting transhumance corridors in the Far North Province of Cameroon. *Pastoralism: Research, Policy and Practice*, 3(1), 26. <https://doi.org/10.1186/2041-7136-3-26>
- Netting, R. M. (1993). *Smallholders, householders : farm families and the ecology of intensive, sustainable agriculture*. Stanford University Press.
- News Ghana. (2019, February 15). The Ghana Pastoral Policy, the Vehicle to drive Cattle Ranching Law. Available at <https://www.newsghana.com.gh/the-ghana-pastoral-policy-the-vehicle-to-drive-cattle-ranching-law/> [Accessed January 20, 2020]
- North, D. C. (1984). Government and the Cost of Exchange in History. *The Journal of Economic History*, 44(2), 255–264. <https://doi.org/10.1017/S0022050700031855>
- North, D. C. (1990). *Institutions, institutional change, and economic performance*. Cambridge University Press.
- Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic Analysis. *International Journal of Qualitative Methods*, 16(1), 160940691773384. <https://doi.org/10.1177/1609406917733847>
- Nsiah-Gyabaah, K. (1996). *Ghana: Bushfires in Ghana*. Available at [https://gfmc.online/iffn/country/gh/gh\\_1.html](https://gfmc.online/iffn/country/gh/gh_1.html) [Accessed January 20, 2020]
- Nyantakyi-Frimpong, H., & Bezner Kerr, R. (2015). A political ecology of high-input agriculture in northern Ghana. *African Geographical Review*, 34(1), 13–35. <https://doi.org/10.1080/19376812.2014.929971>
- O'Neil, M. (2016, August). In Ghana, Women and “Market Queens” Dominate the Economy. *Vice*, 12. Available at [https://www.vice.com/en\\_us/article/bjggyd/in-ghana-women-and-market-queens-dominate-the-economy](https://www.vice.com/en_us/article/bjggyd/in-ghana-women-and-market-queens-dominate-the-economy) [Accessed August 24 2019]
- Oxford Business Group. (2020). *Subsidies to promote fertiliser use in Ghana have been largely successful | Ghana 2016 | Oxford Business Group*. <https://oxfordbusinessgroup.com/analysis/fertile-results-subsidies-promote-fertiliser-use-have-been-largely-successful-and-may-be-phased-out>

- Oya, C. (2012). Contract Farming in Sub-Saharan Africa: A Survey of Approaches, Debates and Issues. *Journal of Agrarian Change*, 12(1), 1–33. <https://doi.org/10.1111/j.1471-0366.2011.00337.x>
- Paglietti, L., & Sabrie, R. (2012). *Outgrower schemes: advantages of different business models for sustainable crop intensification*.
- Parfitt, J., Barthel, M., & MacNaughton, S. (2010). Food waste within food supply chains: Quantification and potential for change to 2050. In *Philosophical Transactions of the Royal Society B: Biological Sciences* (Vol. 365, Issue 1554, pp. 3065–3081). Royal Society. <https://doi.org/10.1098/rstb.2010.0126>
- Porter, G., & Phillips-Howard, K. (1997). Comparing contracts: An evaluation of contract farming schemes in Africa. *World Development*, 25(2), 227–238. [https://doi.org/10.1016/S0305-750X\(96\)00101-5](https://doi.org/10.1016/S0305-750X(96)00101-5)
- Prowse, M. (2012). Contract farming in developing countries: a review. (A savoir; Vol. 12). Paris: AFD, Agence française de développement.
- Ragasa, C., & Chapoto, A. (2017). Limits to Green Revolution in rice in Africa: The case of Ghana. *Land Use Policy*, 66, 304–321. <https://doi.org/10.1016/j.landusepol.2017.04.052>
- Ragasa, C., Dankyi, A., Acheampong, P., Wiredu, A. N., Chapoto, A., Asamoah, M., & Tripp, R. (2013). *Patterns of Adoption of Improved Maize Technologies in Ghana*.
- Ragasa, C., Lambrecht, I., & Kufoalor, D. S. (2018). Limitations of Contract Farming as a Pro-poor Strategy: The Case of Maize Outgrower Schemes in Upper West Ghana. *World Development*, 102, 30–56. <https://doi.org/10.1016/J.WORLDDEV.2017.09.008>
- Raynolds, L. T. (2002). Wages for wives: Renegotiating gender and production relations in contract farming in the Dominican Republic. *World Development*, 30(5), 783–798. [https://doi.org/10.1016/S0305-750X\(02\)00008-6](https://doi.org/10.1016/S0305-750X(02)00008-6)
- Rehber, E. (2000). Vertical Coordination in the Agro-Food Industry and Contract Farming: A Comparative Study of Turkey and the USA. In *Food Marketing Policy Center*.
- Rehber, E. (2007). *Contract Farming: Theory and Practice* (First). The Icfai University Press.
- Resnick, D. (2018). What Are the Impacts of Devolution on Agricultural Civil Servants and Services in Ghana? In *Strategy Support Program | Policy Note* (Vol. 14). Available at <http://www.ifpri.org/publication/devolution-revolution-implications-agricultural-service-> [Accessed June 30, 2019]
- Reuters. (2019). UPDATE 1-Ghana company says it discovers 1.5 bln barrels of offshore oil. Available at <https://www.reuters.com/article/ghana-oil/update-1-ghana-company-says-it-discovers-1-5-bln-barrels-of-offshore-oil-idUSL8N28L30U> [Accessed January 4, 2020]

- Rockefeller (2019) Awareness: A Key to Reducing Post-Harvest Loss in Africa - The Rockefeller Foundation. Available at <https://www.rockefellerfoundation.org/blog/awareness-key-reducing-post-harvest/> [Accessed June 29, 2019]
- Rodgers, Y., & Akram-Lodhi, H. (2019). The Gender Gap in Agricultural Productivity: Five African Countries. [online] UN Women, UNDP, and UN Environment, pp.1-31. Available at: <https://wedocs.unep.org/bitstream/handle/20.500.11822/28383/CostGenderGap.pdf?sequence=1&isAllowed=y> [Accessed 6 Feb. 2020].
- Roy, E. P. (1963). *Contract farming, U.S.A.* Interstate Printers and Publishers.
- Royer, J. S. (1995). Potential for cooperative involvement in vertical coordination and value-added activities. *Agribusiness*, 11(5), 473–481. [https://doi.org/10.1002/1520-6297\(199509/10\)11:5<473::AID-AGR2720110510>3.0.CO;2-W](https://doi.org/10.1002/1520-6297(199509/10)11:5<473::AID-AGR2720110510>3.0.CO;2-W)
- Sachs, J. D. (2008). The African green revolution. In *Scientific American* (Vol. 298, Issue 5, p. 42). Scientific American Inc. <https://doi.org/10.1038/scientificamerican0508-42>
- Sala-i-Martin, X., & Subramanian, A. (2013). Addressing the Natural Resource Curse: An Illustration from Nigeria. *Journal of African Economies*, 22(4), 570–615. <https://doi.org/10.1093/jae/ejs033>
- Sanderson, S. (1985). The Americas in the new international division of labor. New York, N.Y.: Holmes & Meier.
- Sawicka, B. (2019). Post-harvest Losses of Agricultural Produce. *Handbook of the Historiography of Biology*, pp.1-16.
- Scherr, S., (1999). "Soil degradation: a threat to developing-country food security by 2020? 2020 vision discussion papers 27, International Food Policy Research Institute (IFPRI).
- Sheahan, M., Barrett, C., (2014). Understanding the agricultural input landscape in Sub-Saharan Africa : recent plot, household, and community-level evidence (English). *Policy Research working paper ; no. WPS 7014*. Washington, DC: World Bank Group. Available at <http://documents.worldbank.org/curated/en/165341468002108906/Understanding-the-agricultural-input-landscape-in-Sub-Saharan-Africa-recent-plot-household-and-community-level-evidence> [Accessed September 2, 2019]
- Smalley, R. (2013). *Plantations, Contract Farming and Commercial Farming Areas in Africa: A Comparative Review Land and Agricultural Commercialisation in Africa (LACA) project Working Paper series*. [www.future-agricultures.org](http://www.future-agricultures.org)<http://www.future-agricultures.org/lacaorbeintouchwiththeauthor>



- Snyder, K. A., Miththapala, S., Sommer, R., & Braslow, J. (2017). The Yield Gap: Closing the Gap by Widening the Approach. *Experimental Agriculture*, 53(3), 445–459. <https://doi.org/10.1017/S0014479716000508>
- Stearns, P. N. (2016). *Globalization In World History*. Routledge. <https://doi.org/10.4324/9781315561370>
- Stiglitz, & J.E. (1985). Economics of information and the theory of economic development. *Brazilian Review of Econometrics*, 5(1). <https://ideas.repec.org/a/sbe/breart/v5y1985i1a3129.html>
- Sumberg, J. (2012). Mind the (yield) gap(s). *Food Security*, 4(4), 509–518. <https://doi.org/10.1007/s12571-012-0213-0>
- Sykuta, M. E., & Cook, M. L. (2001). A New Institutional Economics Approach to Contracts and Cooperatives. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.291189>
- Tendall, D. M., Joerin, J., Kopainsky, B., Edwards, P., Shreck, A., Le, Q. B., Kruetli, P., Grant, M., & Six, J. (2015). Food system resilience: Defining the concept. In *Global Food Security* (Vol. 6, pp. 17–23). Elsevier. <https://doi.org/10.1016/j.gfs.2015.08.001>
- Tonah, S. (2002). Fulani Pastoralists, Indigenous Farmers and the Contest for Land in Northern Ghana. *Africa Spectrum*, 37(1), 43–59.
- Tonah, S. (2006). Migration and Farmer-Herder Conflicts in Ghana's Volta Basin. In *Source: Canadian Journal of African Studies / Revue Canadienne des Études Africaines* (Vol. 40, Issue 1).
- Tripp, R and Ragasa, C., (2015). Hybrid maize seed supply in Ghana. GSSP Working Paper 40. Washington, D.C.: *International Food Policy Research Institute (IFPRI)*. <http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/129746>
- Tully, K., Sullivan, C., Weil, R., & Sanchez, P. (2015). The State of soil degradation in sub-Saharan Africa: Baselines, trajectories, and solutions. In *Sustainability (Switzerland)* (Vol. 7, Issue 6, pp. 6523–6552). MDPI AG. <https://doi.org/10.3390/su7066523>
- UNDP in Ghana. (2020). *Increased Resilience to Climate Change in Northern Ghana through the Management of Water Resources and Diversification of Livelihoods*. [online] Available at: [https://www.gh.undp.org/content/ghana/en/home/operations/projects/environment\\_and\\_ene](https://www.gh.undp.org/content/ghana/en/home/operations/projects/environment_and_energy/Adaptation_Fund_Project.html)rgy/Adaptation\_Fund\_Project.html [Accessed 6 Feb. 2020].
- UNESCO. (2020). *Ghana | UNESCO UIS*. Available at <http://uis.unesco.org/en/country/gh> [Accessed December 2, 2019]

- United Nations Conference on Trade and Development. (2009). *World Investment Report | World Investment Report 2009*. <https://worldinvestmentreport.unctad.org/wir2009/>
- USAID. (2017). *Improving the Management of Agriculture Demonstration Sites in Food Security Programs A Practitioner's Guide*.
- USDA. (2018). *Grain and Feed Update*. Available at <https://www.fas.usda.gov/commodities/grain-and-feed> [Accessed January 25, 2020]
- van Gelderen, M., & Jansen, P. (2006). Autonomy as a start-up motive. *Journal of Small Business and Enterprise Development*, 13(1), 23–32. <https://doi.org/10.1108/14626000610645289>
- van Ittersum, M., van Bussel, L., Wolf, J., Grassini, P., van Wart, J., Guilpart, N., Claessens, L., de Groot, H., Wiebe, K., Mason-D'Croz, D., Yang, H., Boogaard, H., van Oort, P., van Loon, M., Saito, K., Adimo, O., Adjei-Nsiah, S., Agali, A., Bala, A., Chikowo, R., Kaizzi, K., Kouressy, M., Makoi, J., Ouattara, K., Tesfaye, K. and Cassman, K. (2016). Can sub-Saharan Africa feed itself?. *Proceedings of the National Academy of Sciences*, 113(52), pp.14964-14969.
- Wienco. (2010). *The Masara N'Arziki Farmers Association* . <http://wienco.com/Site/subsidiaries.html> [Accessed January 18 2020]
- Wisner, B. (1989). *Power and need in Africa*. Trenton, N.J.: Africa World Press.
- World Bank. (2019). *LSMS-Integrated Surveys on Agriculture | surveyunit*. <http://surveys.worldbank.org/lsms/programs/integrated-surveys-agriculture-ISA>
- Wu, F., Groopman, J. D., & Pestka, J. J. (2014). *Public Health Impacts of Foodborne Mycotoxins*. <https://doi.org/10.1146/annurev-food-030713-092431>
- Wu, S. Y. (2014). Adapting contract theory to fit contract farming. *American Journal of Agricultural Economics*, 96(5), 1241–1256. <https://doi.org/Doi 10.1093/Ajae/Aau065>
- Wuepper, D., & Sauer, J. (2015). *Contributing to Contract Farming: Is Farmer Behavior Determined by the Past?* Retrieved December 10, 2018, from [http://www.bioecon-network.org/pages/17th\\_2015/Wuepper.pdf](http://www.bioecon-network.org/pages/17th_2015/Wuepper.pdf)
- Yahaya, A.-K., & Amoah, S. (2013). Bushfires in the Nandom District of the Upper West Region of Ghana : Perpetual Threat to Food Crop Production. *Journal of Environment and Earth Science*, 3, 10–14.
- Yembilah, R., & Grant, M. (2014). The political ecology of territoriality: territorialities in farmer–herder relationships in Northern Ghana. *GeoJournal*, 79(3), 385–400.