UNIVERSITY FOR DEVELOPMENT STUDIES

ANALYSIS OF MARKETING CHANNELS, GROSS MARGIN AND POSTHARVEST LOSSES OF SMALLHOLDER IRRIGATED TOMATO FARMING IN KASSENA-NANKANA MUNICIPALITY

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BY

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DECEMBER, 2019

DECLARATION

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this University or elsewhere.

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We hereby declare that the preparation and presentation of the thesis was supervised in accordance with the guidelines on supervision of thesis laid down by the University for Development Studies.

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ABSTRACT

This study sought to analyse the marketing channels, gross margins, and postharvest losses of smallholder tomato farming in the Kassena Nankana Municipality (KNM) of Upper East Region, Ghana. The study investigates the available marketing channels of irrigated tomato farming and their determining factors, estimate farmers' gross margins, postharvest losses and factors affecting the postharvest losses in KNM. Multistage sampling technique was employed to select 272 respondents comprising 172 farmers from six communities and 100 traders in the Kassena-Nankana Municipality. A semi-structured questionnaire was used to collect data during the 2017 farming season. In analyzing the determinants of choice of marketing channels, multinomial logit model was used, whilst gross margin formula was used for gross margin analysis. Descriptive statistics and Ordinary Least Square (OLS) were used to estimate the postharvest losses and factors affecting postharvest losses respectively. The results revealed that, the average size of irrigated tomato farm land of a smallholder tomato farmer in the KNM was 0.92 acres. Majority of the farmers sold tomatoes to retailers, followed by wholesalers and roadside traders being the least. The multinomial logit revealed that, variables such as improved variety seeds, farm size and access to market information significantly and positively influenced the choice of marketing channel of the producers in the KNM. Conversely, age, education, gender, household size, Farmer Based Organization (FBO), cost of labour and harvesting period negatively affected the choice of marketing channels. The gross margin analysis revealed that, farmers who used improved tomato variety seeds had more yield and revenue than those who used the local variety seeds. The revenue per acre of the smallholder irrigated tomato farmers in the KNM stood at GHS 4,262.01 for the season, whilst the total cost stood at GHS 940.87 per acre of land. Consequently, the smallholder tomato farmer in KNM of the UE/R realised a gross margin of GHS 3,321.14 per acre of land for the season. In spite of this, the smallholder tomato farmer was significantly affected by postharvest losses. The smallholder irrigated tomato farmer incurred an average of 41% (GHS 3,574.68) post-harvest losses per acre and a total of 59% (GHS 5,098.72) for the season. Equally, the postharvest losses were positively affected by the farmers' age, credit received, market information, cost of labour and time of harvest. On the other hand, education, household size, use of mobile phone, gender, and average distance to nearest market were negatively affected by postharvest losses. Finally, the study recommends the strengthening of cooperatives and farmer-based organizations among smallholder farmers, the supply of improved seeds, strengthening market information system and establishing processing and storage facilities or revamping the Northern Star Tomato Company.

DEDICATION

I dedicate this work to the Almighty Allah and the family of Issah Ganiu through whose encouragements and support this research was made possible.

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LIST OF ACRONYMS

ATR	African Traditional Religion
CSIR	Council for Scientific and Industrial Research
COL	Cost of Labor
DFTM	Distance from Farm to Market
EDU	Education of Farmer
EFD	European Food Distribution center
EPA	Economic Partnership Agreement
FAO	Food and Agriculture Organization
FBO	Farmer Based Organization
GEN	Gender of Farmer
GIDA	Ghana Irrigation and Development Authority
GSS	Ghana Statistical Service
ICOUR	Irrigation Company of the Upper East Region
IFPRI	International Food Policy Research Institute
IIA	Independence of Irrelevant Alternatives
ILO	International Labor Organization

KNM	Kassena Nankana Municipality
LGA	Local Government Area
MNL	Multinomial Logit
MoFA	Ministry of Food and Agriculture
NSTC	Northern Star Tomato Company
OLS	Ordinary Least Square
PRO	Public Relation Officer
SAP	Structural Adjustment Program
TC	Total Cost
TR	Total Revenue
TVC	Total Variable Cost
USDA	United State Department of Agriculture
VIF	Variance Inflation Factor
VAR	Variety of crops

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Tomato (Lycopersicon esculentum) is noted to have come from the Solanaceae family, which constituted one of the vital components of vegetable crop worldwide. A study by center of European Food Distribution (EFD) (2016) established that, fresh tomato represents the largest and fastest growing vegetable crop worldwide with a production growth of 49% between 2000 and 2013 for which China is rated the leading producer. The study EFD (2016) further revealed global tomato production to stand at 130 million tons, for which 88 million are sold in the market and 42 million being processed.

According to Goodman (2015), the amount of tomato Ghana produced each year is 510,000 metric tons, whilst 7,000 tons of tomato per month is imported from neighboring countries to supplement local consumption. It is therefore, not surprising that many smallholder farmers are venturing into tomato cultivation across the length and breadth of the country. Following the study by Haruna (2012) citing Oppong-Konadu (2002), it was established that, some famers of the Savannah as well as forest-savannah belt in Ghana regarded cultivation of tomatoes as one of the important farming business. Hence, famers of Upper East Region (UE/R) of Ghana have long been cultivating the crop particularly, between October-April of the dry-season cropping period, as far as the 1960s.

Fresh tomato forms one of the most nutritious and vital components of most household food consumptions in UE/R and Ghana as a whole. It serves as a supplementary source of minerals and vitamins in our diet. Tomato production equally serves as a source of employment and income generation to most smallholder tomato farmers in UE/R who

would have been unemployed especially during the lean season (October-April). These dry season farmers have been empowered by, the construction of irrigational facilities such as Tono Dam and the Vea Dam (Bongo). Also, about 220 dugout dams and wells have been constructed in the region to provide a boost to the smallholder tomato farming in the region. These no doubt has attracted the large number of tomato producers and intermediaries in the tomato sector. To this effect, the study of Robinson & Kolavalli (2010a) pointed out that, over 90,000 farmers in the UE/R are employed in production of tomato whilst 300,000 individuals are in the wholesale and retail tomato sector. The high involvement of people in the tomato sector coupled with the high demand for it across the length and breadth of the country, calls for the need to take into consideration other business and related entities such as the wholesalers and retailers in ensuring that the commodity reaches the door step of the final consumer. In that regard, the market wholesalers (Market Queens) and the retailers play a significant role in the tomato channel of distribution to get the commodity to the final consumer on one hand and dominates the management and control of the marketing system on the other. They achieved this by either influencing the price or quantity of supply of the commodity in order to maximize profits. Interestingly, Amikuzuno, Setsoafia & Seini (2015) asserted that, a considerable portion of the tomato supplied to the Ghanaian markets' is greatly regulated by the Market Queens at all times and emphasized that, during bumper harvest, smallholder tomato farmers have no option than to agree on any price offered them at the farm gate by the middlemen due to the perishable nature of the commodity. Hence, the wholesalers usually exploit farmers by controlling the farm gate price to their advantage, thereby causing considerable postharvest losses to the smallholder tomato farmers. In a related development, Amikuzuno *et al.* (2015)

maintained that, the middlemen equally shared part of these losses in the course of transporting and marketing the commodity from the farms to the market centers.

The postharvest loss has been aggravated by some trade policies undertaken by Ghana governments over the past years. One of such policies is the Trade Liberalization in the Sub Region which promotes free movement of people, goods and services leading to the influx of tomatoes from neighboring Burkina Faso into the country. According to Donkoh *et al.* (2013), the decision of the Ghana government in implementing some economic and trade policies such as Economic Partnership Agreement (EPA) since the 2007 has led to the high importation of tomato from Burkina Faso into the country. Nevertheless, the study maintains that, the UE/R is still the hope for the supply of tomato to many towns and cities in Ghana especially during the dry season. Besides, the Kassena Nankana Municipality (KNM) of the UE/R shares boundary with Burkina Faso, which provides her an opportunity for knowledge and experience sharing. As a result, the study in tomato gross margins and postharvest losses of the smallholder farmer of the Municipality will be of great interest in terms of production, employment as well as poverty reduction.

The emerging empirical justification is that, there exists a positive correlation in tomato production and the poverty reduction (Armah, 2013) because of its potential growth and employment creation. However, Armah's (2013) study noted that, despite the numerous benefits of tomatoes cultivation, some constraints make its production less profitable in Ghana and Africa at large and that postharvest losses are one of such constraints.

1.2 Problem Statement

Tomato production in the UE/R is extensively undertaken in the dry season (October - April). The region has the potential of producing tomato in commercial quantities to meet the increasing demand of the commodity in Ghana. Meanwhile, the perishable nature of tomato poses severe challenges during and after harvesting. This requires the provision of storage facilities, provision of improved varieties and a price mechanism that will safeguard the marginal benefits of the smallholder farmer as well as actors in the marketing value chain of the region, hence, saving them from low gross margins and postharvest losses. Through this means, the tomato farmers will be motivated to improve production in both quantity and quality to meet the increasing market demand. It is equally worth mentioning that, actors along the tomato value chain play important but separate roles in adding some value to the commodity (tomato) before passing it on to the final consumers. As a result, the market share of the actors in the tomato value chain differs right from input supply stage, through the producers, intermediaries and the final consumers.

In the UE/R, for example, the price of tomato is inversely related to the supply, due to this, during bumper harvest the so-called Market Queens try to exploit the marketing system to their advantage by offering lower prices to the farmers (Amikuzuno *et al.*, 2015). The fact that the commodity is perishable, tomato farmers have little or no option than to sell even at the lowest price. In addition, the survey report by Adimabuno (2010), points to the Market Queens as the actors exploiting the tomato-marketing sector in the country. This contributes to the higher postharvest losses among the smallholder tomato farmers in the UE/R. Correspondingly, the effect of postharvest challenges with perishable agricultural products like tomato to the famers and traders in the region cannot be swept under the carpet as far as this study is concerned. A study

by Workneh, Tilahun, Osthoff & Steyn (2011) in Ethiopians' tomato industry on postharvest losses, revealed a postharvest loss of 30% of the national output of tomato and then postulated the losses to be associated to poor packaging, lack of storage facilities and poor transportation systems. Interestingly, the study by Addo, Ose, Mochiah, Onsu, Cho, & Ki (2015) across the major tomato producing centers in Ghana realized some appreciable losses in most units of operations with severity because of poor handling operation level. The losses ranged from 40% - 66.67% for UE/R, 27.27% - 66.67% for Brong Ahafo and 5.88% - 37.50% for Ashanti Regions.

The socioeconomic importance of tomato production and marketing coupled with the increasing demand and the existence of Tono Irrigation Scheme, which has an artificial lake with a surface area of 1,860 Hectares and water storage capacity of 93 m^3 provides an opportunity to guaranteeing food security and alleviating poverty in the Municipality. This has attracted the researchers' attention to explore the gross margins of the smallholder tomato farmer in the KNM. Besides, the perishable nature of tomato, poor marketing system and higher competition from neighboring Burkina-Faso tomato producers have equally left the question of postharvest losses and effects on smallholder tomato farmers of KNM of the UE/R unanswered. The involvement of tomato intermediaries at both domestic and foreign levels will have gender sensitivity effects on the tomato smallholder farmer in the value chain, which is critical and needs to be studied. However, according to my search, most of the studies carried out so far on the productions of tomato are general and did not address the specific needs of the smallholder farmer at each tomato production zones. Therefore, this research sought to; empirically analyze the marketing channels, gross margin and postharvest losses of smallholder irrigated tomato farming in the UE/R, taking Kassena Nankana Municipality as a case study.

1.3 Research Questions

This research attempted to find answers to the following questions:

1. What are the available marketing channels of irrigated tomato farming and their determining factors in the tomato value chain of the KNM?
2. What are the gross margins of tomato production under irrigation in the tomato value chain?
3. What is the extent of postharvest losses and the factors affecting the postharvest losses among smallholder irrigated farming in the tomato value chain?

1.3.1 Main Objective

The main objective of this study is to analyze the marketing channels gross margins and postharvest losses of the smallholder irrigated tomato farmers in KNM of UE/R of Ghana.

1.3.2 Specific Objectives

1. To investigate the available marketing channels of irrigated tomato farming and their determining factors in the tomato value chain in of the KNM ;
2. To estimate gross margins of tomato production under irrigation in the tomato value chain;
3. To estimate the extent of postharvest losses and factors affecting the postharvest losses among smallholder irrigated farming in the tomato value chain.

1.4 Justification

Smallholder irrigated tomato farming has a greater contribution to household employment. The KNM and for that matter the UE/R of Ghana has higher economic potentials in terms of climatic conditions, well developed irrigation scheme, labor force

and access to exchange of knowledge and experience from tomato farmers in Burkina Faso needed to improve the tomato production (MoFA, 2016). In Ghana, per capita consumption of tomato is 675,399 kg (MoFA, 2016). With these, one would have expected output and income levels to be high, leading to the reduction in poverty to the barest minimum if not completely eradicated. Yet poverty levels in the area are still relatively high (Dinye, 2013). Against this background, the research focuses on gross margins and postharvest losses of the Smallholder Tomato Farmer (STF) in terms of the production, harvesting, marketing and losses along the chain. This will help stakeholders to redesign programs for the tomato sector. The research will further aid actors and investors in the value chain to understand the current relationships of the actors and the channel choice of distribution of the fresh tomato in the value chain. This will also support actors/investors to device alternative means of reaching out to their customer base, if the margins of price and profits are found significant with the choice of customers.

The study would equally bring to bear the magnitude of profits/losses and the factors responsible for the postharvest losses in the production and marketing process of the tomato subsector. This would be useful to stakeholders and/or other policy makers in redesigning and implementing policies that can contribute to increasing tomato production as well as profits margins of tomato farmers in the Municipality. With this, more youth would be encouraged to go into tomato production, which will eventually contribute to improving employment and reducing poverty in the long run. Policy intervention emerging from this study could help promote tomato production in the KNM, which will have a positive significant impact not only on the people of the Municipality but the nation at large.

1.5 Organization of the Study

This study contains five chapters, chapter one, which is the introductory part consists of; background of the study, research problem, research questions, research objectives, justification and organization of the research. Chapter two discusses the review of the literature. Chapter three, however, details the methodology employed for the study. It does describe the collections of data, description of the study area, and analytical tools employed to achieve the stated objectives. Presentation and analysis of data are covered in Chapter four. Chapter five covers summary, conclusion and relevant recommendations for policy makers and well-wishers.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This part of the study has to do with review of the study both empirical and theoretical which has been conducted and reported at both local and international levels and are related to the study. It therefore focuses on smallholder tomato farming and postharvest losses along the value chain.

2.2 Over view of Tomato Production in Ghana

According to MoFA (2012) report, tomato is considered as a vegetable crop even though botanists recognized it as a fruit. Nutritionally, it is grouped under the vegetable class. Following Srinivasan (2010), tomato, *Solanum lycopersycum* is a vegetable crop cultivated by many people for its succulent fruit with fresh tomato cultivation doing well in the tropical, sub-tropical and temperate climatic regions than any other climatic regions worldwide. This is because, tomato naturally needs reasonable warmth and sunshine for its vegetative and reproductive growth of lower temperature at about 12^{0c}. The study by Adu-Dapaah & Oppong-Konadu (2002) cited by Haruna (2012) revealed that, tomato cultivation in Ghana forms an important farming activity for people living in the savannah and forest savannah belts of the country, and that it has long been one of the lucrative crops in the UE/R. Hence, farmers who would have been unemployed especially during the dry season (October-April), as they cultivate it in order to generate income for their households needs. Fresh tomato in the UE/R had been on small-scale household production basis before the 1960's. However, by early 1963, fresh tomato farming in the region had witnessed the exodus of subsistence production to commercial production. This stemmed from the ambitions of the first President of

Ghana, Dr. Kwame Nkrumah putting up an industrialization policy that aimed at processing agricultural raw materials into finished product for both local consumption and for export. Subsequently, tomato cannery called Pwalugu Tomato Company Limited which is now called Northern Star Tomato Company (NSTC) was established for processing tomato paste at Pwalugu in the UE/R in 1968. This partly enhanced the value chain ranging from production, marketing and processing.

Soon after the 1980s, Ghana adopted trade policies such as Economic Partnership Agreement (EPA) which brought about lots of devastating consequence to the tomato sector (Donkoh *et al.,* 2012). The consequences range from low demand for locally produced tomato, the loss of jobs leading to low production, to the collapse of tomato factories in Ghana as a result of heavy importation of cheap fresh tomato from neighboring Burkina Faso and cheaper tomato paste from Europe and China. Therefore, what farmers of KNM may do is to take the advantage of their proximity to Burkina Faso and adapt the technology and experience of the Burkinabe farmers to enhance competiveness of their production and marketing in the country.

According to MoFA (2011) Ghana's total land of tomato cultivation is estimated to be 50,000 hectares. Notwithstanding this, the annual achievable yield of tomato production in the country stands at 15 tons per hectare, which represent only 48% of what would have achieved (MoFA, 2011). The quantity of tomato production in Ghana has been erratic since the 1980s as a result of the EPA policy by the International Monetary Fund (IMF) and the World Bank. Hence, lessons from this EPA have triggered Ghana's government to put attention on the nontraditional exporting crops such as tomato to increase its production in the country. For instance, tomato production in Ghana fell from 100,000 tons to 50,000 tons per annum and the period of 1990 to

2000, but realized an increase in annual production from 50,000 tons per annum to about 200,000 tons, 250, 000 tons and 340,218 tons in 2009 and 2013 respectively (FAOStat, 2015).

Following a study by Donkoh *et al.* (2012) on the technical efficiency of tomato farmers in the UE/R of Ghana, it revealed that farmers were technically efficient and concluded that, the tomato sector in the UE/R is still viable. It is however important to state that, technical efficiency does not necessarily mean higher profits, but the ability of firms or producer to achieve a maximum output using a given amount of inputs. Further studies by Adimabuno (2010), observed that most farmers in the UE/R cultivates tomato on a small scale for the supplement of households' diet and for sale. The tomato industry remains one of the important sectors of livelihood of the people of KNM and many other communities in the Upper East Region. The IMF and the World Bank to promote trade among developing and western nations introduced the SAP on developing countries (Donkoh *et al.*, 2012). The SAP placed emphasis on the cultivation of cash crop such as cocoa to the disadvantage of non-exporting crops. What is worse, is the scrabbling of subsidy and trade restriction on agricultural products resulting in the flooding of cheap tomato into the Ghanaian markets leading to a fall in local tomato production and the collapse of the local industries (Robison & Kolavalli 2012; Amikuzuno & Donkoh 2012). For instance, between 1998 to 2004, tomato production fell drastically from 57% to 92% (Asare-Bediako *et al.*, 2007) meanwhile, the imports of processed tomato from EU increased from 3,713 tons to 27,015 tons estimated to about 628% (Donkoh *et al.*, 2012). The deep cut in subsidy, further resulted into higher cost of agro-chemicals thereby increasing the average cost of production of smallholder tomato farmers. These phenomena provided a disincentive to the local tomato farmers hence, the fall in output.

Government role in enhancing the access to agricultural production inputs is imperative and this can be done by revising the policy framework that governs the agricultural inputs market, to help ameliorate the problem of low usage of farm inputs in the country and reintroduced subsidy on some agro inputs like fertilizer and other chemicals for crop production.

2.3 Tomato Marketing in Ghana

Most vegetables such as tomato by nature are perishable, hence regular market for it is imperative. The major market centers in Ghana are Navrongo (UE/R), Tamale (N/R), Techiman (Brong-Ahafo Region), Kumasi (Ashanti Region) and Accra (Greater Accra Regions). However, the seasonal nature of tomato production has influenced the direction and flow of tomato in the country. According to Amikuzuno (2012), as cited in Fredrick, (2015), the production of tomato in the UE/R and Burkina Faso reaches its peak between January to March. In contrast, between May to November, the production of tomato in Brong-Ahafo, Ashanti Region and Greater Accra Regions is at its peak. Due to this, the direction of flow of tomato between December-March is from the north to south, whilst between May-November direction of flow is from the south to north of the country. For instance, the UE/R and for that matter KNM tomato which is mostly produced during the dry season (December to March) supplies the major markets with her products. Whilst the Brong Ahafo and Ashanti Regions supply the commodity throughout the various markets in the country during wet season (May to November).

2.4 Marketing channels of tomato in Ghana

Fresh tomato marketing channel describes the available channels of distribution of tomatoes from the farmer through the intermediaries to the final consumer. The marketing system in the Upper East Region has been dominated by the Market Queens

(wholesalers) from southern Ghana ever since the collapse of the Pwalugu Tomato Company (Frederick, 2015). However, there exist other channels such as; the retailers and roadside traders who equally perform a significant role in the channel choice of distribution of tomato in the region. With these multiple marketing channels, the choice of the tomato farmer in selling his/her tomato depend largely on the availability and proximity of the particular market, since tomato is perishable as cited by (Robinson & Kolavalli, 2010b). Due to this, some traders even formed links with some farmers for the purchase of the commodity. The links of the traders are deep-rooted so much, that it eventually evolved into what is termed as, the cartel system and the two-stage marketing system (Robinson & Kolavalli, 2010b). The system implies that, a trader accepts the cost and risk of locating farmers at the farms during and after harvesting as well as transporting the commodity to sell to the final consumer at the market centers. However, the risk is closely link to price and profits. Hence, wholesalers transfer the cost of this risks of transportation on to retailers who in turn transfer it to the final consumer. A research conducted by Lyon (2011) in the Kumasi tomato market noted that wholesalers have formed associations among themselves, retailers and with the farmers to protect their interest and integrity by holding members responsible for any misconduct. According to Amikuzuno *et al.* (2015), the Market Queens have monopolized the tomato market by determining the price and the quantity of tomato that should be brought to the market. Yet, Robinson & Kolavalli (2010a) asserted that the wholesalers imposed barriers to entry in other to prevent gluts and their investments in the market which is similar to the other major market centers such as Navrongo, Tamale, Techiman and Accra. Interestingly, some farmers also form serious links with the other actors (such as, retailers) to sell their produce in order to prevent losses. As a result, some retailers bypassed the wholesalers to purchase the commodity direct from

farmers at the farm gate due to their proximity. The interplay of the tomato retailers and farmers in the distribution system is quite significant in the UE/R that, some retailers buy and even sell to other retailers (roadside traders) for onward retailing. Following Frederick (2015) citing Haruna, Nkegbe & Ustarz (2012); Robinson & Kolavalli (2010b), there exist various channels in the marketing of tomatoes in Ghana, namely:

Farmer ⟶ Regional Traders

Farmer ⟶ Processors

Farmer ⟶ Local Market ⟶ Consumer

Farmer ⟶ Market Queens (Wholesalers) ⟶ Retailers ⟶ Consumers

Robinson & Kolavalli (2010b) emphasized that the retailers and wholesalers function as an important bridge between the tomato farmers and the final consumers especially in urban areas, hence, reducing the marketing chain of the tomato industry into a simpler one and thereby reducing time in providing fresh tomato to consumers.

2.5 Tomato Consumptions in Ghana

There are a wide range of tomato consumption in Ghana. These are fresh tomato, imported canned tomato and dry tomato. According to Amikuzuno *et al.* (2015), established that most households in Ghana preferred consuming fresh tomato than canned or dried. Fresh tomato consumption in Ghana is in two-sided demand system, categorized as either individual household consumption or public/restaurant level consumption (Adimabuno, 2010). A case in point is that, whilst average/high income household consumer may be concerned with the health implication of consuming the commodity, order low-income consumers/ 'poor people' may be concerned with low-

priced tomato. Similarly, restaurant operators may be concerned with low-priced products in order to make profits.

Tomato consumptions in most Ghanaians homes are a daily routine. As a result, most of the fresh tomato produced in Ghana is consumed locally. Agyekum (2015) noted that, closed to 90% of the fresh tomato produced in Ghana are domestically consumed. Agyekum's (2015) study further maintained that, Ghana is still on deficits in terms of the production and supply of tomatoes, and as a result depends largely on imports from Burkina Faso for fresh tomato to the tune of 70, 000 to 80, 000 tons annually.

The Statistical Service Department of the Ministry of Food and Agriculture (2013) observed that, Ghana spent about 1.4 million Ghana Cedis in importing tomatoes to argument the local supply of the product in the country. The importance of tomatoes in the Ghanaian households' is irreplaceable and unavoidable, hence, the constant increase in demand for the product leaves Ghana with no option than either revamping her tomato industry or rely on imports to meet the demand for the product.

2.6 The Concept of Value Chain and its Analysis

The concept of "Value Chain" was made popular by Professor Michael E. Porter of Harvard University in 1985. According to Porter (1985), "the concept of the value chain is based on the process view of organizations, the idea of seeing a manufacturing (or service) organization as a system, made up of subsystems each with inputs, transformation processes and output. Inputs, transformation processes, and outputs involve the acquisition and consumption of resources such as; money, labour, materials, equipment, buildings, land, administration and management". Ugonna *et al.* (2015), describe value chain as the chain that links various stages a product goes through, from its production, handling, processing and distribution to the consumer. FAO (2011)

report on value chain activities noted that farmers' are linked to the needs of consumers, closely working with suppliers and processors to produce particular products to meet the demand of consumers, and also emphasized that even though information flows and products are important, farmers are linked to the consumers' needs. According to Reddy (2013), the value chain is the value addition at different stages of transfer. Stakeholders at different stages of the value chain add some value in order to increase the value of the end product. This implies that, at every level, value chain considers right from raw materials to the end-user and down to disposing of the packaging after use. The aim is to provide efficient value to the final consumer at a minimal cost.

Mebrat (2014) noted that, the value chain concept is an alliance or strategic network between independent enterprises, within a (vertical) chain of activities that compete on a specific market (defined by consumers and retail outlets) and to satisfy market demands. In more practical terms, an agricultural value chain covers all activities from input supply, production, processing, wholesale and retail to the final consumers. The activities of actors in the value chain will be competitive depending on the size of the population (the market share) or market demand among other factors. Hence, the serene and stable political stability in Ghana, coupled with the trade liberalization among West African countries has further promoted free movement of people, goods and services among member countries.

2.6.1 Tomato Value Chain Activities

The smallholder tomato farmer functions as a producer that constitutes one of the actors in the value chain. Therefore, to obtain a holistic view and understanding of the marketing margins and postharvest losses associated with the smallholder tomato farmer, the stages of the tomato value chain need to be looked at holistically. Yet, the

tomato value chain activities begin from the supply of input, through the farming (production), processing and marketing (distribution) and to the consumption.

2.6.2 Value Chain and Supply Chain Approach

There is a temptation to use "value chain" and "supply chain" interchangeably, but there is some difference in the two concepts which is significant. The supply chain model first mentioned, considers the activities that get raw materials into a manufacturing operation smoothly and economically. The value-chain notion has a different focus and a larger scope. A supply chain simply has to do with a transfer of a goods from one stakeholder to another in a chained manner. The value chain on the other hand refer to the value added at different stages of transfer. In the different stages of value chain, different stakeholders add value to the product to increase the end product value. In other words, a value-chain analysis looks at every step from raw materials to the eventual end user and down to disposing after use. The goal is to deliver maximum value to the end user for the least possible total cost. This makes supply-chain management a subset of the value-chain analysis (Reddy, 2013).

Ugonna *et al.* (2015) maintained that, the Value chain approach to agriculture focuses on improved quality of agricultural products, increased agriculture systems efficiencies or development of differentiated agricultural products, for achievement of a more rewarding position in the market place (competitive advantage) through the collaborative efforts of industry partners. This approach emphasizes on value addition and agriculture innovation driven by the needs and demands of end users and consumers.

2.7 Time, Agro ecological Zones and Volume of Tomato Production in Ghana

The type of ecosystems and climatic zones influences the period of tomato production and its distributions in Ghana. Tomato production and supply in Ghana are seasonal and characterized by low production but higher demand. The main sources of tomato production are; the irrigated (off season) which is practiced in savannah zone and the rain fed (raining season) mostly practiced in the southern parts of the country. The major climatic zones are the savannah climatic zone, tropical rainforest, and coastal savannah. The tomato supplied to the country during dry-season (November-April) is produced in guinea savannah zone in the northern part of the country especially the UE/R and neighboring Burkina Faso. On the other hand, the tropical rainforest and coastal zone supply most of the tomato requirement of the country between April/May-September/October. Frederick (2015) citing FAO (2005) asserted that, the tropical rainforest zone comprising of the rainforest deciduous, semi deciduous and the coastal ecological zones have bimodal rainfall pattern (major and minor seasons) which occurs between March and July annually (major season) as well as September and November (minor season). As such, the cultivation of tomato under Rain fed is mostly practiced during these periods. In contrast, the Guinea and Sudan Savannah Zones experience a single rainfall pattern, which starts from May and ends in September.

Available data shows that, the trend of Ghana's fresh tomato production has not been regular from 2000 to 2006, but has witnessed a constant increase in production from 1762, 264 tons in 2006 to 340, 218 in 2013 tons (MoFA, 2015; FAO, 2015a). The trend of Ghana's tomato production from the year 2000 to 2013 is illustrated in the following graph, figure 2.1. Where, the vertical axis represents year, and the horizontal axis indicates Tomato Production (Tons).

Figure 2.1: Trend of Ghana's Tomato Production from 2000 to 2013

Source: (MoFA, 2015).

2.8 Irrigation System in Ghana

Irrigation can be described as the artificial means of providing the needed water requirement for a crop. According to Namara, Horowitz & Barry (2011) Ghana's irrigation systems are categorized as either public or private depending on the type of management practice and ownership. Namara *et al.* (2011) noted that, all the public irrigation systems in Ghana are under the management of Irrigation Company of Upper East Region (ICOUR) and Ghana Irrigation Development Agency (GIDA) hence, farmers pay a fixed levy for a piece of land for the water usage. According to GIDA as cited by IFPRI (2011), there are twenty-two irrigational schemes developed by government of Ghana, which are under the management of GIDA. In contrast, the private irrigation schemes are borne out of individual farmer's own initiatives, as such, the management and control are solely in the hands of private individuals or

entrepreneurs. Classic examples of the private irrigation systems are, tube wells and small motto-base. Namara *et al.* (2011) further stressed that, most farmers prefer the usage of private irrigation system to the public irrigation in terms of irrigated land area, yields and value of production. Interestingly, the actual cost of irrigation incurred by Ghanaian farmer using public irrigation system is far lower than that of the private system due to government subsidy (Frederick, 2015). The supply of water is distributed via the used of pumps, gravity or both to farmlands depending on the topography and source of water of the irrigated lands. Schemes that employ the use of pumps for lifting water to the fields turn to be costlier relative to schemes without pumps, which emanate from regular maintenance and fueling of motorized pumps.

Correspondingly, the Tono Irrigation Scheme, which was constructed in 1985, in the KNM of the Upper East Region, is the largest agricultural dam and irrigation scheme in West Africa. It is an artificial lake having a surface area of 1,860 Hectares and 5 km long dam (Dinye, 2015). The Tono Irrigational Scheme located in KNM and the Vea irrigation dam located in the Bongo District are the major public irrigational schemes in the Upper East Region under the management of ICOUR. With the exception of farm lands located at the far ends that use motorized pumps to lift water from the canals, all other farmers' access water directly without using motorize pump. The Management of the scheme charges the same fixed levy for both with and without the use of motorized pumps.

2.8.1 Tomato Production in the Upper East Region of Ghana

Tomato cultivation in the Guinea and Sudan Savannah of Ghana is practiced from October to April annually. Hence, the Upper East Region, which is located in the Sudan Savannah mostly has its supply of the produce to the country during the dry season.

This can be attributed to the availability of irrigational facilities at both public and private levels in the region. According to Robinson & Kolavalli (2010a), Ghana relies heavily on the Upper East Region and Burkina Faso irrigation schemes for the production and supply of tomato between January to May hence, pointing to the significant role of dry season farming in increasing vegetable (tomato) production and reducing the unemployment rate in the region.

Tomato farming in the Upper East Region and for that matter the KNM is practiced on small-scale basis. The nature of the small-scale production has led to wide yielding gap, which makes Ghana incapable of producing the product to meet the continuous increase in demand for both household's consumptions and industrial use. This deficit in the yielding gap is annually supplemented by Burkinabe tomato, which causes price transmission in domestic market (Amikuzuno, 2012).

Interestingly, available data from ICOUR from 2009 to 2012 shows complete downward trends of the tomato production from the catchment area of the Tono Irrigational Scheme. The researcher's interactions with the Project/Scheme Manager established that most of the farmers are now substituting tomato for rice and pepper cultivation, which now commands higher price from the industrial sector. Yet, the motivation by government of Ghana as a matter of policy in achieving a boost of food security in rice and maize production could equally be a contributive factor to the decline of tomato farming in the Municipality. This policy is meant at reducing the amount of rice importation and at the same time enhancing maize and other food crop production in the country. This sudden trend is presented in the following graph, figure 2.2.

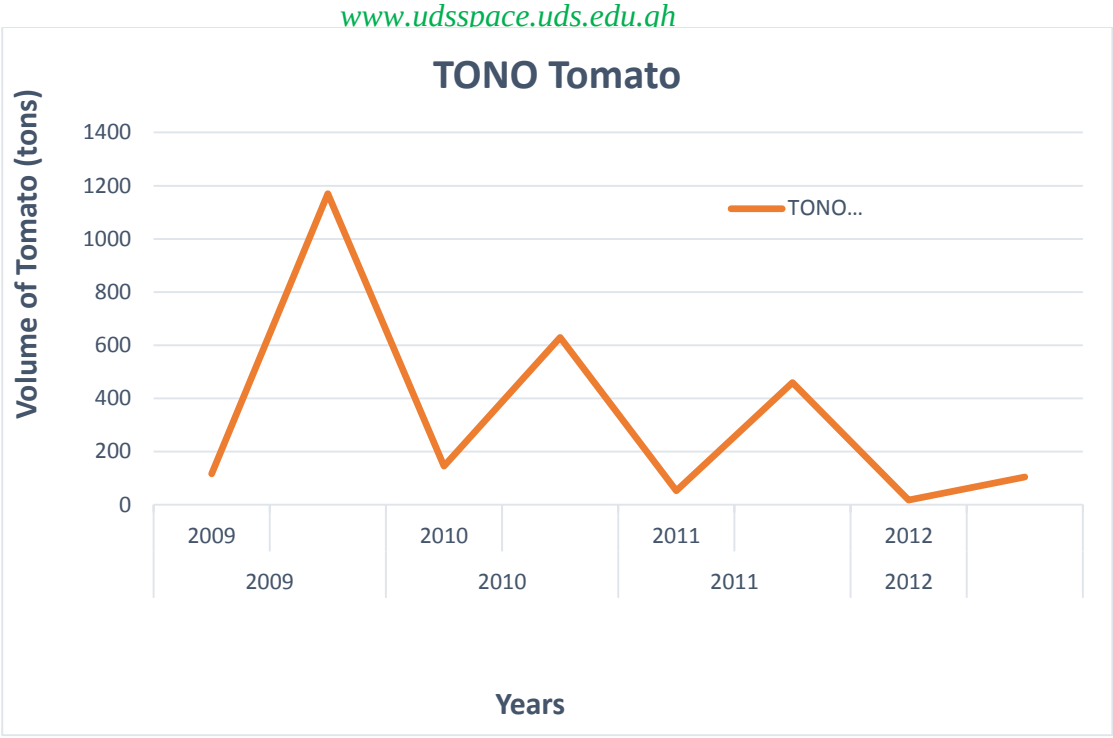

Figure 2.2 Trend of Tomato Production in KNM from 2009 to 2012

Source: ICOUR, 2017.

2.9 Gross Margins of Smallholder Tomato Farmer

According to Leslie (2013), gross margin is assessed by deducting the direct cost in growing a crop from the gross income of the crop. Direct cost includes those associated with crop production operations, harvesting and marketing. Gross margin does not include overhead cost such as interest rate, living costs and insurance that must be met regardless of whether or not a crop is grown. Due to this, gross margin is not the accurate measure for the profit of a particular enterprise. However, gross margins serve as a useful tool in terms of farm budgeting and estimating the likely returns and losses of a particular crop. In estimating a whole farm profit, it is necessary to consider the overhead cost in addition to enterprise gross margins.

Leslie (2013) maintained that, the analysis of gross margins provides an indication of a rewarding enterprise. Hence, it is a technique for reducing the field of choice without resorting to full budgeting. Gross margin analysis helps to make comparison between separate enterprises of the same crop and disregarding the fixed cost of the farm. It does concern with the income derived from the enterprise, and with the direct cost related to producing that income. The gross margin may then be compared with the results from other enterprises. Therefore, cost is categorized in terms of measuring gross margin in farm management and practices as a direct and overhead cost (Leslie, 2013). This is contained in the Table 2.1 below;

Table 2.1 Measuring Gross Margin in Farm Management Practices

Direct Cost	**Overhead Cost**
Land preparation	Administration – accounting, telecommunication
Planting materials	Depreciation of machinery and equipment
Fertilizer	Farm insurances
Sprays	Interest payment
Casual labor	Taxation payments
Contract harvesting	Repairs to water supplies, rodding, buildings
Post-harvest on-farm processing	Wages of permanent employees
Transportation to market	Lease payments

Source: Leslie (2013).

In a related development, a field survey conducted by Amikuzuno *et al.* (2015), noted that, Brong-Ahafo Region farmers achieved higher profit margins of an amount of GHS 345 per tons, whilst that of Greater Accra Region receives GHS 117 per ton and the Upper East Region recorded GHS 49 per ton. However, the situation of the traders in terms of margins of profits is different. Traders receive margins of GHS 571 from tomato in Upper East Region and GHS 344 from imported tomato from Burkinabe farmers (Amikuzuno *et al.,* 2015).

Notwithstanding the low margins of tomato imported from the Burkina Faso to traders, Amikuzuno *et al. (*2015) maintained that, more of the traders still prefer crossing the border for the Burkinabe tomato at the expense of the Upper East Region tomato. The traders prefer making sizeable income but with little risks since the product are perishable. The traders explained that, the tomato from Burkina Faso stands the test of time before spoilage as compared to that from the Upper East Region. In addition, the Burkinabe tomato attracts premium to both traders and transport operators whilst that of UE/R tomato does not. This indicates that, the traders are said to be risk averse and hence, prefer little profit with less risk to higher profits with higher risk.

The findings of Amikuzuno *et al.* (2015) further reveal that, the tomato from Navrongo market alone yielded GHS 7.98 of gross margins, whilst Tamale recorded GHS 16.23.

Amikuzuno *et al.* (2015) study concluded that, there is a direct relationship between higher margins and destination of market from the production zone, hence, reinforcing the relationship between risk and profits. The fact that tomato is a perishable commodity means that long distance traveling will increase the risk of its perishability. Consequently, higher margins will compensate for the possible losses that are likely to occur in the course of the transportation.

A gross margin has lots of significance to farmers in so many ways. These are;

i. Gross margin allows comparison to be made of the relative profitability of alternative cropping options that have similar land, machinery and equipment requirements.

ii. It indicates the costs of production of alternative enterprises, with the help of farm management decisions.

iii. It can be used to analyze the performance of individual enterprises and may indicate areas where possible improvements can be made.

However, Gross margins may be a reasonable measure of the relative profitability of enterprises that make similar demands on farm resources. If major changes in enterprise mix are being considered, more comprehensive budgeting techniques are required to indicate the real profitability situation. When making relative gross margin comparisons between enterprises the resources used by them must be considered (Leslie, 2013).

2.9.1 Marketing Margins

Marketing margin is a commonly used measure of the performance of a marketing system (Mebrat, 2014; Abbott & Makeham, 1981). It is defined as the difference between the price the consumer pays and the price that is obtained by producers, or as the price of a collection of marketing services, which are the outcome of the demand and supply of such services (Mebrat 2014; Cramers & Jensen, 1982).

Hence, the Marketing Margin (MM) of the intermediaries is calculated as;

$$\text{MM} = \frac{\text{Selling Price} - \text{Buying Price}}{\text{End Buyer Price}} \times 100$$

Mebrat (2014) noted that, in marketing chain with only one trader between producer and consumer, the net marketing margin (NMM) is the percentage over the final price earned by the intermediary as his net income once his marketing costs are deducted. The percentage of net income that can be classified as pure profit (i.e., return on capital) depends on the extent to which factors such as the middlemen's own, input, salary is included in the calculation of marketing costs. In other words:

$$\text{NMM} = \frac{\text{Gross margin} - \text{marketing Cost}}{\text{Price Paid by End Buyer}} \times 100$$

Mebrat (2014) further maintained that, in a situation where there are several participants in a chain, the margin is calculated by finding the price variations at different segments and then comparing them with the final price to the consumer. The consumer price then is the base or common denominator for all marketing margins. In analyzing margins, first the Total Gross Marketing Margin (TGMM) will be calculated for. This is the difference between producer's (farmers') price and consumer's price (price paid by final consumer). Computing the Total Gross Marketing Margin (TGMM) has to always be related to the final price or the price paid by the end consumer and is expressed as a percentage (Mebrat, 2014). Hence, the formula to calculate TGMM is given as;

$$\text{TGMM} = \frac{\text{End Buyer Price} - \text{First Seller Price}}{\text{End Buyer Price}} \times 100$$

2.9.2 Model for Analyzing Factors Affecting Market Channel Choice

Market channel choice decisions help to unearth the various options and or opportunities available to the producer to sell their produce in order to make maximum profits or at worst, make minimal losses. Armah (2013) citing the work of Green (2003) noted that, the unordered Multinomial Logistic choice model (MNL), is motivated by a random utility theory with the assumption that, respondents maximize utility in their decisions. Therefore, an individual would choose an alternative that they perceive to give the highest level of satisfaction among the other alternatives available. Unlike the binary logit models, the multinomial logit model allows analysis of decisions when more than two alternatives are involved, and makes possible the determination of choice of probabilities for different categories. The study by Armah (2013) on the factors influencing farmers' choice of indigenous adaptation strategies for agro biodiversity loss in northern Ghana using the Multinomial Logit Model (MNL) analysis, found the variables; age, education, farm size, awareness of climate change, farm cash income and existence of market in community, to have negative influence on choice of strategies. Whilst household head's sex, farming experience, radio ownership, household size, borrowing credit and awareness of reduction in crop diversity, positively influence the choice of strategies.

Mebrat (2014) cited Ogunleye & Oladeji (2007) in using the Ordered Multinomial Logistic Model to analyze the choice of cocoa marketing channel of farmers in the Local Government Area (LGA) of Osun State, Nigeria and their findings proved that, the cost of transportation increases with increasing distance from farm gate to market center turns to have a significant effect on the choice of market outlet.

Alhassan *et al.* (2013) pointed out that, when analyzing factors affecting the marketing channel choice, the factors or independent variable are not specified in any order of

importance or magnitude and hence, the Multinomial Choice Model is appropriate to use. Alhassan *et al.,* (2013) employ the Multinomial Choice Model with logistic distribution to determine the factors that influence the choice of indigenous climate-related strategies by smallholder farmers in northern Ghana, and stressed that this model is appropriate because the indigenous climate related strategies identified were not ordinal in nature. Alhassan *et al.* (2013) results reveal that, the presence of a market, informal credit from friends and relatives, location of farmer, farmer-to-farmer extension, noticing of a decrease in rainfall and noticing an increase in temperature all influence the choice of indigenous climate-related strategies. Hence, they postulated the need to improve on smallholder farmers' access to market, agricultural and extension services.

Again, the study by Mamo & Degnet (2012) applied the Multinomial Logistic Model to assess the factors that influence the market channel choice of livestock marketing in rural Ethiopia among livestock producers, traders, and consumers. Mamo & Degnet (2012) study found the variables; education, sex, access to market information, access to credit facility, cooperative membership and volume of sales to have a significant and positive effect on the producer's market channel choice decisions. Hence, they concluded that, the producer's market channel choice decision was significantly determined by these variables.

Further, Bongiwe & Masuku's (2012) study on the factors that determine the market channel choice of selling vegetables using Multinomial Logistic Model Analysis in Ethiopia found age of farmer, quantity produced, and the level of education to be the most significant determinant variables in choosing to supply their products to non-wholesalers at the expense of the wholesalers in the channel of distribution. In addition, distance from production to market center and cooperatives membership equally proved

to have a significant influence on the choice of market choice channel along the value chain.

Finally, Mebrat (2014) employed Multinomial Logit Model (MNL) to identify the factors influencing tomato marketing channel choice of producers in Oromia National Region, Ethiopia. The Multinomial Logit Model (MNL) output revealed that distance to market, access to credit, bargaining power of producers, farming experience of tomato producers and access to market information are the important variables to determine market channel choices. Mebrat (2014) then postulated that, improving access to services, market information, and infrastructural development are some of the actions to be taken to strengthen the sector's development.

2.10 Post-Harvest Losses of the Tomato Industry

Postharvest losses are the sum of losses in quantity and quality of a product leading to losses of money (FAO, 2010). Since tomato is one of the perishable agricultural commodity, there is the tendency of tomato farmers to face these losses during and after production. The study by Agyekum (2015), pointed to the tomato sector of agricultural products as the worst affected sector in terms of postharvest losses and estimated the losses to about 50% of tomato produce by farmers in Ghana.

Most of the postharvest losses emanate from poor marketing system to the tomato farmers as well as some level of losses along the value chain. Comparing the findings by Agyekum (2015) to that of Robinson & Kolavalli (2010) of studies done in Upper East Region of Ghana, there are no significant difference between them. The study of Robinson & Kolavalli (2010) noted that, farmers of the Upper East Region recorded 50% postharvest losses and attributed the losses to farmers' restricted access to markets (traders). Robinson & Kolavalli (2010) study further had the Brong-Ahafo Region

recording a postharvest loss of 12%, whist the Greater Accra Region recorded 16% of postharvest losses and associated the loss to itinerant queens and inadequate storage facilities.

Interestingly, a research conducted by Addo *et al.* (2015) using the Double-log of OLS spanning a period of three years across the major tomato producing centers in Ghana indicated a significant postharvest loss occurring at almost all the major tomato farming zones in Ghana. The Upper East Region, in particular, recorded postharvest losses of 5.88% - 37.50% due to poor handling operation level. This study by Addo *et al.* (2015) indicated a slight improvement in the levels of postharvest losses as compared to the study of Robinson & Kolavalli (2010) above, at a difference of 12.50%.

The forms of postharvest losses tomato farmers faced differ from what the traders faced in the value chain. According to Adimabuno (2010), tomato may be regarded unacceptable to purchase at the farm gate level by most wholesalers, but the same cannot be said at the market level since traders has many different customers. Yet, tomato traders consider the risk of transporting the commodity on long journeys before the purchase of the product at the farm gate. As a result, if a trader feels a commodity may be rotten soon before reaching the final destination, such commodity is rejected. More to this, whilst the farmers have no or little choice when tomato gets rotten at the field, traders will find some consumers to purchase their rotten tomato at the market. This goes a long way in reducing the trader's levels of postharvest losses.

2.11 Factors Affecting Postharvest Losses

The levels of postharvest losses in the Municipality can directly affect gross margins which equally exert consequential challenges in the profitability of the tomato production and distribution. Less postharvest losses lead to higher gross margins and

the vice-versa. Accordingly, higher demand coupled with higher gross margins will lead to higher income, higher savings, higher investment and hence reduction in poverty in the region. Due to this, there is the need to adopt proper measures such as application and enforcement of appropriate management practices of the tomato production, harvesting and marketing which will minimize the levels of postharvest losses and thereby increasing profit margins of the smallholder irrigated tomato farmers. The effectiveness and efficient use of the tomato farmer's inputs also has the capacity to enhance optimal productivity of tomato in KNM of the UE/R. In order for tomato farmers to make efficient production decisions concerning the use of inputs and mechanisms, there is the need for an effective extension education (Borthe, 2010). Effective extension education is expected to transmit productivity enhancing technologies to farmers (Frederick, 2015). Literature on farmers in Asia asserted that, the goal of agricultural extension and education contributed greatly in productivity and less postharvest losses of the smallholder farmer in Asia during the green revolution era in the 1960s (Borthe, 2010). Efficiency in the use of productive resources (inputs) is key to enhancing productivity gains and hence reducing the risks of postharvest losses of smallholder tomato farmer (Kuwornu, Amegashie & Wussah, 2012).

According to Tetteh (2013), government institutions such as, the Ministry of Food and Agriculture (MoFA), through their farmer education programs under the Extension Service Division can help tomato farmers increase their profit margins by minimizing incidence of postharvest losses in the Municipality. This is because, tomato farmers' advancement in education provides them the opportunity to adopt and adapt improved/modern methods of farming, which have the capacity to bring about optimum utilizations of the vegetable cropping and hence, minimizing the level of losses in both

the production and distribution of the produce (Frederick, 2014; Oja, Bila & Iheanacho, 2012; Rad, Ates, Delioglan, Polatoz & Ozcomlekci, 2010).

2.12 Gender Sensitivity on Agricultural Productivity

Gender has been one of the highly pronounced variables in agricultural production literature that influences productivity. In spite of the fact that females serve as a fundamental labor force in smallholder tomato farming, their involvement in agriculture across the world is characterized by less resources and less access to technology inter alia (Robinson & kolavalli 2010; IFPRI, 2009). These characteristics of females in agriculture, coupled with other factors like their domestic and reproductive responsibilities limit their time for farm work. This therefore impedes their contribution to agricultural production.

Females' access to various productive resources has been the main determinant of their productivity. FAO (2010) noted that females in agriculture worldwide have access to only 20% of land and their apportioned fields are generally smaller and lower in quality. In Ghana, for instance, the land tenure systems practiced have made it difficult for females to obtain land for production purposes. Frederick (2015) therefore noted that land ownership plays a vital role in determining farm productivity. This is true in the sense that land ownership influences the farmers' morale to undertake land improvement and management programs to enhance productivity and sustainability. Furthermore, the ownership of land has also been noted to influence farmers' access to loans to enable them acquire productive resources. The impecuniosity of female farmers therefore hinders their capacity to adopt modern agricultural methods to boost their productivity (Frederick, 2015).

2.13 Gender Sensitivity on Tomato Productivity

The role of gender sensitivity on tomato production in Ghana and for that matter the UE/R is crucial and need to be treated holistically. This stemmed from the fact that, female smallholder's tomato farmers differ from male farmers in terms of farm size, farm management and handling of postharvest challenges. Again, male household heads of tomato farmers have more man-hour and time for farming activities as compared to female household's head tomato farmers. Following the research conducted by Aidoo *et al.* (2014) at the Offinso North District of Ashanti Region in Ghana, it was revealed that, gender had a significant effect on postharvest losses. Aidoo *et al.* (2014) stressed that, female tomato farmers were more prone to high levels of losses than their male counterparts since most females spent part of their time in household chores. This analysis was done using the double log of OLS model. On the contrary, the findings of Babalola *et al.* (2010) concluded that there was very little or no gender inequality in the smallholder tomato farming. According to a study by Addo *et al.* (2015) on tomato production in UE/R, established that there was no gender inequality and they also maintained that gender in the Upper East Region was indifferent at the units of operation and postharvest losses. Although, Addo *et al.* (2015) used a smaller sample size of sixty-eight (68) for the whole of UE/R for their study, their results are consistent with the findings of Babalola *et al.* (2010) that, gender does not have influence on postharvest losses.

2.14 Influence of Labour on Tomato Production

In a world of global competition, success is dependent on the proper use of inputs to generate outputs. Labour is one of such fundamental inputs needed for efficient production, most especially in small-scale farming (Tetteh, 2013). Smallholder tomato

farming is labour intensive, which tends to use manual labour for virtually all production operations, thus indicating that farmers use large quantities of manual labour to carry out production activities (Tetteh, 2013).

Considering the vital role played by labour in small-scale tomato farming, its shortage during certain stages of the production process like the harvesting of vegetables may be very expensive, taking into consideration the amount of losses (Xaba & Masuku, 2013). The intensive use of manual labour by smallholder tomato farmers might be the only way of getting the work done due to lack of funds to invest in capital-intensive operations. According to World Bank (2009) as cited by Frederick (2015) farm labour is classified into three distinct classes as unpaid labour (family labour), paid-in-kind (labor exchange or barter), and self-employed or wage labour. Smallholder farmers extensively depend on family labour to cater for virtually all labour needs of their farms (Thepa, 2009). Hence, the over reliance on family labour by smallholder farmers for their farm operations therefore signifies that family labour is the first-hand labour for carrying out production operations, since farmers do not need to hold cash to employ the services of family members.

2.15 Influence of Material Inputs

Material inputs, such as fertilizer, weedicides, improved seeds and insecticides play an important role in promoting crop (tomato) productivity. This is evident in the results of the Green Revolution in Asia and Latin America, where increased use of inputs, particularly fertilizer and improved seeds resulted in agricultural productivity growth. The IFPRI (2010) asserts the need to intensify the use of agricultural inputs in the African continent in order to witness a massive productivity growth. The need to intensify the use of modern production inputs like fertilizer, improved seeds, and

existing technologies in Ghana's tomato sector to improve productivity is evident in the yield gap of about 20%-84% recorded for most crops including tomato in the country (MoFA, 2013). The foregoing arguments therefore signify that productivity gains in tomato are directly linked to increased utilization of material inputs (such as fertilizer, weedicides, herbicides, improved seeds, irrigation etc.) in production. On the contrary, declining yields of tomato and low level of tomato farmer's income are noted to be the attributes of low utilization of agricultural input in production (Tetteh, 2013).

2.16 Influence of Age

Age is a possible determinant of a tomato farmer's ability to carry out production operations successfully and efficiently (Dlova, Fraser & Belete, 2004). Younger farmers (farmers within the age bracket of 15 to 64 years) are often more willing to adopt modern farming technologies and also more successful in carrying out various physically demanding farming operations compared to elderly farmers (farmers more than 65 years) (Dlova *et al.*, 2004). This argument is in consonance with literature (Todaro & Smith, 2012), which asserts that people under age 15 and above 64 years are often financially dependent due to lack of strength to carry out various income generating activities.

Notwithstanding the fact that younger farmers are more energetic and capable of working efficiently, Vu (2008) as cited by Frederick (2015) noted that the effect of age in determining the efficiency of farmers is ambiguous on one hand, older farmers are considered more efficient than younger farmers because of their long years of experience in production. On the other hand, younger farmers may be more willing to adopt and adapt more efficient technologies and more physically strong to carry out farm activities relative to older farmers.

2.17 Influence of Education

Tomato farming activity requires some basic level of education to appreciate the scientific basis of agricultural production. The level of basic education can help tomato farmers make decisive agro entrepreneurial decisions. According to Frederick (2015) citing the study by Nwaru (2004), noted that, education is the key to unlocking the natural talents and inherent enterprising qualities of farmers. Yet, Frederick (2015) citing Rad, Ates, Delioglan, Polatoz, & Ozcomlekci, (2010) asserts that education enhances tomato farmers' ability to derive, decode and evaluate vital information for agricultural (tomato) production and stressed that tomato farmers' ability to interpret instructions on agro chemicals, adopt modern agricultural technologies and make informed decisions on farming operations is dependent on education. Formal education improves the skills of tomato farmers and also makes them more responsive to risk taking and change relative to farmers with no formal education (Xaba & Masuku, 2013). Khan & Saeed (2011) found out that education of tomato farmers' education in Northern Pakistan is one of the determinants positively affecting the level of productivity and emphasized that if properly invested into, can result in increased production and net profits.

CHAPTER THREE

METHODOLOGY OF THE STUDY

3.1 INTRODUCTION

This chapter discusses the study area, sampling technique, the source and methods of data collection and the econometric models applied. The description of dependent and independent variables employed in this study and summary of the chapter are all presented in this chapter.

3.2 PROFILE OF THE STUDY AREA

This section deals with the historical background and location of the UE/R, the nature of land, climate, demographic, drainage systems, and the Tono Irrigation Project in the KNM.

3.2.1 History and Location of the UE/R

The UE/R is the study area, with emphasis on the Kassena Nankana Municipality (KNM). The UE/R historically, was part of what used to be the Upper Region, which was also carved out of the Northern Region, on 1st July 1960 (GSS, 2013). The Upper Region was divided into Upper East and Upper West Region in 1983 during the regime of the Provisional National Defense Council (PNDC).

It is located in the northeastern corner of the country, between longitude 0^0 and $10'$ West and latitudes 10^0 $30'$ N and 11^0N. It is bordered to the north by Burkina Faso, the east by the Republic of Togo, the west by Upper West Region and the south by

West and East Mamprusi Districts in the Northern Region (Figure 3.1). Administratively, the region is comprised of thirteen districts.

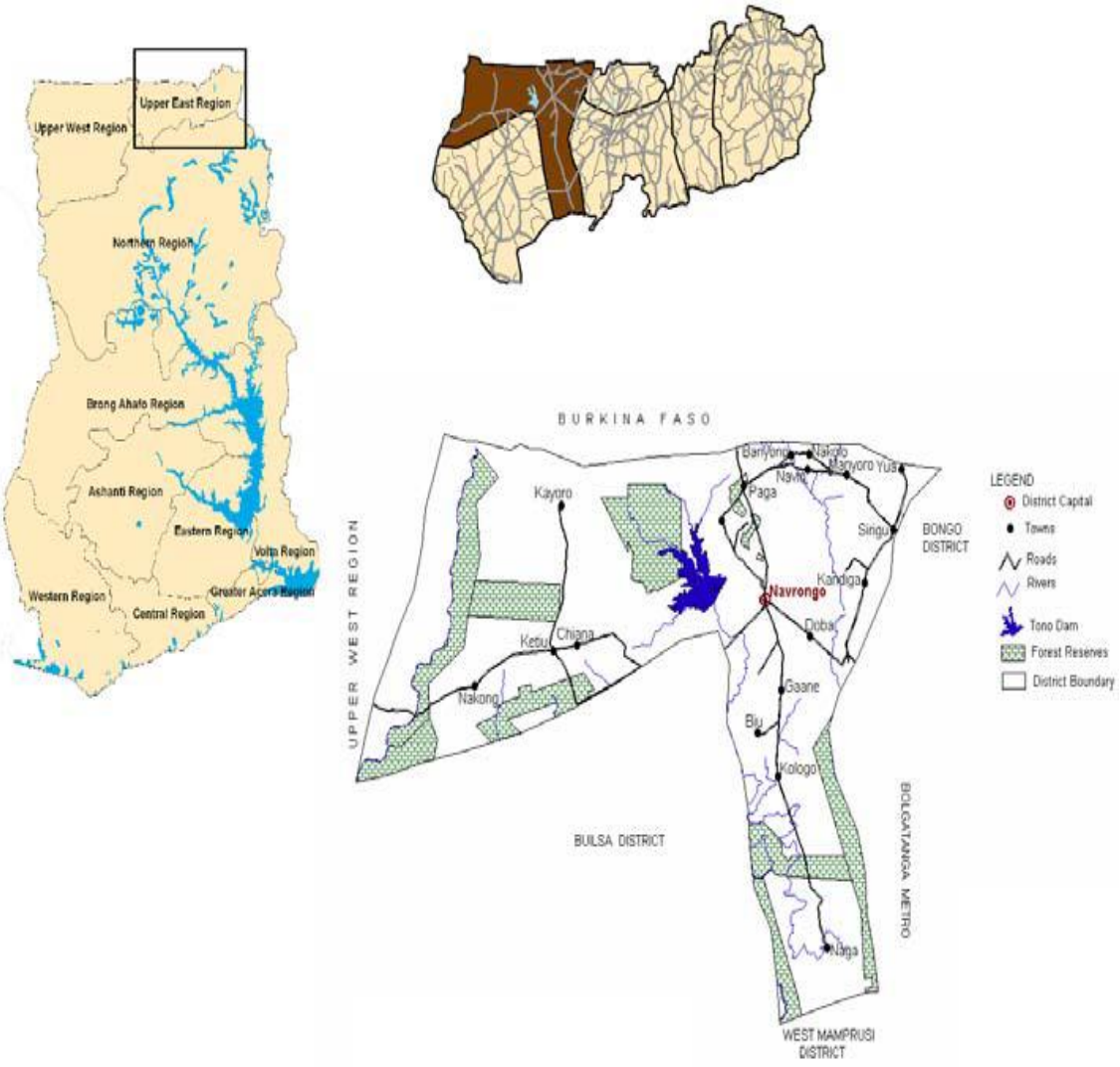

Figure 3.1 Maps of the UE/R and the KNM

Source: GSS 2013.

3.2.2 Nature of Land and Climate

The land is relatively flat with few hills to the east and southeast of the region. The total land area is about 8,842 sq. km, which translates into 2.7 percent of the total land area of the country (MoFA, 2013; GSS, 2013).

The region has a single rainfall pattern throughout the year, which is erratic in space and duration. The raining season falls between April/May and September/October with the mean annual rainfall of 800mm to 1100mm (GSS, 2013). There is a long period of dry season from November to mid-March, characterized by cold and dusty Harmattan winds. Temperature at this period can be as low as 14^0C at night, but can go to more than 35^0centigrade during the daytime (GSS, 2012).

3.2.3 Demographic Characteristics

The 2010 population census revealed the UE/R to have a population of 1,046,545 persons, which constituted 4.2% of Ghana's population (GSS, 2012). The region has an annual population growth rate of 1.2%. The census results further indicated the predominance of female relative to males in the region (GSS, 2012). Out of the total population, 48.4% represented the male population whilst 51.6% represented the female population in the region (GSS, 2012). The 2010 population census depicted a majority (51.6%) of the people in the region falling within the economic active range of 15 to 64 years old, implying that proper utilization of human resource can yield significant economic benefits to the region and the nation at large.

3.2.4 Drainage and Irrigational Systems

The UE/R has well developed artificial dams such as, the Vea and Tono Irrigation Dams. There are also about 220 more dams and dugout wells in the region, which have lands suitable for crops such as onion, tomato and pepper cultivations. Equally

important is the tributary of the Volta River called the White Volta. The White Volta takes its source from Burkina Faso. It stretches itself through the Talensi District of UE/R, where the Northern Star Tomato Company (NSTC) is located and eventually joining the Volta River.

3.2.5 The Kassena Nankana Municipality (KNM)

The Kassena Nankana Municipality is one of the thirteen (13) districts in the UE/R. The Municipality was formally referred to as the Kassena Nankana East District, which is situated within latitudes 10º 30' and 10º 50'N and longitudes 1º 5' and 1º 25'W. The Municipality shares boundary to the North with Burkina Faso, North East with Kassena Nankana West District, to the South East with Bolgatanga Municipality and Bongo District, to the North West with Kassena Nankana West District and to the South West by Builsa North and South District and the West Mamprusi District in the Northern Region. The Municipality has a total land size of 1,657km square with 326 communities, which are predominantly farmers. The people in the Municipality are 'Kassenas and Nankanas' ethnic groups and the capital is called Navrongo.

According to the 2010 population and housing census, the KNM population was estimated to be 92,188 representing 8.8 percent of the region's total population, with a population density of 92 persons per kilometer. Agriculture is the mainstay of the local economy with about 68% of the population (92,188) accounting for the people employed in agriculture and 32% accounting for traders, food processors, small-scale artisans and public servants. The Kassena Nankana Municipality is also one of the top place where smallholder tomatoes farming is practiced in the UE/R. The Tono Dam is the major supply of water for vegetable production especially in the dry-season.

3.2.6 The Tono Irrigation Project

The Tono Irrigation Scheme is comprised of 5km long dam, with an artificial lake of a surface area of 1,860 hectares and has water storage capacity of 93 million m^3 of which 37 million m^3 of which can be used for irrigation (IFPRI, 2011). However, the original layout of the scheme targeted a development of more than 2,400 hectares of irrigable land. The irrigation plots are served by two main canals (left and right bank) with an overall length of 42 km and a network of laterals and sub-laterals of a further 210 km and 120 km of roads created for access. The Tono Dam is endowed with well-established public irrigation schemes. It is the main source of water supply for irrigation of crops in the dry season. It comprises of well-developed canals and other irrigational facilities to supply water to distance farms lands.

3.3 Sampling Technique and Sample Size Determination

The population of the study area consisted of all irrigated farmers who produced tomatoes in the 2016/2017 farming season in the Municipality and the intermediaries who bought the product from the Municipality.

The researcher employed the use of multistage sampling technique, comprising of simple random sampling technique and purposive sampling in selecting respondents from the study area. The first stage was achieved by purposively selecting of ten (10) out of twenty (20) communities engaged in dry season tomato farming at the KNM of the UE/R of Ghana. This was based on the availability of data obtained from ICOUR and the assistance received from some informant in the municipality on dugout wells. Secondly, four (4) communities were further selected purposively out of the ten (10) communities. These were achieved based on the magnitude of tomato cultivation in these areas and the supply of water through artificial dam, with the availability of well-

established irrigation schemes. Two communities were also conveniently selected based on the existence of dugout wells that ensure constant supply of water throughout the season, for the crop production, (See appendices). In sum, six (6) communities were considered for the study. These communities selected for the study were: Korania, Bonia, Mayoro, and Gaani (ICOUR) Nayagnia and Doba (Dugout wells). The simple random sampling with replacement technique was adopted in the selection of farmers from those communities as the third stage. A method of balloting was adopted for the simple random sampling with replacement technique. This method provided each respondent an equal chance or the same chances of being chosen. To ensure the validity of the sampling technique, a list of farmers who belong to Farmer Based Organizations (FBO) and those who do not was collected (from ICOUR of the Tono Irrigation Scheme) and used for comparisons.

In all, a sample size of 172 tomato-producing households/farmers were selected for the interview. Out of the 172 tomato-producing farmers and households, twenty-seven (27) famers were randomly chosen from each of the communities using the simple random sampling with replacement.

However, the market gross margins and postharvest losses could not be achieved without involving the traders who were engaged in the value chain to get the commodity to final consumer. A visit to the study area revealed some emergence of roadside trading operations, within the retailers whom might purchase tomato from other retailers, wholesalers, or producers for onwards retail to the final consumer. Hence, a purposively sample size of 100 traders was chosen, which included; 40 wholesalers, 40 retailers and 20 roadside traders were selected for the study. In all, a total of two-hundred and seventy-two (272) sampled size was selected from the KNM of the UE/R for the study. Equally, information on the demographic characteristics of tomato farmers was

collected on the last farming season (2016/2017) or in the immediate past season. This is because tomato production could be sensitive to gender characteristics. In addition, other socio-economic characteristics such as income, sales, output of the farmers and also information on the factors influencing the postharvest tomato losses were collected.

3.3.1 Sample Size

The study of Yamane (1967) noted that, to make a research representative, the sample size is calculated using the formula; $$\boldsymbol{n = \frac{N}{1+N(e^2)}} \quad \textbf{(3.1)}$$

Where N = Total number of farmers in the KNM;

n = Sample size;

e = 0.1 (10% confidence level);

1 = Constant of proportionality.

Notably, the 2010 population and housing census, revealed that 68% of the total population of 92,188 in the KNM were involved in agriculture. Thus, 62688 were the farmer's population in KNM.

Therefore, using this sample size formula; $n = \frac{62688}{1+62688\times0.01} = 99.8$

Hence, to ensure that the study was more representative, a sample size of 172 tomato-producing households was use instead of 100 for the interview. In addition, a convenient sample of 100 traders were also considered and interviewed to substantiate the validity of some important variable responses from the marketers' point of view.

3.4 Sources of Data

One source of data has been used for this study. This is primary source. These consist of cross-sectional information collected from farmers and traders in the KNM for the 2017 production season.

This primary source of data was collected using a semi-structured questionnaire for the five communities sampled for the study. Some of the variables of interest for the primary data include: age, gender, marital status, religion, levels of education, and household size. Other primary data were, household farm experience, income level, hours of work, farm size, producers' channel choices of sale, improved seeds usage, cost of other inputs, farmer-based organization, transportation cost, farm gate price of tomato per crate, market price, access to extension services and returns from the production. The rest of the primary data was on market information, and postharvest losses.

Also, data were however, obtained from KNMA, ICOUR and MOFA on tomato farmers and the management of irrigation lands along the catchment area of Tono in the region through discussion. Data on total land size, population and other variables ware extracted from books, journal and articles

3.4 Preliminary Survey

Before carrying out the data collection, the researcher undertook a reconnaissance/ preliminary survey of the study area in order to gain a firsthand experience and information of the study area. During this visit, the researcher recruited two people (teachers) with Bachelor Degree each from the Municipality who were later trained on the research questionnaire and how to carry it out to assist in the data collection. The

researcher also interacted with officials of ICOUR and MoFA concerning the major communities of the study area engaged in tomato cultivation.

Accordingly, names of some individual tomato farmers and communities were obtained from ICOUR. This offered the researcher the opportunity to visit some individual tomato farmers and their group leaders, traders and the "Market Queens" to interact with them on the tomato activities in the value chain.

3.5 Research Instruments

The key instrument used in this study was a semi-structured questionnaire. Each household or tomato farmer data consisted of three main parts. Section one consisted of demographic characteristics, information on households' composition of the farmers and traders. It also captured information on the activities of the tomato farmers, namely farm size, farming experience, cost of production, access to extension services, inputs supply among others. The second section of the questionnaire consisted of information on the level of production, farm labour and gender activities, access to market, credit, extension services and information on farmers and traders who suffered postharvest losses during the last cropping season. The last part of the questionnaire collected information on distance of marketing agents to the farm centers, revenue structure and some socio-economic factors that influence postharvest losses.

3.6 Data Collection and Cleaning

3.6.1 Pre-testing of Questionnaire

The quality of data, as a best research practice is to adopt pre-testing of data collection tools. Through this means, the quality of the data collection and analyses would be

enhanced. As a result of this, the researcher pre-tested the questionnaire in some of the communities and markets within the Municipality in October, 2017 for one week before starting the actual fieldwork. These communities included, Bonia, Gaani and Navrongo markets. In all, five (5) each of farmers, traders and consumers were interviewed in the Municipality. This pre-testing resulted in restructuring some of the items in the questionnaire, as some of the farmers could not recollect the actual losses they incurred in the past season.

3.6.2 Data Collection

After pretesting the data collection instrument, the actual data collection was carried out in December, 2017 in all the six (6) communities selected for the study. These communities were Korania, Bonia, Mayoro, and Gaani (ICOUR) Nayagnia and Doba (Dugout wells). Data collection was done by the researcher and two other people (teachers) trained by the researcher to assist in the collection of the data from the study area. The questionnaire was written and administered in English Language but sometimes, have to be translated in to Kasem (the native language) or Ashanti language depending on the convenience of the respondent. This was necessary because, some of the farmers did not have formal education and hence could not understand English Language.

3.6.3 Data Cleansing

After each day's data collection, the researcher went through the administered questionnaire, and the minor problems occurred were used as a guide for the next days for better data collection. The field assistant was equally instrumental in terms of going back and making phone calls for some vital information from the field. Further, after everything about the collection of data was said and done, the administered

questionnaire was entered into a Statistical Package for Social Sciences (SPSS) which was later re-coded for analysis. During the coding process, the researcher went through the entered data to identify every error that occurred as a result of wrong entries which were equally traced back to the questionnaire for corrections to be done before analysis.

3.6.4 Conceptual Framework

This section provides a framework of internal consistency of the thesis. The framework explains how the channel choice of marketing influences the gross margins of the tomato farming, postharvest losses and its effects on profits level of tomato production and marketing. To that extent, the channel choice adopted by a smallholder tomato farmer in marketing his/her produce may possess some consequential effects on the gross margins. The major channel choices identified among the smallholder tomato farmers in the Kassena Nankana Municipality (KNM) are, from the producers to the wholesalers (Market Queens), retailers, roadside traders and the final consumers.

There is a well-established linkage in the channel choice, gross margins and postharvest losses of tomato cultivation in the KNM of UE/R of Ghana. This is because, a farmer choice of adopting a particular channel may yield higher revenue than other channel choices which goes a long way to reducing the magnitude of postharvest losses. Hence, Frederick (2015) citing Samboko (2011) argued that, a well-functioning market is noted to be a factor that directly and indirectly affects the level of farm productivity as well as the amount of profitability of farming. This fact, no doubt, emphasizes the need to have an efficient agricultural market, as these market channel choices will enable farmers' to efficiently sell their outputs in order to achieve higher gross margins or profits.

Similarly, the efficient marketing systems of tomato by farmers leading to higher gross margins will reduce the chances of tomato spoilage which would have been resulted in to postharvest losses since the commodity is perishable. Agyekum (2015) established that, most of the postharvest losses of tomato emanates from poor marketing system of the tomato farmers along the value chain and stressed that, the tomato sector is the worst affected sector of all agricultural produce in terms of postharvest losses and estimated the losses to about 50% of tomato produce by farmers in Ghana. Consequently, the implementation of subsidy programs by Ghana government on agro-inputs to increase access and the use of inputs aimed at enhancing optimal productivity, may be a fiasco without the efficient marketing systems for the produce.

Finally, the levels of postharvest losses in the Municipality (KNM) can directly affect gross margins which equally exert a consequential challenge in the profitability of tomato production and distribution. This is because, less postharvest losses lead to higher gross margins and the vice-versa. Hence, efficient marketing systems will increase gross margins and subsequently leads to lower postharvest losses in the Municipality.

3.7 METHOD OF DATA ANALYSIS

The data for this study was analyzed using the Statistical Package for Social Sciences (SPSS 20) and STATA 13. The raw data was entered into SPSS 20 and cleaned data was afterwards imported into STATA 13 for analysis.

3.7.1 Descriptive Statistics

This aspect of the data has to do with analysis of the socio-economic and demographic characteristics of data collated from the field. Therefore, among the descriptive statistics used included, mean, standard deviation, minimum, maximum, percentages,

and frequency. The results from these descriptive analyses of the data were presented in tables and chart.

3.7.2 Further Data Analysis

3.7.2.1 Mapping the Value Chain

A value chain mapping provides a good comprehension of the relationships, sequence of activities and the main actors engaged in the value chain. This exercise was carried out to identify the various actors of the chain, their linkages and all activities of the chain from production to marketing. In the structure and flow of the value chain activities, the following questions were considered:

What are the main activities carried out in the value chain to obtain the final product?

Who are the operators involved in these activities and what are their roles?

What are the flow of products, information and knowledge in the value chain?

What are the production volumes and the number of actors?

Where does the product (or service) originate from and where does it go?

What types of relationships and linkages exist among the various chain actors?

What types of business services are feeding into the chain, including the regulatory and policy framework in which the sector is operating?

After having developed the general conceptual map of the value chain, the next step was to analyze the chain's economic performance such as channel choice decision, gross margin and postharvest challenges.

3.7.3 Multinomial Choice Model

One of the objectives for this study was to model the channel choice and the major factors affecting the channel choice decision of the smallholder's farmers. Hence, the researcher wanted to determine the effect of the explanatory variable, such as, production characteristics, household characteristics and marketing characteristics on the dependent variable (Market channels) in terms of the probability of smallholder tomato farmer choosing between the market channels in the tomato value chain. As a result, the MNL model was appropriate to use because the marketing channels identified were not ordinal in nature (Alhassan *et al.*, 2013).

Armah (2013) noted that, the multinomial logit model allows analysis of decisions when more than two alternatives are involved, and makes possible the determination of choice probabilities for different categories. Since the tomato farmers in the KNM have more than two alternative choices such as wholesaler, retailers, roadside traders and the final consumers the unordered MNL model was employed for this study. The choice of choosing a market channel or not could be traced to the general framework of utility model as being noted by Greene (2000). With this, the dependent variable assumes independence across the choices. This means that, it does not allow correlation or substitution between any of the alternatives. Given that Y_j and Y_k represent a smallholder farmer utility for two choices, which could be denoted by $U_j$andU_k, respectively. According to Green (2000), the Marginal utility model could be specified as:

$$U_j = X'\beta_j + e_j \quad and \quad U_k = X'\beta_k + e_k \tag{3.1}$$

Where, U_j and U_k are the perceived utility of market channel j and k, respectively, X_i is a vector of explanatory variables influencing perceived desirability of involving market channel, β_j and β_k channel choice parameters and e_j and e_k are error terms, assumed to be independently and identically distributed. If a household decides to use option j on *ith* market chain, it follows the perceived utility or benefit from option *j* is greater than that from other options (*k*):

$$P_r(Y_i = 1) = \frac{e^{BjXi}}{\sum_{k=0}^{n} e^{BkXj}} \quad (3.2)$$

The above model is transformed below as:

$$\mathrm{P_r}(Y_i = 1) = \frac{\mathrm{e}^{\mathrm{X}\beta(1)}}{\mathrm{e}^{\mathrm{X}\beta(1)} + \mathrm{e}^{\mathrm{X}\beta(2)} + \mathrm{e}^{\mathrm{X}\beta(3)}} \quad (3.3)$$

$$\mathrm{P_r}(Y_i = 2) = \frac{\mathrm{e}^{\mathrm{X}\beta(2)}}{\mathrm{e}^{\mathrm{X}\beta(1)} + \mathrm{e}^{\mathrm{X}\beta(2)} + \mathrm{e}^{\mathrm{X}\beta(3)}} \quad (3.4)$$

$$\mathrm{P_r}(Y_i = 3) = \frac{\mathrm{e}^{\mathrm{X}\beta(3)}}{\mathrm{e}^{\mathrm{X}\beta(1)} + \mathrm{e}^{\mathrm{X}\beta(2)} + \mathrm{e}^{\mathrm{X}\beta(3)}} \quad (3.5)$$

The model above as it stands, is not identified because there is more than one solution to $\beta(1)$, $\beta(2)$ and $\beta(3)$ that yields the same probabilities for Y=1, Y=2 and Y=3.

To make the model identified, we arbitrarily set one of the β coefficients to zero and it does not matter which one is set to zero (Green, 2000).The remaining coefficients then measure the relative change to the base or reference group. The coefficients differ because they have different interpretations, but the predicted probabilities for Y=1, Y=2

and Y=3 will be the same. For example, if we set Y=1 as the benchmark or base outcome category, then we have;

$$\mathrm{P_r}(Y_i = 1) = \frac{1}{1 + \mathrm{e}^{\mathrm{X}\beta(2)} + \mathrm{e}^{\mathrm{X}\beta(3)}} \qquad (3.6)$$

$$\mathrm{P_r}(Y_i = 2) = \frac{\mathrm{e}^{\mathrm{X}\beta(2)}}{1 + \mathrm{e}^{\mathrm{X}\beta(2)} + \mathrm{e}^{\mathrm{X}\beta(3)}} \qquad (3.7)$$

$$\mathrm{P_r}(Y_i = 3) = \frac{\mathrm{e}^{\mathrm{X}\beta(3)}}{1 + \mathrm{e}^{\mathrm{X}\beta(2)} + \mathrm{e}^{\mathrm{X}\beta(3)}} \qquad (3.8)$$

Further, with the multinomial logit, we interpret the marginal effects and not the signs of the coefficients. The variables of interest are, farmers' age, farmers' formal education, gender of farmer, household size, improved variety of tomato seeds, farmer access to credit, use of hired labour, farm size in acres, harvesting period (Dec/Jan) and harvesting period (Jan/Feb).

In addition, the Hussmann Test of Independence of Irrelevant Alternatives (IIA) assumptions were used to justify the existence and correction of multicollinearity.

Finally, we determine the relative probability of the$Y_i's$. The relative probability of $Y_i's$ to the base outcome is called relative risk ratio.

The relative risk ratio (RRR) is the ratio of the probability of choosing one outcome category over the probability of choosing the baseline category. RRR is obtained by simply exponentiation of the linear equations.

The significance of the RRR is that it measures the relative risk ratio for a unit change in the independent / explanatory variable.

Therefore, RRR is calculated by:

$$\text{RRR} = \frac{\Pr(Y_i = 2)}{\Pr(Y_i = 1)} = e^{\text{Xb}(2)} \qquad (3.9)$$

3.7.4 Gross Margins

Gross margin was another approach used to measure the profitability of the smallholder tomato farmers. Leslie (2013) established that, gross margin analysis is a tool for assessing relative profitability of farm enterprise geared towards enhancing effective decision making in production process. Hence, this study employed the gross margin measure to compute the profitability of the smallholder tomato farmers in the KNM of the UE/R.

Gross margin is measured by computing the difference between total revenue and the variable cost of production. To make the analysis realistic, the weighted average price of crates of tomato was used instead of the price at farm gate. The reason for this is that, harvesting is done at different times and at different prices across the Municipality. However, the actual market price for the cropping season of 2016/2017 was valued for the cost and revenue of produce. Gross margin is therefore, calculated as:

$$GM = TR - TVC \qquad (3.10)$$

Where; GM is the gross margin (Ghana cedis) per acre of land.

TR is the price of each crate multiplied by quantity of fresh tomato sold.

TVC is the price of each input unit multiplied by the quantity used.

Alternatively, Gross margin can therefore be calculated as:

$$GM = \sum (P_y * Y) - \sum Pi * X_i \qquad (3.11)$$

Where; GM is the gross margin (Ghana cedis) per acre of land.

Y is the quantity of tomato output per acre.

P_y is the weighted average price of a crate of fresh tomato.

P_i is the price of each ith input unit.

X_i is the quantity of input use per acre for each ith input.

The revenue is computed as the product of the quantity of fresh tomatoes obtained (Y) in crates from an acre and weighted average price per crate (P_y).

Quantity of fresh tomato per acre (Y) is calculated by totaling the quantities of fresh tomato (crates) produced divided by the number of acre farmed for 2016/2017.

The output (Y) symbolically is computed by:

$$Y = \frac{\sum Q_i}{Ht} \qquad (3.12)$$

Where Qi represent quantity of tomato harvested and Ht, represent the number acres cultivated for the season.

Kuwornu *et al.* (2012) stated that, the weighted average price in crate of fresh tomatoes (P_y) is computed by:

$$\boldsymbol{P}_{\boldsymbol{y}} = \frac{\sum \boldsymbol{y_i}\, \boldsymbol{w_i}}{\sum \boldsymbol{y_i}} \qquad (\mathbf{3.13})$$

The weighted average price in ton of fresh tomatoes (P_y) is the summation of the product of the different prices of tomato(w_i), and the quantities of outputs (y_i) of fresh tomato sold divided by the total quantities in tons, ie;

$$P_y = \frac{\sum(Sellin\ Prices\ of\ the\ crate(w_i) * \text{Quantities of } Ouputs\ sold\ (y_i))}{Total\ Quantities} \quad (3.14)$$

The other aspect of gross margin is the TVC, which is also calculated by:TVC = $\sum P_i * X_i$ Where X_i is the variable inputs used and P_i represents the prices at which they were bought.

3.7.5 Econometric Model

The study adopted a semi-log OLS regression Model to assess the factors influencing post-harvest losses among the tomato farmers in the KNM. The reason for using semi-log is that some of the independent variables are dummy (1 or 0), and the log of 0 gives you an undefined function, hence cannot be included in a regression analysis. The model below is therefore specified for the analysis:

$$lnPHL = \beta_0 + \beta_1 lnHTM + \beta_2 lnCOL + \beta_3 VAR + \beta_4 lnSIZ + \beta_5 lnDFT + \beta_6 FBO + \beta_7 lnQTY + \beta_8 lnAGE + \beta_9 GEN + \beta_{10} EDU + \varepsilon_i \quad (3.15)$$

From the model above, PHL are the losses after harvest measured in crates of tomato produced by each of the farmers surveyed. Also, gender, age, education, cost of labor, time used for harvesting crops, variety of crop, farm size, distance from farm to place, farmer's membership of organizations, quantity of tomato harvested were the

explanatory variables, β_1 to β_{10} are the parameters of the explanatory variables to be estimated and ε_i is the error term in the regression model.

3.7.5.1 Dependent Variable

The dependent variable is output loss (postharvest loss) which is a continuous dependent variable measured in crates per harvest.

3.7.5.2 Independent Variables

The various independent variables specified in the model above are explained into details in this section. They include gender, age, education, cost of labor, time used for harvesting crops, variety of crops, farm size, distance from to market place, farmers' membership to organization and quantity of tomato harvest.

Gender of Farmers (GEN)

This is a dummy variable that takes the value of 1 if the farmer is male and 0 otherwise. This explains whether there exists any significant difference in the levels of postharvest losses on gender and how males manage the postharvest losses differently from females. The research expected male farmers to have low postharvest losses as compared to their female counterparts. This is because, male household heads have more labor in terms of man-hour for production than female's household heads. Again, female household heads have other household chores to attend to and hence, having less time in farming activities.

Age

The explanatory variable age is continuous and specifies the years of household heads of the smallholder tomato farmer (older or younger). This is because, tomato production

and harvesting required more labor. As a result, ages of households determine the man-hour, strength and the quality of labor for farming. Through this means, the model was able to explain how significant differences existed in the levels of postharvest losses between older family and younger family. The researcher expected older households to have more experience than younger households' heads. Hence, older households are in a better position to manage postharvest losses than younger households.

Education (EDU)

The education of the smallholder famer is another explanatory variable and it describes literacy level of the smallholder farmers with formal education vis-a-vis those without formal education. Formal education helps farmers read instructions and labels on agricultural inputs and their usages. Again, literate farmers are more likely to adopt new varieties and improve on technology than their counterparts without formal education. This is in accordance to Khan & Saeed (2011) findings, which noted that education positively influences agricultural productivity. By this, the researcher expects household heads with literacy to have higher yields than illiterate household's heads. Hence, literate households are in a better position to manage postharvest losses than illiterate household farmers.

Cost of Labor (COL)

Labor is composed of the household membership and hired labor unit used in carrying out manual farm works to produce a given quantity of tomato per an acre of land. Labor was measured in 8 hours per day. The activities of labor range from nursing, planting, weeding, to harvesting and marketing. The researcher expected that farmers that engaged large manual labour were more likely to incurred more cost and hence, more likely to experience higher losses than those employed less manual labour.

Farm Size

Farm size describes the number of acreages a farmer cultivates in a particular season. The reason for its inclusion is that, large farm sizes unaccompanied by ready market, transport and storage facilities would lead to higher postharvest losses than small farm sizes. Babalola *et al.*, 2012 as cited by Addo *et al.*, 2015 reported that, a farmer's scale of production increases without transportation and storage facilities will lead to postharvest losses. The researcher expected households head with large farm size to experience more postharvest loss than those with smaller farm size, all other factors being constant.

Time of Harvest (HTM)

The time of harvest, as included in the model marks the end of production and it indicates the period at which the product is ripe to plucking of the fruit. This is crucial because, any delay in harvesting would lead to consequential losses. The researcher expected households that delayed in harvesting would experience higher postharvest losses as compared to those who did not delayed in harvesting the crop.

Distance from Farm to Market (DFTM)

The distance from farm to market measures how long it takes a farmer to transport the produce from the farm gate to the market. The reason for this inclusion was that longer distance transportation increases cost of production, which affects profit margins and postharvest losses.

Variety of Crops (VAR)

The variety of crops explains the kind of seeds the household farmer used in planting (either improved seeds or local seeds). Variety of crops used has influence on the crop

yield and the level of postharvest losses. Farmers who have access to improved seeds that can withstand pest and diseases have higher chances of experiencing less post-harvest losses than their counterparts. Hence, researcher expected household farmers using improved seeds to have less postharvest losses than those without improved seeds.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussions of the study area. Basically, the discussion is centered on production, harvesting and marketing of tomato by the smallholder irrigated tomato farmers in the UE/R of Ghana. The results on the respondents' socioeconomic characteristics as well as the various objectives are discussed in this chapter. The first section presents the demographic characteristics of the smallholder irrigated tomato farmers and the traders. The second section deals with the marketing analysis of tomato with respect to the choice of marketing channels and factors affecting the channel choice of the farmers in the value chain. The third section detailed the findings of tomato production and harvesting with respect to the gross margins analysis of the irrigated smallholder tomato farmer. The final section focused on postharvest losses of the smallholder irrigated tomato farmer.

4.2 Descriptive Statistics

4.2.1 Socioeconomic Characteristics of Respondents

The socio-demographic characteristics (as summarized in table 4.1) considered in this study are gender, age, household size, marital status, education, religion and FBO/Associations. These characteristics help to understand the overview of the respondents under discussion. This is because, the characteristics of the respondents potentially affect the general activities of the farmer.

Household Heads

The descriptive analysis shows that, a total of one hundred and fifty-two (152) of the farmers interviewed were household heads which constituted, 88.4% of the sample, with only twenty (20) of the respondents constituting 11.6% being non household heads. The study equally revealed that a very high percentage (78%) of the traders constituted household heads, whilst only 22.0% of the traders were non households' heads.

Gender

The analysis of gender revealed that, majority (136) of the respondents (farmers) were males which represented 79.1% with only thirty-six (36) of them representing 20.9% being female. This male-dominated occurrence came as no surprise as farming is perceived to be the preserve activity for men especially, within the Northern culture of Ghana. In addition, the socio-cultural role under pinning northern Ghana custom as men being the breadwinner of the family is being reflected by the study. All hundred traders interviewed were females. The findings of Agyekum (2015) estimated that, there exist approximately 5,000 tomato wholesalers in Ghana. This implies that, the sampled tomato farmers of KNM contributes an estimate of two percent (2%) of the total tomato wholesale population in the country. The female dominance in the tomato marketing system can be attributed to the cultural underpinning of the northern ethnic groups who see tomato business as women ventures because of its relation with cooking (Addo *et al.*, 2015).

Age

Another important variable in this study is age. This is because, age determines the quality and strength of the workforce. The result of the field survey indicates that; the average age of the farmers' respondents is 40.3 years. This implies that, on the average, KNM has an active and potential manpower requirement for the tomato industry. Out of the hundred traders interviewed, the mean age of the traders is estimated as 39.2% with the minimum age of 24 and maximum age being 55 years. This means that, on the average, the tomato marketers are composed of an active labor force of the country.

Household Size

According to the Institute of Statistical Social and Economic Research (ISSER) (2014), a household refers to a person or a group of related or unrelated persons living together in the same housing unit, share the same housekeeping and cooking arrangements and are considered as one unit under one recognized head. This is an important variable because, it determines the number of labour force available to a particular household on the average. The field survey analysis revealed that, a mean value of seven (7.0) constituted the household size of the smallholder tomato farm household in KNM.

Marital Status

On the variable marriage, the results indicated that, majority (81.4%) of the tomato producers were married, whilst 1.7% were not married (single). Besides, 11.6% of the farmers are widows whilst, 5.2% of the farmers are not equally married due to divorce. Overall, there is higher incidence of marriage among farmers interviewed in the KNM. The results, reinforces the sociocultural importance associated with marriage which may enable the small holder tomato farmer to give birth to more children needed for

farm assistance. This is in accordance to Tetteh (2013) who established that Smallholder tomato farming is labour intensive, and tends to use manual labour for virtually all production operations, thus emphasizing the important role of manual labour in carry out tomato farming activities.

Also, majority (59%) of the traders are equally married, 12% are not married due to divorce, 17% are single and the remaining 12% are widows.

Education

Out of the farmers' respondents interviewed, none had tertiary education with 32.0 % of them without any formal education. This could lead to serious consequences in terms of productivity. However, a proportion of 36.1% of the farmers had primary education, with 14.5% of them having JHS education while 17.4% of them had SHS/Vocational and Technical education. In all, about 68% of the farmers interviewed had formal education whilst about 32% were illiterate. Yet, out of the 100 traders interviewed, none of them had tertiary education, with the majority (30%) having primary education, whilst 26% having SHS/Vocational/Technical education, 19% had JHS education and 25% were illiterate.

Religious Affiliation

The study indicates that, the KNM is a Christian-dominated community. This steamed from the fact that, out of the respondents interviewed, 77.9% belongs to Christianity with only 12.8 % of them professing the Islamic religion and 9.3% of them practicing the African Traditional Religion (ATR). Similarly, majority (72%) of the traders belong to Christianity, whilst 14% belongs to Islamic religion and 14% adherent of the ATR.

Famer-Based Organization (FBO)

The variable, FBO, revealed that, majority (81.1%) of the farmers do not belong to any organization with only 18.6% belonging to some sought of groups. Evidence from the field revealed that, most of the tomato farmers initially belonged to FBOs which were dissolved because, some of them had substituted tomato production which was formally their primary or major crop for other crops (pepper and okra) which commands high demand in the market. However, the analysis of the traders revealed that, they are by far more organized than the farmers since, they (trader) had organizations. Results from the analysis revealed that, a greater percent (70.4%) of the traders belong to groups/associations with only 20.6% not being part any group or association.

Table 4.1 Socio-economic Characteristics of Tomato Producers and Traders

	Farmers Observation (172)			Traders Observations (100)		
	Frequency	**%**	**Mean**	**Frequency**	**(%)**	**Mean**
Respondent is Household Head						
Yes	152	88.4		78	78.0	
No	20	11.6		22	22.0	
Total	172	100		100	100	
Gender (%)						
Male	136	79.1		0.0	0.0	
Female	36	20.9		100	100	
Total	172	100		100	100	
Age (Mean)	172		40.3			39.2
Household size (mean)	172		7.0			5.5
Marital Status (%)						
Married	140	81.4		59.0		
Single	3	1.7		17.0		
Divorced	9	5.2		12.0		
Widowed	20	11.6		12.0		
Total	172	100		100		
Educational Achievement						
None	55	32.0		25.0		
Primary	62	36.1		30.0		
JHS/MSLC	25	14.5		19.0		
SHS/Vocational/Technical	30	17.4		26.0		
Tertiary	0	0.0		0.0		
Total	172	100		100		
Religious affiliation						
Christianity	134	77.9		72.0		
Islam	22	12.8		14.0		
African Traditionalism	16	9.3		14.0		
Total	172	100		100		
FBO Associations/membership						
Yes	32	18.6		70.4		
No	140	81.1		20.6		
Total	172	100		100		

Source: Field Survey, 2017.

4.3 Marketing Channels of Irrigated Tomato Farming

The descriptive analysis in Table 4.2 above revealed that, majority (129) of tomato farmers, representing a total of 75.0% of the irrigated tomato farmers of KNM interviewed prefer choosing the retailers' marketing channel for the sale of their produce. This is in line with Bongiwe &Masuku's (2012) study on the factors that determine the market channel choice of selling vegetables using Multinomial Logistic Model Analysis in Ethiopia found tomato farmers in choosing to supply their products to non-wholesalers at the expense of the wholesalers in the channel of distribution.

Yet, tomato farmers from the field/survey, complained that, most tomato buyers (wholesalers) from southern Ghana (Market Queens) by-passed the Municipality to neighboring Burkina Faso for the purchase of the commodity, without restrictions at the border. As a result, the few (wholesalers) that remained patronizing tomato from the KNM dictates the price at the farm gate. This has made some farmers to also by-pass the few wholesalers buying from the Municipality to the retailers and roadside traders for the sale of their produce. This is in accordance with Donkoh *et al.* (2013) findings, which asserted that, Ghana's implementation of some economic and trade policies such as the Economic Partnership Agreement (EPA) since the 2007 has led to high importation of fresh tomato from Burkina Faso into the country. The results however, contradict the works of Robinson & Kolavalli (2010) and Adimabuno (2010) who all pointed out that, the wholesalers (Market Queens) monopolized the marketing systems and use their dominance to exploit the farmers in the region. This is because, at the time of the research, there existed no such monopoly, as farmers could sell their produce to buyers of their choice.

Table 4.2 below of the study further brought to bear the wholesalers, as the second highest (88) representing 51.2% of the channel choice of the producers. Interestingly, the wholesalers maintained that, tomato production in terms of quantity and quality in the Municipality is dwindling. As a result, some wholesalers (35%) preferred crossing the border to Burkina Faso for the commodity. The dwindling assertion of tomato production in the Municipality as maintained by the wholesalers was confirmed during the researcher's interactions with the Tono Irrigational Project/scheme Manager who noted that, most of the farmers were now substituting tomato as their primary production for rice, okra and pepper cultivation. This was evident in farms of some communities such as Bonia, Korania, and Doba during the field survey.

The analysis equally established that, a total of 69 representing 40.1% of the producers form the third (roadside traders) channel choice of distribution of the tomato by farmers of KNM, whilst consumers channel were the least (46) channel choice of the producers, representing 26.7%.

Table 4.2 Relative Frequencies of Marketing Channels of Producers in the KNM

Marketing Channel	Number of Producers	Percentage
Wholesalers	88	51.2
Retailers	129	75.0
Road Side Traders	69	40.1
Final Consumers	46	26.7

Source: Field Survey, 2017.

It is important to note that, the number of producer as in the table above contains multiple responses and as such, would necessarily appear to be more than the total sample size of the producers.

4.3.1 Multiple Channel Choice of Farmers

The analysis of the farmers equally brings to bear different multiple choice of channels adopted by tomato farmers for their produce. Whilst some farmers preferred selling to only a single channel choice, some preferred double channels and others preferred multiple channel choices.

Table 4.3 Choice of Combinations of Marketing Channels of Tomato Producers

Channel I Only		**Channel II Only**		**Channel III & IV Only**	
Channel Choice	Sample (%)	Choice of Channels	Sample (%)	Channel Choice	Sample (%)
Wholesalers only	8.1	Wholesalers – Retailers	20.9	Wholesalers-Retailers-Road Side Traders	10.5
Retailers only	20.9	Wholesalers - Roadside Traders	2.3	Wholesalers-Retailers-Final Consumers	0.6
Road Sider Traders only	1.2	Wholesalers-Final Consumers	3.5	Wholesale-Road-Final Consumers	3.5
Final Consumers only	0.0	Retailers-Roadside Traders	9.3	Retailers-Road Sider Traders-Final Consumers	5.2
		Retailers-Final Consumers	5.8	Wholesalers-Retailers-Road Side Traders-Final Consumers	1.7
		Road Side Traders - Final Consumers	6.4		
Sample Percent	30.2		48.3		21.5

Source: Field Survey, 2017.

The first column in Table 4.3 above, illustrates the percentage of farmers who adopted only one channel for the sale of their produce. The table revealed that overall, 30.2 % of the farmers adopted channel one. This composed of 8.1% of the farmers who chose to sell their produce to only wholesalers whilst, 20.9% of the farmers sold their produce

to retailers only, 1.2% for roadside traders only and none sold through only consumers. This may be attribute to the fact that, some of the farmers has regular customers for the purchase of their produce. This, however, was dependent on the different output levels of the various producers.

Further, the percentage of farmers that preferred channel two only in the second column of the table revealed that, a percentage (48.3%) sold their produce through channel two choice. The various compositions are; 20.9% of the tomato farmers sold their tomato to both wholesalers and retailers, 2.3% of the farmers sold their produce to wholesalers and roadside traders, whilst about 3.5% sold their produce to wholesalers and consumers only. In addition, about 9.3% of the farmers adopted only retailers and roadside traders channel, whilst 5.8% sold to only retailers and consumers' channel choice and 6.4% sold to the roadside traders and the final consumer in marketing their produce. This came as no surprise as tomato is a perishable commodity, farmers whose tomato are ripe cannot postpone selling. As a result, sell to buyers who available at that time.

Furthermore, the analysis in Table 4.3 equally brings to bear the combinations of three or four channels for marketing of tomato. The results revealed that, a total of 21.5 % of tomato farmers sold their produce to channel three. This percentage is made up of 10.5% of the farmers who choose the combination of wholesalers-retailers-roadside traders and final consumers only, whilst 0.6% of the farmers adopted the combinations of the wholesalers-retailers-final consumers channel. In addition, about 3.5% of the farmers adopted the wholesalers-roadside traders-final consumers' channel, whilst, 5.2% adopted the retailers-roadside traders-final consumers and 1.7% sold through wholesalers-retailers-roadside traders-final consumers channel choice of distributions.

Over all, the various channel choices of marketing tomato emanated from the field survey by smallholder farmers are identified below:

Channel one (I): Producers → Retailers → Final Consumers.

Channel two (II): Producers → Wholesalers → Retailers → Final Consumers.

Channel three (III): Producers → Roadside traders' → Final Consumers.

Channel four (IV): Producers → Retailers → Roadside traders' → Final Consumers.

4.3.2 Marketing Channels Characteristics of Tomato Traders

The field survey revealed that, there exists two main sources of tomato supply channel in the region. These are the KNM and the Burkina Faso sources. Tomato from the KNM is supplied to the market from late December to early January. By late January to February onwards, the Burkina Faso tomatoes peak and eventually flood the region in particular and the country at large. The analysis established that, majority (65%) of the traders prefer purchasing their produce from the KNM, with only 35% choosing to purchase their produce from Burkina Faso (see Table: 4.4 below). This can be attributed to the fact that, most of the traders were interviewed from the study area, although not all of them sell their product in the Municipality. Yet, even those that transport the product out of the region make stopover in order to sell to retailers or roadside traders for onward retail to the final consumer. In addition, the higher percentage (49%) for market proximity, which is cited as a reason for the preference of KNM tomato by the traders is another crucial factor accounting for most traders' channel choice of the KNM. This is because there exists a direct relationship between cost and distance. An

increases in distance from the farm gate to market has the probability of increasing cost due to transportation cost which no doubt will decrease profit margins of the traders.

Table 4.4 Marketing Channel Choice of Traders in the KNM of the UE/R

Details	Frequency	Percentages (%)
Source of Tomato Preference:		
KNM	65	65.0
Burkina Faso	35	35.0
Total:	100	100
Reasons for Preference Choice:		
Proximity to Market	49	49.0
Better Quality	43	43.0
High Supply	8	8.0
Total:	100	100
Price Determination:		
Bargaining	85	85.0
Traders	15	15.0
Total:	100	100

Source: Field Survey, 2017.

4.4 Gross Margins Estimation and Discussions

4.4.1 Descriptive Statistics of Gross Margin Variables

Gross margin analysis is an important tool for measuring relative profitability of firms and producers. In the case of tomato producers in the KNM of the Upper East Region of Ghana, the gross margin analysis was used to unearth the levels of relative profitability of the farmers at various levels of production.

Descriptively, the results established that, with the standard deviation of 0.41, the average acre of irrigated tomato farm land was 0.92, whilst the minimum and maximum irrigated land size of a smallholder tomato farmers stood at 0.50 and 2.0 acres of land respectively, as shown in Table 4.5 below. In general, the smallholder tomato farmer

markets (sells) tomato to the wholesalers, retailers, and roadside traders either by the use of crates (large crate) or boxes (small crates) or both, which are estimated to be 54kg and 15kg respectively.

Table 4.5 Descriptive Statistics of Gross Margin Variables

Details	Obs	Mean	Std. Dev.	Min.	Max.
Irrigated Land (Acres)	**172**	**0.92**	**0.41**	**0.50**	**2.0**
Quantity of Tomatoes Sold					
Local Variety					
Large Crates (54kg)	79	18.68	21.8	0	120.00
Small Crates (15kg)	79	37.51	33.2	8.00	160.00
Improved Variety					
Large Crates (54kg)	112	22.54	22.7	0	106.00
Small Crates (15kg)	112	37.77	15.9	10.00	88.00
Average Price per Crate					
Local Variety					
Large Crates (GHS/54kg)	79	142.15	101.7	0	300.00
Small Crates (GHS/15kg)	79	91.01	22.9	0	120.00
Improved Variety					
Large Crates (GHS/54kg)	112	261. 79	93.3	0	350.00
Small Crates (GHS/15kg)	112	98.34	19.6	60.00	120.00
Mean Revenue by Variety					
Local Variety					
Large Crates (GHS/54kg)	79	3,726.07	6,800	0	36,000.00
Small Crates (GHS/15kg)	79	2,872.79	2,200	0	10,000.00
Improved Variety					
Large Crates (GHS/54kg)	112	6,344.82	6,877.3	0	29,680.00
Small Crates (GHS/15kg)	112	3,839.06	1,986.03	900.00	7,920.00

Source: Field Survey, 2017.

Evidence from the field survey revealed that, two forms of tomato seeds are used by smallholder irrigated tomato farmers in the production of the commodity (Improved variety seeds and local seeds). According to the farmers, the use of local seeds was

meant to cut down cost of production. Ironically, Table 4.5 above revealed that there exists a great amount difference in terms of maximum output sold and average price generated from tomato of the local variety and the improved variety. To this effect, the total revenue of tomato of the local variety is lower than the improved variety and hence, might reduce profit level of the farmer with local variety seed.

The Table 4.5 above revealed that, the farmers' mean output of tomato of the local variety sold for the season stood at 18.68 and 37.15 in large and small crates respectively, whilst at the same time, the farmers' mean output and quantity of tomato sold from the improved variety seeds was 22.54 and 37.77 in large and small crates respectively. Meanwhile, the findings of MOFA (2011), established that, Ghana's growth rate of tomato production and average yields per annum was estimated at 15 tons per acre.

In sum, the local and improved tomato yields mean that, on the average, output of the local variety seeds yielded lower quantities of tomato than the output from improved variety seeds.

Further, the average price of tomato sold from the output of local variety seeds is less than that of the improved variety. The analysis in Table 4.5 established that, the average price of tomato from local variety was GHS 142.15 and GHS 91.01 of the large and small crate respectively, whilst the tomato average price of improved variety for the large and small crate stood at GHS 261.79 and GHS 98.34 respectively. Consequently, the smallholder tomato farmers with improved variety seeds receive more revenue than those with local variety seeds.

4.4.2 Gross Margins of Tomato Production

The gross margin analysis was computed by deducting the direct cost of the smallholder tomato production from the Total Revenue (TR). From table 4.6 below, the average total revenue of irrigated tomato farmer for the local and improved variety in both large and small crates was between GHS 3,921.05 and GHS 25,715.00. This implied that, on the average, the revenue received by smallholder irrigated tomato farmer for the sale of tomato is quite higher. Evidence from the field revealed that, tomato of the improved variety is bigger than the local variety hence, attracting higher demand from the wholesalers (southern Ghana tomato Market Queens). In all, the maximum revenue per acre of land across the smallholder irrigated tomato farmers in the KNM stood at GHS 12,857.50 with an average GHS 4,262.01.

However, the maximum total revenue that smallholder irrigated tomato farmer generated from the local variety of the large crate stood at GHS 36,000.00 for the season whilst the maximum total revenue of the small crate was GHS 19200.00 for the season. Yet, tomato from the improved variety in both large and small crates yielded a maximum amount of GHS 37,100.00 and GHS 10,560.00 respectively to the smallholder irrigated tomato producers.

Overall, the Table 4.7 revealed that, the average revenue per acre of the smallholder irrigated tomato farmers in the KNM for the 2016/2017 farming season was quite higher, hence, an incentive for continue production. Equally important is the direct cost which is otherwise called the Total Variable Cost (TVC) was categorized into labour cost and inputs cost.

Total Cost of Labour per Acre

Labour is an important variable factor needed for production. In view of this, the cost of labour was computed in the area of land preparation, bed preparation, nursing,

transplanting, application of fertilizer, chemical application, weed control and harvesting. Overall, the maximum total labour cost per acre of land of a farmer in the KNM is GHS 1,191.07 Ghana Cedis at an average of GHS 355.48.

Inputs Cost

Inputs are another important economic variable needed for efficient production. Generally, the higher the quality of inputs the higher the outputs and the lower the quality of inputs the lower the outputs or returns (other things being equal). The inputs used by the smallholder irrigated tomato farmer of the KNM were; fertilizers, weedicides, pesticides, organic manure, irrigated water fees and watering cans. The results shown in Table 4.6 of the gross margin analysis revealed that a total of GHS 1,142.00 yielded the maximum total inputs cost per acre whilst an amount of GHS 585.39 constituted the average total cost per acre of inputs of the farmers. As a result, the total variable cost per acre of the smallholder irrigated tomato farmer for the season stood at GHS 2,333.07 at an average cost of GHS 940.87.

In the nutshell, it is evident from Table 4.6 below that, irrigated smallholder tomato farmer in KNM of the UE/R realised an average gross margin of GHS 3,321.14 per acre of land for the season. The appreciable profit margins of the farmers concord with the findings of Donkoh *et al.* (2012) on the technical efficiency of tomato farmers in the UE/R of Ghana, which revealed that, farmers were technically efficient and asserted that, the tomato industry of the region was still viable. The appreciable margins of the farmers can be attributed to the fact that most tomato farmers had marketed their produce through the retailers at the expense of the wholesalers in the value chain. As a result, this breaks the monopoly power and exploitations of the wholesalers in the Municipality.

Table 4.6 Gross Margin Analysis of Tomato Production under Irrigation

Details	Maximum (GHS)	Average (GHS)
Total Output Sold in Crates (kg)		
Local Variety: Large Crate	120.00	18.68
Local Variety: Small Crate	160.00	37.51
Improved Variety: Large Crate	106.00	22.54
Improved Variety: Small Crate	88.00	37.77
Mean irrigated land in acres	2.00	0.92
Average Price of a Crate of Tomatoes		
Local Variety: Large Crate	300.00	142.15
Local Variety: Small Crate	120.00	91.01
Improved Variety: Large Crate	350.00	261.79
Improved Variety: Small Crate	120.00	98.34
Total Revenue		
Local Variety: Large Crate	36,000.00	2,655.36
Local Variety: Small Crate	19,200.00	3,413.79
Improved Variety: Large Crate	37,100.00	5,900.75
Improved Variety: Small Crate	10,560.00	3,714.30
Average Revenue	25,715.00	3,921.05
Revenue/acre land irrigated	12,857.50	4,262.01
Variable Costs/Acre		
Labour Requirements:		
Land Preparation	240.00	57.27
Bed Preparation	116.00	54.51
Nursing of Seeds	60.00	20.80
Transplanting	66.67	26.35
Fertilizer Application	80.00	3.80
Chemical Application	60.00	13.60
Weed Control	48.40	13.25
Harvesting	520.00	165.90
Total Labour Cost/Acre	1,191.07	355.48
Inputs		
Fertilizers	600.00	301.28
Weedicides	60.00	33.21
Pesticides	72.00	36.17
Organic Manure	80.00	28.22
Irrigated water fees	240.00	147.10
Other Direct Cost: Watering cans	90.00	39.41
Total input Costs/Acre	1,142.00	585.39
Total Variable Costs/Acre	2,333.07	940.87
Gross Margin/Acre	10,624.43	3,321.14

Source: Field Survey, 2017.
NB: Large crate is 54kg and small crate is 15kg

4.5. Postharvest Losses of Irrigated Tomato Farmers in KNM

The third objective of the study sought to assess the extent of post-harvest losses among the smallholders irrigated tomato farmers in the KNM. Hence, the postharvest losses incurred by the smallholders irrigated tomato farmers in the KNM are presented in Table 4.7 below:

Evidence from the field survey indicated that, fresh tomato fruit averagely lasts for three days, equivalent to 72 hours after plucking it from its plant before beginning to show signs of deterioration and spoilage. This, however, depends largely on the variety, mode of handling and packaging of the fruit. Due to this, tomato farmers mostly preferred living their ripe tomatoes unpluck until buyers arrive. The field survey equally revealed that, farmers whose tomatoes are ripe but did not have their customers forth coming, cover their un-harvested tomato with dried grasses to reduce the possibility of rot or spoilage.

In spite of these efforts, the results revealed a significant amount of tomato lost in terms of quantities and revenue to the smallholder tomato farmer. This steamed from the fact that, at the standard deviation of 41%, an irrigated tomato farmer in the KNM cultivates 0.92 acre of land on the average, with the minimum acre of land a famer cultivates being 0.5 whilst the maximum acre of land by a farmer being 2.0. This is evident in Table 4.7 below. From Table 4.7, about 19.36 crates were lost to the farmers for the season on the average.

In all, the total value of postharvest losses stood at 5,098.72 Ghana Cedis representing 59 % with the mean value of 3,574.68 Ghana Cedis representing 41% post-harvest loss per acre by the smallholder irrigated tomato farmers of the KNM. This is in accordance with literature. For instance, the findings of Robinson & Kolavalli (2010) established

that, tomato farmers of the Upper East Region recorded 50% postharvest losses and attributed the losses to restricted access to markets for farmers produce by traders. Similarly, the study by Addo *et al.* (2015) established that Ashanti and Brong-Ahafo regions recorded significant postharvest losses in almost all unit of operations ranging from 40 % - 66.67 % and 27.27 % - 66.67 % respectively.

Table 4.7 Post-Harvest Losses of Producers in the KNM

	Obs	Mean	Percent (%)	St. Dev.
Total land cultivated	172	0.92	-	0.41
Average number of crates lost	172	19.36	-	25.63
Total value of post-harvest losses	172	5,098.72	59	9.99127
Post-harvest loss per acre	172	3,574.68	41	6.01527

Source: Field Survey, 2017.

It is important to note that, most of the smallholder's tomato farmers had their farms less than one acre (0.5 to 1 acre) as a result, the computation of the postharvest loss per acre levels appears to be higher. Besides, the postharvest losses computed above is based on quantities of tomato lost.

4.6. Modelling Channel choices of Tomato Production

This section presents and discusses the econometrics factors that determining market channel choice of tomato production in the Municipality. These analyses are done at farmers' level.

4.6.1 Factors Influencing Choice of Marketing Channel of Tomato Farmers

The Multinomial Logit Model (MNL) was used to analyze the factors influencing the choice of marketing channels by smallholder tomato farmers in KNM. This is because, the parameters estimate of MNL model offer only the direction of effect of the explanatory variables on the dependent variable. The Haussmann test of independence of irrelevant alternatives (IIA) assumptions was used to test the three channel choices of the model. Consequently, the test fails to reject the null hypothesis of independence of the included market channels and established that, the multinomial logit model was correctly specified. Hence, the application and specification of the MNL model to the data set was justifiable. The MNL model's estimation is statistically significant in explaining the choice of market channel by farmers. The test of multicollinearity was equally conducted and the results of variance inflation factor (VIF) established that, there exist no correlations between any of the independent variables. The Haussmann and multicollinearity tests are presented in Table 4.6.1 and 4.6.2 at appendices respectively.

The results of multinomial logit model in Table 4.4 at the appendices revealed that, the Chi square value is 119.00, and it is statistically significant at 1% level. The results show that the explanatory variables explains 33.14 percent of total variation of market channel choice of tomato farmer in KNM. At 1% significant level, the hypothesis that, all the coefficients with the exception of the constant are zero is rejected by the test.

Table 4.8 Empirical Determinants of Choice of Marketing Channels by Tomato Producers in KNM in UE/R of Ghana

	Multinomial Logit Results		**Marginal Effects**			
Combination of marketing channels	**Channel II**	**Channel III**	**channel II**	**Channel III**		
Variable	Coefficient	Coefficient			Chan II Std. Err.	Chan III Std. Err.
Farmer's age in years	-0.0465	-0.192***	0.00587	-0.01855**	0.0493	0.0699
Farmer has formal education	-0.1270	-0.253***	-0.0029	-0.01986**	0.0817	0.0950
Gender of farmer-Male	-1.140	-0.852	-0.1253	-0.01708	0.697	0.867
Household size	-0.396***	-0.425**	-0.03456*	-002056	0.144	0.189
Farmer belongs to an FBO	-0.210	2.385***	-0.200801*	0.2857***	0.774	0.894
Used improved variety of tomato seeds	2.190***	2.399**	0.18745*	0.11943	0.847	1.089
Farm size in acres	3.240***	1.760*	0.40256***	-0.02656	0.858	0.958
Labour cost	-0.0209***	-0.010*	-0.00269***	0.000325	0.0053	0.0059
Access to market information	1.874**	-0.853	0.36368***	-0.22801***	0.741	0.815
Mean market distance	0.263	-0.426	0.07244**	-0.06678**	0.264	0.291
Farmer has received credit	0.0011	0.0022	0.00022	0.000177	0.0015	0.0015
Harvesting period_Dec/Jan.	-4.250***	-2.944**	-0.4835***	-0.03737	1.227	1.423
Harvesting period_Jan/Feb	-4.501***	-4.778***	-0.3960***	-0.22815*	1.359	1.556
Constant	9.532***	16.46***			3.275	4.117
Base Outcome: use of only one (I) marketing channel						
Number of observations	**172**			172		
LR chi^2(26) = 119.00						
Prob > chi^2=0.0000						
Log likelihood =-120.03864						
Pseudo R^2= 0.3314						

*****, ** and * imply statistical significance at 1%, 5% and 10% respectively.**

Source: Field Survey, 2017.

As indicated in Table 4.8, the results of the coefficients of determinants of marketing channels choice by tomato producers in the first column is analysed as below:

Age: The results revealed the farmer age to be negatively significant on channel three (III) choice of the tomato distribution. Statistically, an increase in the age of smallholder tomato farmer by one year, decreases the probability of selling their produce through channel three choice of distribution by 0.192 crates of tomato. Hence, older farmers are less likely to adopt channel three at the expense of the other channels relative to the based category.

Formal Education: From the multinomial analysis, the coefficient of farmers with formal education is negative at 1% significant level on only channel three (III) choice of the smallholder tomato farmer. This means that, tomato farmers with formal education are less likely to sell their produce through channel three (III) than those without formal education. The output of the model predicts that, as farmer's households' level of education increases by one year, the probability of adopting channel three (III) marketing choice for the sale of tomato would decreases by 0.253.

Households Size: Farmer's household size is significant at 1% and 10% level with a negative effect on two channels as well as three channels of distribution of tomato by the smallholder tomato farmer respectively. This shows that, farmers with larger household sizes are less likely to adopt selling their fresh tomato through two (II) and only three (III) channels than their counterparts with small household sizes. Consequently, an increases in household size of farmers by one person, decreases the probabilities of small holder farmers in marketing their tomato through channel two (II) and channels three (III) choice respectively by 0.396 and 0.425.

Used of Improved Tomato Variety Seeds: The use of improved variety of tomato seeds is significant and positively has effect on both channel two (II) and three (III) choice at 1% and 10% levels respectively. As such, household tomato farmers in the KNM using improved variety of tomato seed are more likely to prefer channel two (II) marketing and three (III) marketing channel for the sale of their produce. Practically, one percent increase in the use of improved tomato variety seeds of the household tomato farmer in KNM would increase the likelihood in the marketing of tomato by 2.190 and 2.399 through the channel two (II) channel three (III) choices.

FBO MEMBERSHIP: Farmers belonging to an FBO is positively significant at 10% level in only channel three (III) choice of tomato distribution. The results mean that, farmers with FBO are more likely to sell their produce through only three (III) channel choice of distribution than their counterparts without FBO membership.

Farm size: The variable farm size has positive signs for both only two (II) and three (III) channel but was significant at 1% for only channel two (II) and 10% level for only channel three (III). These show that, the larger the farm size a household allocate for tomato production the more likely they would adopt only two and three/four channels for marketing of their tomato. Hence, as household farmer in the KNM increases land size allocation for tomato production by one acre, only channel two (II) and three (III) choice of marketing tomato would increase by 3.240 and 1.760 respectively.

Cost of Labour: Another important variable is the cost of labour. This is because, cost of labour increases cost of production and such decreases marginal revenue of the farmer. Cost of labour is found to be negatively significant at 1% and 10% levels at both two channels and three/four channel choice of distribution by the small holder farmer. This

means that, an increase in the cost of labour decreases the probability of the small holder farmer selling their produce through channel two (II) and three (III) choice of distribution.

Access to Market Information: The availability of market information helps farmers decide which particular market their produce could sell in order to maximize profits. The results revealed that, access to market information is positively significant and at 5% level on only two channel choices. This means that, farmers with access to market information are more likely to sell their tomato through only channel two marketing choice relative to the based category. This has met prior expectations of the researcher because, the researcher postulated that, access to market information enables the tomato farmer have variety of markets for the sale of his/her produce instead of allowing them to rot at the farms. This is in conformity to the study by Mebrat (2015) on the factors that influence the market channel choice of tomato marketing among tomato farmers, traders, and consumers in Ethiopia which established that the variable, access to market information, have a positive significant effect on the tomato farmers market channel choice decisions.

December-January Harvesting Period: The December-January harvesting period has a negative significance at 1% and 5% levels at both two and three/four channel choices of distribution. By implication, an increase in harvest of tomato between December to January decreases the likelihood of farmers selling their tomato through both channel two and channel three (III) choice of distribution. This can be attributed to the fact that, during these periods (December-January) the commodity is limited in supply, as such, commands higher demand. Hence, has met researcher's prior expectations.

January-February Harvesting Period: The variable, January-February harvesting period is significant but, negatively affects the two channel choice as well as channel three (III) choices at 1% level of the tomato distribution in KNM. This means that, fewer farmers are more likely to adopt two and three (III) channel choice relative to the based category.

4.6.2 Major Factors Affecting Choice of Marketing Channels of Tomato Producers

The base outcome used for this estimations was channel one. The marginal effect estimates represent the probability of selling through to only channel two (II) or channel three (III) relative to the base category. As a result, all the possible alternatives of tomato marketing channels in the KNM are compared to the base category, which is only channel one (I). In fact, the marginal effect of Multinomial Model analysis on the factors that influences the choice of indigenous climate related strategies of smallholder farmers in Northern Ghana by Al-hassan *et al.* (2013) stressed that, using marginal effects is superior to the estimated coefficients, as a result you have to choose the channel that best fit the model as the base category.

The results of marginal effect in Table 4.8 above revealed that, the age of the farmer has a negative effect on the probability of a farmer in KNM choosing channel three (III). The negative relationship indicates that, as the age of the farmer increases, the likelihood of selling to channel III decreases. Basically, as farmers age advances, they are less likely to sell through channel III by 1.855% relative to the base category. Hence, older famers are less likely to adopt selling their tomato to channel III as compared to younger farmers relative to the base category.

Further, formal education of farmer is significantly having a negative effect on the choice of selling to channel three (III) relative to the base category. Statistically, an increase in the

level of farmer's formal education, would lead to a corresponding decrease in the probability of selling to channel three (III) by 1.986% relative to the base category. This means that, farmers with formal education are less likely to sell their tomato to channel III relative to the basic category. Hence, educated tomato farmers are less likely to sell their produce through the three (III) channel as compared to illiterate farmers relative to the base category. This has met prior expectations and is in contradiction to Mamo & Degnet's (2012) study on the factors that influence the market channel choice of livestock marketing in rural Ethiopia among livestock producers. Their study found the variable, education, to be significant and has a positive effect on the producer's market channel choice decisions.

Furthermore, household size is another important variable in the Table 4.8 Household size refers to the total number of people eating from the same pot and are living under the same head. The results of the marginal effect revealed that, household size was found to negatively affect household decision to sell to only channel two (II) of the marketing choices. As such, an increase in household's size by one person decreases the probability of a farmer's choice of selling through only channel two (II) by 3.456% relative to the base category (only channel one). Implying that, larger household's farmers are less likely to sell their produce through channel II as compared to smaller household's farmers relative to the base category.

More so, farmers belonging to FBO are found to affect tomato farmers' decisions to market their produce through the two channel choice negatively but, affects channel three/four choice positively. As a result, being a member of FBO by a farmer decreases the probability of his/her marketing tomato through only two channel choice by 20.080%. In contrast, failing to belonging to FBO membership by one person will increase the probability of

selling through the three (III) channel choice by 28.57%. This has contradicted the prior expectation of the researcher. The researcher expected that, famers with FBO are better organized and would be able to establish good relationship with a particular and regular customer base, for the purchase of their produce.

Equally important, the use of improved variety seeds is found to have a positive significance with only two channel choice of distribution relative to the based category. Statistically, an increase in the adoption of improved variety seeds will increase the likelihood of selling through only two channels by 18.745%. Evidence from the field revealed that, tomato fruits of the improved variety are more plump or bigger than the local variety. As such, they command higher demand by most wholesalers from southern Ghana and other tomato buyers than the local tomato variety. This has met the prior expectation of the researcher. The researcher expected that, famers with improved variety tomato will attract more customers than their counterparts with local variety tomato.

Another important economic variable is farm size, which measures the average land cultivated. Farmers who have allocated more acres of land for tomato production would obtain more tomato than those with less allocation of land. Farm size significantly and positively affects household's decision to sell their produce to channel two markets choice only. Therefore, a 1-acre increase in tomato farmer's farm size increases the probability of a farmer's position of selling through channel two choice of marketing by 40.256% relative to the base category. By implication, farmers that cultivate larger land sizes produces more quantities of tomato and choose to sell through channel two marketing choice as compared farmers with less farm size relative to the base category. This could be attributed to the fact that, tomato farmers choose the nearest marketing channel in other to minimize their losses.

This has met researcher's prior expectations and it is in accordance to Mebrat (2015) study on the factors that influence the market channel choice of tomato marketing in rural Ethiopia among tomato producers. His study found the variable, farm size, to have a significant and positive effect on the producer's market channel choice decisions.

More to the point, the cost of labour could affect tomato productivity and hence, affects the channel choice of producers. This is because, cost of labour increases cost of production and as such may decrease profits margin of the farmer. The results established cost of labour to be significant but negatively affects the channel choice of the tomato producers on channel two (II). This implies that, 1 Ghana cedi increase in the cost of labour will decrease the probability of marketing tomato through only two channel choice by 0.269% relative to the base category.

Again, access to market information is an incentive to farmer's decision of the channel choice decision. This steamed from the fact that, the smallholder tomato farmer is always aiming at making profits from his produce. The marginal effect of the access to market information significantly and positively affect the channel two choice but negatively affects the channel three (III) choices of the smallholder tomato farmer. The positive significance of the channel two choice implies that, an increase of access to market information increases the probability of the smallholder tomato farmer in selling their produce through the two channel choice by 0.364 as compared to those without market information relative to the based category. In contrast, the negative significance of access to market information on the channel three (III) choice indicates that, farmer's access to market information decreases the probability of selling through the channel III choice by 0.228 relative to the base category.

Additionally, distant to market is a disincentive to increased production due to the cost of transportation coupled with the perishable nature of tomato. The average distant from farm to market is found to be significant at both channel two choice and channel three (III) choices. The marginal effect on the two channels is positive which means that, as the distance between the farm and market source increases by a kilometre, the probability of the tomato farmer selling through two channels increases by 0.07244. However, the negative significance on the three (III) channel choice indicates that, an increase in distance from the farm to market source by a kilometre, decreases the probability of the tomato farmer from selling through channel three (III) choice by 0.06678 relative to the base category.

Equally, the variable harvesting period (December/January) describes the time at which some tomato farmers in the KNM harvest their tomato for sale (Amikuzono *et al.*, 2015). The December/January harvesting period has negatively affected the two channels choice. This means that, an increase in tomato harvest between December/January by a crate decreases the probability of the tomato farmer from selling through channel two (II) choice by 0.4835 as compared to those harvesting in January/February relative to the based category.

Finally, harvesting period (January/February) describes the time at which most tomato farmers in the KNM and some Burkina Faso harvest their crop for sale (Amikuzono *et al.*, 2015). This variable is equally significant but negatively affects both the two and three (III) channel choice relative to the based category. This negative significance implies that, an increase in tomato harvest between January/February by a crate decreases the probability

of the tomato farmer from selling through channels two and three/four choice by 0.3960 and 0.22815 respectively relative to the based category.

4.7. Postharvest Losses and the Drivers

The forth objective of the study sought to assess the factors affecting postharvest losses among the smallholder irrigated tomato farmers in KNM. Hence, these factors affecting postharvest losses of the smallholder irrigated tomato farmers in KNM are presented in Table 4.9.

4.7.1 Factors Affecting Post-Harvest Losses of the Smallholders Irrigated Tomato Farmers

The factors affecting postharvest losses were analyzed using semi-log of OLS. The analysis was done in modeling the total losses and losses per acre level. The variables of interest were: educational level, gender, age in years, membership of FBO, farmer use of mobile phone, quantity of tomato harvested, distance to nearest market, farm size, tomato seed variety, total labor cost, credit received, market information, and period of harvest. The results are displayed in Table 4.9.

From Table 4.9, the results of the analysis established that, the adjusted R-squared which measures coefficient of determination is 0.7284. This implies that 72.84% of the total variation of quantities of tomato lost during the time of harvesting and after harvesting are explained by explanatory variables. The F-statistics for both results was at 1% significant level suggesting that, all the independent variables jointly explain the amount of postharvest losses in KNM. The summary of the model is shown in Table 4.9.

Table 4.9 Determinants of Post-Harvest Losses of Tomato Famers

Variables	Model 1: Log of Total Losses		Model 2: Log_Per Acre Losses	
	Coefficient	Std. Error	Coefficient	Std. Error
Age in years	-0.0326***	0.00933	-0.0424***	0.0106
Educational level	-0.0130	0.0124	-0.00622	0.0140
Gen (Male)	-0.546***	0.116	-0.545***	0.131
Household size	-0.0468*	0.0245	-0.0226	0.0277
Membership of FBO	-0.163	0.157	-0.218	0.178
Uses a mobile phone	-0.339**	0.154	-0.119	0.174
Uses improved tomato seed	-0.160	0.134	0.0339	0.152
Farm size in acres	-0.0816	0.162	0.183	0.184
Quantity harvested tomatoes (Crates)	0.00380	0.00249	0.00174	0.00282
Total labor cost (GHS)	0.00760***	0.000859	0.00546***	0.000972
Market information	0.465***	0.118	0.313**	0.133
Average distance to nearest market	-0.185***	0.0447	-0.00222	0.0506
Amount of credit received	0.000608**	0.000241	0.000158	0.000273
Tomatoes harvested in Dec-Jan	0.917***	0.228	0.415	0.258
Tomatoes harvested in Jan-Feb	1.272***	0.205	0.656***	0.232
Constant	4.254***	0.478	3.038***	0.541
Observations	172		172	
R-squared	0.7284		0.5616	
F(15, 156)	27.89		13.32	
Prob > F	0.000		0.000	

Note: *** p<0.01, ** p<0.05, * p<0.1.

Source: Field Survey, 2017.

Age was found to be significant at 1% level and negatively affects postharvest losses of smallholder tomato farmer at output's loss per acre level. This relationship shows that, older farmers are less likely of incurring more postharvest losses at output per acre level.

This is because, the farmers gain more experience as they are engaged in continues production. As a result, a 1year increase in the age of a farmer decreases occurrence of postharvest losses by 0.0326 at total loss as compared to 0.0424 losses per acre level. Hence, the age of farmer has met the researcher's prior expectations.

The results of the model in Table 4.9 above revealed that, gender is highly sensitive among smallholder tomato farmers. As a result, this variable met the researcher's prior expectations. Farmer's gender (Male) was found to be significant and negatively affects the levels of postharvest losses at 1% level in the output per acre level. This implies that, male farmers are less likely to incur higher levels of postharvest losses as compared to their female counterparts. This is in accordance with the findings of Aidoo *et al.* (2013) who concluded that, there was a significant negative effect in gender on postharvest losses and that, there existed gender inequality among tomato farmers.

Contrary to this is the finding of Babalola *et al.* (2010) who asserted that, there was a little or no significant effect of gender on postharvest losses. It is important to note that, male farmers are naturally stronger and have more time (man-hours) than female farmers. Due to this, male farmers can embark upon farm activities more effectively than female farmers. Yet, other socio-cultural and household responsibilities could be a hindrance to realising the fullest participation or involvements of female tomato farmers in the tomato industry. However, when the tomato fruits are ripe and ready for harvesting and marketing, more females are hired as labourers, whilst their male counterparts are responsible for carrying and loading them. Hence, pointing to the fact that, gender sensitivity existed right from the farming stage up to the marketing stage across the smallholder tomato farmers.

Labour cost was another important variable which consisted of all the expenses incurred by farmers in employing labour in the production and marketing of the product. The labour cost was statistically significant at 1% level and positively affected the postharvest losses of the tomato farmer at an acre level. This implies that, an increase in farmer's labour cost of production increases the quantity of postharvest losses for the season. This has met the prior expectations of the researcher because, the researcher stipulated that an increase in labour cost will increase farmer's postharvest losses of tomato production per acre level as some tomato farmers were reported to have committed suicides in municipality during the field survey. This was due the fact that, these farmers had contracted loans to farm but, could not repay due to high postharvest losses incurred.

Market information available to farmers in the marketing of their produce is crucial because, it helps farmers to understand the market dynamics in order to bargain effectively for higher price of their produce. From the regression analysis, farmers' access to market information has a positive significance at 5% level per acre level for the season. As a result, a farmer who has market information stands the chance of incurring less postharvest losses as compared to those without market information. This implies that, farmers who has no market information are more likely to incur postharvest losses than those with market information.

Then also, the period of harvesting tomato was considered as an important factor to postharvest losses of the smallholder tomato farmer. This has been categorised into two harvesting periods (December-January and January-February). From the Table 4.9 tomato harvested between late December and early January was found to be significant and positively affects postharvest losses. This occurs at outputs per acre level. This means that,

farmers who harvested tomato from December-January incurred more postharvest losses in outputs per acre level. This has not met the prior expectations of the researcher. Because, the researchers expected less postharvest losses of tomato harvested between late December and early January since, the commodity is often scarce during these periods.

Finally, tomato harvested during January to early February has 10% positive significant on postharvest losses per acre level as well as total production. Practically, farmers whose tomatoes are harvested in these periods are more likely to experience huge postharvest losses. This has met prior expectations of the researcher. Because, January to early February is mostly the period of gluts in which almost all tomato farmers are harvesting their produce as revealed from the field survey. Besides, it is the period in which the Burkinabe tomato product is imported in to the country. Evidence from the field survey revealed that, most farmers in the KNM had their tomato harvested and marketed in late December to January. This confirms the finding of Ihle and Amikuzuno (2009) who concluded that, the UE/R tomato is harvested and supplied to the market in January whilst the Burkinabe tomato is supplied to Ghana's market from February onwards.

CHAPTER FIVE

SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Introduction

This section provides the summary of the research, the key findings, conclusions drawn from the findings and recommendations on the current trends of the tomato industry of the Kassena Nankana Municipality (KNM) in particular and the Upper East Region of Ghana at large.

5.2 Summary of Key Findings

The Kassena Nankana Municipality of the Upper East Region of Ghana is an important tomato producing community and has huge economic potentials in terms of well-developed irrigation scheme, labour force and access to exchange of knowledge and experience from the Burkinabe tomato farmers to improve upon its production in order to meet the growing tomato needs or requirement of Ghana. The study sought to analyse gross margin and postharvest losses of the smallholder irrigated tomato farmers in the KNM of the UE/R of Ghana. It therefore examined the gross margins, market channel choice, factors affecting channel choice of the producers, postharvest losses and factors affecting the postharvest losses in the Municipality. Whilst determinants of choice of marketing channels were analysed using multinomial logit model, drivers of postharvest losses were analysed with the help of OLS regression model.

The multistage sampling procedure was adopted for the study to select a total of 272 respondents in the tomato value chain of the Municipality. These consisted of 172 farmers,

and 100 traders. The analysis of market channel choice of tomato farmers established that, channel one (I) was use as the based category for the analysis. Consequently, the analysis revealed that, some farmers prefer selling their tomato through channel two (II), others prefer selling their produce to channel three (III) choices relative the based category. With this, farmers sold their produce to different traders pointing to the existence of no monopoly by any actors especially wholesalers in the value chain of the KNM. However, it is obvious from the survey that, majority (75%) of the farmers sold their produce through the retailers' channel. With wholesalers, as the second highest representing 51.2% of the channel choice of the producers. Interestingly, the wholesalers asserted that, tomato production in terms of quantity and quality in the Municipality was very appalling. The analysis equally established that, a total of 40.1% of the producer's form the third (roadside traders) channel choice of the sale of tomato by farmers in the KNM, whilst consumers channel was the least channel choice of the producers, which stood at 26.7%.

In analyzing the factors affecting the market channel choice of the smallholder tomato farmers, the results established that, improved variety seeds, farm size and access to market information greatly and positively influenced the choice of marketing channel in the KNM. On the other hand, age, education, gender, household size, FBO, cost of labor and harvesting period negatively affected the choice of marketing channels.

Further, the survey revealed that, the average acres of irrigated tomato farm land in the KNM was 0.92 whilst the minimum and maximum irrigated land size of a smallholder tomato farmer stood at 0.5 and 2.0 acres respectively. Meanwhile, the variety of tomato seeds used in the cultivation was composed of both improved and local variety.

The result indicated that, the farmer's average total output of tomato crates of local variety (large and small crates) sold for the season stood at 56.19 per acre and the mean total output of improved variety (large and small crates) was 60.31 crates per acre. This implies that, on the average, output of the improved variety seeds per acre yielded higher quantities of tomato (crates) than the output of tomato (crates) from local variety seeds per acre.

At the same time, on the average, the total revenue per acre of the smallholder irrigated tomato farmers in the KNM was GHS 4,262.01 at an average of GHS 3,921.05. However, the total variable cost (TVC) of the smallholder irrigated tomato farmer for the season stood at GHS 2,333.07 at an average cost of GHS 940.87. Consequently, smallholder tomato farmer in KNM of the UE/R realised average gross margin of GHS 3,321.14 per acre of land for the season.

Furthermore, the smallholder tomato farmer was greatly affected by postharvest losses. The smallholder tomato farmer incurred a minimum loss of GHS 500 to postharvest losses and an average of GHS 3,574.68 representing 41% per acre with a total post-harvest loss of GHS 5,098.72 representing 59% for the season in the KNM. This losses (41%-59%) no doubt, contributed to the decrease in profit margins of the tomato farmers in the KNM.

The study equally revealed that, a postharvest loss was positively affected by the farmer's age, credit received, labour cost, market information, and time of harvest. However, education, household size, use of mobile phone, gender, and average distance to the nearest market was negatively affected by postharvest losses.

5.3 Conclusion

To begin with, the presence of some irrigation scheme in the form of Tono irrigation and dugout wells, access to credit and the distance between farms and market centres forms the foundation to the smallholder irrigated tomato farming in the KNM.

Further, from the above analysis, a smallholder tomato farmer adopts different channels of marketing their produce in the KNM. Whereas most of the farmers preferred selling through the retailer's channel of distribution, others preferred the wholesalers and some to the roadside traders in marketing of their produce. In view of the above, the study concludes that, smallholder irrigated tomato farmers have little or no preference of selling their produce to wholesalers. The analysis of the factors affecting the market channel choice established that, used of improved variety seeds, farm size and access to market information greatly and positively influenced the choice of marketing channel. Whilst age, education, gender, household size, FBO, cost of labor and harvesting period negatively affected the choice of marketing channels.

Furthermore, the outputs of tomato from improve variety seeds yielded higher quantities and revenue than the local variety tomato. The study equally revealed higher gross margins hence, researcher concludes that, in spite of the level of postharvest losses, the gross margins accrued to the producers is reasonably high and a motivation factor for farmers to reconsider working around the clock to reducing the postharvest losses and thereby increasing profits margin.

Finally, the smallholder tomato farmer incurred high postharvest losses and the losses ranges between GHS 3,574.68 (41%) per acre to a total post-harvest loss of GHS 5,098.72 (59%) for the season. The postharvest loss was positively affected by the farmer's age,

credit received, labour cost, market information, and time of harvest. Whilst, education, household size, use of mobile phone, gender, and average distance to the nearest market was negatively affected by postharvest losses.

5.4 Policy Recommendations

The following recommendations are made based on the findings of the study:

Firstly, the analysis revealed that, much of the farmers' produce went to the retailers. This means that there exist no interference of intermediaries and limited selling markets in the value chain. This potentially reduces the share of producer profit. In this regards, it is imperative to promote strong collective cooperatives among smallholder farmers which will go a long way to improve their bargaining power in the value chain.

Secondly, the analysis reveals a significant amount of gross margin. Hence, potential investors could take advantage of the higher gross margins from the KNM and invest in the irrigation of tomato farming needed to increase its supply in the country. Besides, tomato of improved variety seed in KNM yielded more output, quality and revenue than local variety seeds. Due to this, farmers of the Municipality must accept a change, by adopting the new and improved variety seeds of tomato for cultivation. Government through MoFA should equally intensify the supply and provision of education on using improved variety seeds, so as to increase tomato production in the Municipality.

Thirdly, the postharvest losses incurred is very high in spite of the substantial gross margin farmers achieved. As a result, government should establish storage facilities or revamp the Northern Star Tomato Company (NSTC) to purchase the produce in the Municipality. Through this means the levels of postharvest losses among the smallholder's irrigated

tomato farmers in the region would be minimised which would go a long way to increase profits margin.

Finally, the Ordinary least squares (OLS) model result on postharvest losses revealed that, farmers are sensitive to access to market information. Market information can help farmers to reduce postharvest losses through market choices, from the very first steps of the production process up to when the product is actually sold. This is because, current market information accessed through different sources reduces risk, perceptions and encourages marketed surplus of tomato product. Hence, strengthening market information system will go a long way to alleviate the level of postharvest challenge.

5.5 Suggestions for future studies

Firstly, future research could be aimed at researching into the differences in gross/profits margin of tomato produced from dugout wells and Tono irrigation scheme in the KNM.

Secondly, future researchers should compare the gross margins between tomato farmers and traders in the value chain of the KNM.

Finally, future research should aim at researching into what the Burkinabe tomato farmers do different from the tomato farmers of the Kassena Nankana Municipality of the Upper East Region of Ghana thereby making the Burkinabe tomato more preferred to that of tomato of the KNM.

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APPENDIX 'A' (EVIDENCE OF SOFTWARE GENERATED ANALYSIS)

**** suest-based Hausman tests of IIA assumption (N=172)

Ho: Odds(Outcome-J vs Outcome-K) are independent of other alternatives.

Omitted	chi2	df	P>chi2	evidence
2	7.857	14	0.897	for Ho
3	9.212	14	0.817	for Ho

Iteration 0: log likelihood = -179.53664
Iteration 1: log likelihood = -126.24674
Iteration 2: log likelihood = -120.54182
Iteration 3: log likelihood = -120.04224
Iteration 4: log likelihood = -120.03864
Iteration 5: log likelihood = -120.03864

Multinomial logistic regression — Number of obs = 172
LR chi2(26) = 119.00
Prob > chi2 = 0.0000
Log likelihood = -120.03864 — Pseudo R2 = 0.3314

chan_com	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1	(base outcome)					
2						
f_age	-.046476	.0493079	-0.94	0.346	-.1431177	.0501658
edu_level	-.1270458	.0816604	-1.56	0.120	-.2870973	.0330056
gend_f	-1.139813	.6965628	-1.64	0.102	-2.505051	.2254251
hhs	-.396197	.1438076	-2.76	0.006	-.6780547	-.1143394
FBO	-.2095385	.7738368	-0.27	0.787	-1.726231	1.307154
seed_var	2.189627	.8470224	2.59	0.010	.5294934	3.84976
farm_size	3.240159	.8575191	3.78	0.000	1.559453	4.920866
tlab_cost	-.0208953	.0053262	-3.92	0.000	-.0313344	-.0104561
mkt_info	1.873763	.7414069	2.53	0.011	.4206318	3.326893
dist_mkt	.2629707	.2644788	0.99	0.320	-.2553983	.7813396
cred	.0011004	.0015151	0.73	0.468	-.001869	.0040699
HT_DJ	-4.249555	1.226997	-3.46	0.001	-6.654424	-1.844685
HT_JF	-4.50074	1.359137	-3.31	0.001	-7.164598	-1.836881
_cons	9.53173	3.275432	2.91	0.004	3.112002	15.95146
3						
f_age	-.1918333	.0699346	-2.74	0.006	-.3289026	-.054764
edu_level	-.252996	.0949586	-2.66	0.008	-.4391114	-.0668805
gend_f	-.8518755	.8670242	-0.98	0.326	-2.551212	.8474607
hhs	-.4248554	.1887951	-2.25	0.024	-.7948871	-.0548237
FBO	2.384946	.8941619	2.67	0.008	.6324213	4.137471
seed_var	2.398656	1.089146	2.20	0.028	.2639677	4.533343
farm_size	1.760467	.9583188	1.84	0.066	-.1178033	3.638737
tlab_cost	-.0100004	.0058552	-1.71	0.088	-.0214763	.0014755
mkt_info	-.8532432	.8147487	-1.05	0.295	-2.450121	.7436349
dist_mkt	-.4258266	.2911308	-1.46	0.144	-.9964325	.1447792
cred	.0022358	.0015449	1.45	0.148	-.0007921	.0052637
HT_DJ	-2.944442	1.422632	-2.07	0.038	-5.73275	-.1561339
HT_JF	-4.777885	1.555717	-3.07	0.002	-7.827035	-1.728734
_cons	16.46278	4.116533	4.00	0.000	8.394529	24.53104

```
. margins, dydx(*) predict (outcome (2))

Average marginal effects                        Number of obs   =        172
Model VCE    : OIM

Expression   : Pr(chan_com==2), predict(outcome (2))
dy/dx w.r.t. : f_age edu_level gend_f hhs FBO seed_var farm_size tlab_cost mkt_info dist_mkt cred HT_DJ HT_JF
```

	Delta-method dy/dx	Std. Err.	z	P>|z|	[95% Conf.	Interval]
f_age	.0058766	.0075216	0.78	0.435	-.0088654	.0206185
edu_level	-.0029177	.0098095	-0.30	0.766	-.0221438	.0163085
gend_f	-.125347	.0890277	-1.41	0.159	-.2998381	.0491441
hhs	-.0345659	.0197474	-1.75	0.080	-.0732701	.0041384
FBO	-.2008019	.1052859	-1.91	0.056	-.4071585	.0055548
seed_var	.1874898	.1099702	1.70	0.088	-.0280477	.4030274
farm_size	.4025681	.0958519	4.20	0.000	.2147017	.5904344
tlab_cost	-.0026907	.0005523	-4.87	0.000	-.0037733	-.0016081
mkt_info	.3636837	.0839669	4.33	0.000	.1991117	.5282557
dist_mkt	.0724482	.035303	2.05	0.040	.0032555	.1416409
cred	.0000222	.0001819	0.12	0.903	-.0003343	.0003786
HT_DJ	-.4835282	.1421438	-3.40	0.001	-.762125	-.2049315
HT_JF	-.3960488	.1490027	-2.66	0.008	-.6880887	-.1040089

```
. margins, dydx(*) predict (outcome (3))

Average marginal effects                        Number of obs   =        172
Model VCE    : OIM

Expression   : Pr(chan_com==3), predict(outcome (3))
dy/dx w.r.t. : f_age edu_level gend_f hhs FBO seed_var farm_size tlab_cost mkt_info dist_mkt cred HT_DJ HT_JF
```

	Delta-method dy/dx	Std. Err.	z	P>|z|	[95% Conf.	Interval]
f_age	-.0185486	.0072368	-2.56	0.010	-.0327325	-.0043648
edu_level	-.0198638	.0078054	-2.54	0.011	-.0351622	-.0045654
gend_f	-.0170843	.0789707	-0.22	0.829	-.171864	.1376955
hhs	-.0205685	.0185987	-1.11	0.269	-.0570213	.0158842
FBO	.2856716	.0844515	3.38	0.001	.1201497	.4511934
seed_var	.1194295	.1032072	1.16	0.247	-.082853	.321712
farm_size	-.0265671	.0802095	-0.33	0.740	-.1837748	.1306406
tlab_cost	.000325	.0004578	0.71	0.478	-.0005722	.0012223
mkt_info	-.2280121	.0654192	-3.49	0.000	-.3562314	-.0997928
dist_mkt	-.0667817	.0269275	-2.48	0.013	-.1195587	-.0140048
cred	.0001771	.0001209	1.47	0.143	-.0000598	.000414
HT_DJ	-.0373772	.1202732	-0.31	0.756	-.2731083	.1983538
HT_JF	-.2281545	.121643	-1.88	0.061	-.4665704	.0102614

Table 4.3.1 Test of Independence of Irrelevant Alternatives (IIA)

Suest-Based Haussmann Tests of Independence of Irrelevant Alternatives

Omitted	Chi^2	Df	$P>chi^2$	Evidence
2	7.857	14	0.897	for H_0
3	9.212	14	0.817	for H_0

Source: Field Survey Data, 2017.

NB: Ho: Odds (Outcome-J vs Outcome-K) are independent of other alternatives.

Table 4.3.2 Test for Multicollinearity among Explanatory Variables

Results of Test of Multicollinearity

Variable	Variance Inflation Factor (VIF)
Age	1.79
Education	1.92
Gender of farmer	1.94
Household size	1.84
FBO	1.92
Variety of tomato seeds used by farmer	1.63
Farm size	1.90
Labour Cost	1.55
Mean Market Distance	1.88
Credit access	1.87
Use of hired labour	1.55
Tomato harvest in December-January	1.58
Tomato harvested in January-February	1.38

Source: Field Survey, 2017.

```
. reg ltphl f_age edu_level gend_f hhs FBO mphone seed_var farm_size volume_harv tlab_cost mkt_info dist_mkt cred HT_DJ
> HT_JF
```

Source	SS	df	MS	Number of obs	=	172
				F(15, 156)	=	27.89
Model	118.063799	15	7.87091994	Prob > F	=	0.0000
Residual	44.0235257	156	.282202088	R-squared	=	0.7284
				Adj R-squared	=	0.7023
Total	162.087325	171	.947879092	Root MSE	=	.53123

ltphl	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
f_age	.032646	.009326	3.50	0.001	.0142245	.0510675
edu_level	-.0130451	.0123815	-1.05	0.294	-.0375022	.0114119
gend_f	-.5460017	.1158342	-4.71	0.000	-.7748074	-.3171959
hhs	-.0468203	.0244987	-1.91	0.058	-.0952123	.0015717
FBO	-.1627229	.1572237	-1.03	0.302	-.4732849	.1478391
mphone	-.3392545	.1540248	-2.20	0.029	-.6434978	-.0350112
seed_var	-.1604483	.1342387	-1.20	0.234	-.4256084	.1047117
farm_size	-.0816329	.1622331	-0.50	0.616	-.40209	.2388241
volume_harv	.0038009	.0024893	1.53	0.129	-.0011161	.0087179
tlab_cost	.0075974	.0008589	8.85	0.000	.0059009	.0092939
mkt_info	.4645395	.1177179	3.95	0.000	.2320129	.6970661
dist_mkt	-.1852966	.0446742	-4.15	0.000	-.2735409	-.0970523
cred	.0006075	.0002413	2.52	0.013	.000131	.0010841
HT_DJ	.9168316	.2276765	4.03	0.000	.467105	1.366558
HT_JF	1.272144	.2053077	6.20	0.000	.8666024	1.677686
_cons	4.2539	.477865	8.90	0.000	3.309979	5.197821

```
. reg lnphl f_age edu_level gend_f hhs FBO mphone seed_var farm_size volume_harv tlab_cost mkt_info dist_mkt cred HT_DJ
> HT_JF
```

Source	SS	df	MS		
Model	72.2761557	15	4.81841038	Number of obs	= 172
Residual	56.4296302	156	.361728399	F(15, 156)	= 13.32
				Prob > F	= 0.0000
				R-squared	= 0.5616
				Adj R-squared	= 0.5194
Total	128.705786	171	.752665415	Root MSE	= .60144

lnphl	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
f_age	.0423721	.0105586	4.01	0.000	.0215158	.0632283
edu_level	-.0062165	.014018	-0.44	0.658	-.033906	.021473
gend_f	-.5448363	.1311438	-4.15	0.000	-.803883	-.2857895
hhs	-.022576	.0277367	-0.81	0.417	-.0773639	.0322119
FBO	-.2183905	.1780038	-1.23	0.222	-.5699991	.1332182
mphone	-.1187173	.1743821	-0.68	0.497	-.4631721	.2257375
seed_var	.0339164	.1519809	0.22	0.824	-.2662895	.3341223
farm_size	.1834071	.1836753	1.00	0.320	-.1794043	.5462186
volume_harv	.0017431	.0028183	0.62	0.537	-.0038238	.00731
tlab_cost	.0054623	.0009724	5.62	0.000	.0035416	.007383
mkt_info	.3128011	.1332765	2.35	0.020	.0495417	.5760605
dist_mkt	-.0022207	.0505787	-0.04	0.965	-.1021281	.0976868
cred	.0001577	.0002731	0.58	0.565	-.0003819	.0006972
HT_DJ	.4153538	.2577682	1.61	0.109	-.0938126	.9245202
HT_JF	.6560697	.232443	2.82	0.005	.1969279	1.115212
_cons	3.037823	.5410238	5.61	0.000	1.969145	4.1065

APPENDIX 'B'

PHOTOGRAPHS FROM THE FIELD SURVEY

Tono Irrigation Scheame

Source: Field Survey, 2017.

Dug-out wells

Source: Field Survey, 2017.

APPENDIX 'C'

FACULTY OF AGRIBUSINESS AND APPLIED ECONOMICS, DEPARTMENT OF AGRICULTRE AND RESOURCE ECONOMICS, NYANKPALA CAMPUS

This research is design to collect data relating to ***Marketing Channels, Gross Margins and Postharvest Losses of Smallholder Tomato Farming in the Kassena Nankana Municipality.***

Please be assured that data collected will be used ***ONLY*** for academic research being conducted by **Issah Ganiu as part of his M Phil programme** at the Department of Agriculture and Resource Economics, UDS-Tamale. Respondents are assured that, all responses provided shall remain confidential. Thank you for your time.

FARMER'S HOUSEHOLD QUESIONNAIRE

Activity	***Name***	***Name*-household head (HHH)**	***Community Name***
Enumerator			
Respondent (Famer)			

A. SOCIO-DEMOGRAPHIC CHARACTERISTICS

QUESTIONS	**RESPONSES**
1. Are you the household head (HHH)? If NO, >> **Q5**	01=Yes [ ] 02= No [ ]
2. Age of household head	
3. Gender/Sex of HHH	01=Male [ ] 02= Female [ ]
4. Marital status	01=Married [ ] 02=Singled [ ] 03=Divorced [ ] 04=Widowed [ ]
5. If NO to **Q1**, what is the Age of farmer? Else, go to Q8.	
6. What is your relationship with HHH?	01=Spouse[ ] 02=Child[ ] 03=Care-taker[ ] 04=Other[ ]Specify:_____
7. What is the Gender/Sex of farmer?	01=Male [ ] 02= Female [ ]
	01=None[ ] 02=Non-Formal Education[ ] yrs

8. What is your level of education?	03=Primary School[ ]yrs 04=JHS/MSLC[ ]yrs 05=SHS/Voc/Tech[ ]yrs 06= Tertiary[ ]yrs 07= Other (Specify) :_____
9. Religion	01=Christianity [ ] 02=Islam [ ] 03=ATR [ ] 04= Others [ ] (Specify:_____
10. Ethnicity	01= Kassena[ ] 02=Nankana[ ] 03= Waala[ ] 04= Others [ ] Specify:_____
11. Do you belong to any FBO?	01=Yes [ ] 02= No [ ]
12. If YES, which of the following services or assistance did you received?	01=Technical/Training assistance[ ] 02=Input credit [ ] 03=Cash credit [ ] 04=Machinery/Equipment services [ ] 05=Marketing services [ ] 06=Transportation of inputs and/or products[ ]

B. HOUSEHOLD STRUCTURE, COMPOSITION & SIZE

13. Household (HH) size (those who eat from the same pot with household head/respondent)	
14. Household composition by Gender/Sex	01= No. of Males_____ 02= No. of Females _____
15. Number of people in the household in the following age category	01= Less than 15yrs: _____ 02= Between 15 – 60yrs: _____ 03= Above 60yrs: _____
16. Level of education attained by household members	**# of Males:** **# of Females:** 01=None ____ _____ 02=NFE ____ _____ 03=Prim-SHS ____ _____ 04=Tertiary ____ _____ **05=Total:**
17. Major Occupation of household head/ respondent	_____

	[*i.e. 01=Tomato production, 02=Livestock rearing, 03=Other vegetable/crop production, 04=Fishing, 05=Produce marketing, 06=Pito brewing, 07= Petty trading, 08=Salaried worker, 09=Artisanry (carpentry, masonry, etc.*)]
18. How many years have you been involved in the major occupation?	
19. Minor Occupation engaged in	
20. How many years have you been involved in the minor occupation?	
21. Which of these does Household members engaged in ?	Farm activities[ ] Non-farm activities [ ]
22. Annual Non-Farm Income	***Activity Days in week Rate Amount(GH₵)*** Wage labour: Salaried work: Petty Trading:

	Others:

C. FARM CHARACTERISTICS & PRODUCTION:

QUESTIONS	RESPONSES
23. Mode of Tomato production	01=Rain-fed only[ ] 02=Irrigated only[ ] 03=Both[ ]
24. If IRRIGATED, what is your source of irrigation water? (List all but indicate the main)	
25. Years of experience under tomato production	01=Rain-fed[ ] years 02=Irrigated [ ] years 03=Both [ ] years
26. What type/variety of tomato seeds did you used?	1)…… 2)…… 3)……
27. Which sources do you acquired the tomato seeds?	
28. How did you acquire the seeds?	01=Cash 02=Credit Others.....
29. What is your rating of the level of reliability of this source of water?	01=Very reliable[ ] 02=Reliable[ ] 03=Average[ ] 04=Unreliable[ ] 05=Very unreliable[ ]
	01=Continuous production

30. What is/are your main reasons for engaging in irrigated tomato farming?	02=Household food security 03= Extra farm income [ ] 04=Improved HH nutrition [ ] 05=High productivity [ ] _____(Plots/Beds/acres)
31. What is your total irrigated farm size under cultivation?	
32. How long do you water your tomato (Months)?	
33. How much does it cost you access the water supply?	
34. What are the major setbacks of tomato production in this area?	
35. Do you always have buyers for your fresh tomato? if yes, list where your customers are coming from;	*(Specify and rank in order of prior* …… …… ……

	…… ……
36. Do you have challenges in marketing/selling your tomato?	*(Specify and rank in order of prior* …… …… …… …… ……
37. What do you think are solutions to those challenges	*(List th* …… …… …… …… ……
38. How do you maintain the quality of tomatoes?	*(List them);*

39. Farm Labour/Gender activities, please fill the table below;

	Labour Required in Man Days	

Tomato Farm Activity	No. of Family Labour			No. of Hired Labour		No. of Cooperative		Cost/ Wage rate	*Total Cost*
	Male (M)	Female (F)	Children(< 18yrs)	M	F	M	F		
Land Preparation									
Bed preparation									
Nursing of seeds									
Seedling transplanting									
Fertilizer application									
Chemical application									
Weeding/weed control									
Harvesting									
Other cost:									

40. How do women handle the tomatoes after harvest differently from their men counterparts in your community?

……

……

……

41. EQUIPMENTS /FIXED COST ESTIMATION:

Item	Owned =1 Rented = 2	Unit Price	Quantity	When acquired?	Economic life (years)
Watering can					
Cutlass					
Hoe					
Gloves					
Wellington boot					
Bucket					
Knapsack Sprayer					
Garden fork					
Shovel					
Garden trowel					
Fence (Levy)					

Others:					

42. Please indicate in the cost structure of tomato Agro-chemicals production in the table below;

Agro-chemicals Inputs	Usage;1=Yes 2=No	Units Per Acres	Unit Cost/ Acre (Ghc)	Total Cost
Fertilizer (kg)				
Weedicides (kg)				
Organic Manure (kg)				
Pesticides (kg)				
Others (Specify)				

D. INFORMATION ACCESS

43. Did you have a chance to set the price of tomato? 01 = Yes; 02 = No

44. Did you have market information before you sold your tomato? 01 = yes ( ) 02 = no ( )

Why?.....

.....

45. What was the source(s) of this information? 01=Colleague farmers [ ] 02=Family/Relatives [ ] 03=Marketers [ ] 04=MOFA/AEAs [ ] 05=Radio/TV [ ] 06=Others [ ](Specify:_____

46. Do you have a mobile phone? 01=Yes [ ] 02=No [ ]

47. Did you use the mobile phone to access market information? 01=Yes [ ] 02=No [ ]

E. EXTENSION SERVICE& FARMER BASE ORGANISATION

48. Have you ever been visited by any extension officers in the last production period?

a. Yes b. No. If yes, complete this table below;

49. List the type officers, number of visit and purposes as below:

Extension Services	***No. of visit/yr***	***Purpose of visit***

F. CREDIT

50. Do you have access to credit for 2016/17 year? A. Yes ( ) B. No ( )

51. If yes, from which source? …….

52. If No, why?

……

53. How much credit did you obtained? ……..

54. What challenges have you notice in the formal credit? a. difficult procedures b. high interest rate c. inadequate provision of loan d. others…….

G. DISTANCE OF MARKETING AGENTS TO THE FARMER SOLD TOMATO

55. Which of these agents did you sold your tomato to?

a. Wholesaler's b. retailer's c. roadside traders' d. consumers.

56. Where do you locate them? a. at the farm level b. district market c. local market d. main road side

57. What is the price per crate/box at each of the following selling point?

a. at the farm level…… b. village/local market……c. road side…… d. district market……..

58. How many km you need to travel to get the following markets (on foot), where applicable.

1. Farm gate _____ km 2. Village/local market _____ km 3. roadside _____km 4. The district market _____km

59. What is your means of transport of the tomato from farm to the market? a. motto king b. animal's cart c. vehicle d. head e. others

60. Which of these agents in the following table do you sell your produced in UE/R? Please, **rank from 1 to 4**, with 4 the **most** frequently used, follow by 3, 2 and 1 being **less** frequency used.

Names of Agents	*Ranks in order of priority (From 01 to 04)*
Wholesalers	
Retailers	
Roadside traders	
Consumers	

01=wholesales, 02=retailers, 03=roadsides traders & 04=consumes.

61. Why do you prefer to sell to the agents mentioned above a. Higher Pricing ( ) b. Customer relation ( ) c. Proximity to market ( ) d. Cash payments ( ) d. Others ( ) please specify ……

H. MARKETING & REVENUE STRUCTURE

62. What time of the year do you normally harvest your tomato?

……

63. Please indicate the price of tomato per crate with respect to the variety and size in the following table;

VARIETY	*Average price of a crate/box (Large size)*	*Quantity Sold*	*Average price of a crate /box (Small Size)*	*Quantity Sold*	*Total Revenue*
Total					

64. Please complete the Tomato production in the table below;

Production year	***Number of acres/plots***	***Total Amount produced (crates/boxes)***	***Total Amount sold (crates/boxes)***	***Price/crate***		***Losses incurred for the Season***
				Highest	**Lowest**	
2016/17						

65. What do you do, if your product (tomato) are not sold on time?.....

.....

66. Any comment from the farmer;

……

THANK YOU FOR YOUR COOPERATION

TRADERS QUESTIONNAIRE

PRELIMINARY INFORMATION

	Name	***Telephone No (If any)***	***Community Name***
Enumerator			
Respondent			

I. Location of Information

1. Name of market ……
2. Type of market ……1=urban market 2=village market

II. SOCIO-DEMOGRAPHICS

QUESTIONS	RESPONSES
1. Age of household head	
2. Gender/Sex of HHH	01=Male [ ] 02= Female [ ]
3. Marital status	01=Married [ ] 02=Singled [ ] 03=Divorced [ ] 04=Widowed [ ]
4. Total family size	
5. What is Gender/Sex of Trader?	01=Male [ ] 02= Female [ ]
6. What is your level of education?	01=None [ ] 02=Non-Formal Education [ ] yrs 03=Primary School[ ]yrs 04=JHS/MSLC[ ]yrs 05=SHS/Voc/Tech[ ]yrs 06= Tertiary[ ]yrs 07= Other (Specify) :_____
7. Religion	01=Christianity [ ] 02=Islam [ ] 03=ATR [ ] 04= Others [ ] (Specify:_____
8. Ethnicity	01= Kassena[ ] 02=Nankana[ ] 03= Waala[ ] 04= Others [ ] Specify:_____

9. How long have you been in the tomato business?	……(years)
10. Which period of the year do you buy tomatoes in 2016/17 in the Municipality?	
11. Which forms of trading are you in to?	01= wholesalers[ ] 02= retailers[ ] 03= roadside traders[ ] 04= others[ ]
12. What was the price of tomato in 2016/2017 crop season?	(Crates/Box/ Others)
13. Do you belong to any Trader's Association?	01=Yes [ ] 02= No [ ]
14. Does the Association provide you any assistance?	01=Yes [ ] 02= No [ ]
15. If YES, what services or assistance did you received?	01…… 02…… 04…… 05……
16. What are the major challenges in your purchase of tomatoes from the area?	List them:

III. Purchases and Selling Practices

17. **Which market and agent(s) do you buy tomato? (*Multiple market area is possible, ** Multiple answers are possible and write the codes corresponding to the market area)**

Name of Market	***Actors***	***Quantity purchased/crate***	***Average buying price/crate***	***Payment**** ***1. Cash*** ***2. Credit*** ***3. Advance payment***
	Producers			
	Wholesalers			
	Retailers			
	Roadside traders			
	Others			

18. Where did you prefer buying most of your tomato from (KNM or Burkina)? Specify.....

19. Why do you prefer this source? 1. Better quality 2. High supply 3. Proximity to the market 4. Others (specify)

20. Are all your purchasing centers accessible to vehicles? 1. Yes 2. No.

21. For which market and to whom did you sell tomato. (*Multiple market area is possible, ** and multiple answers are possible)

Name of Market	***Actors***	***Quantity purchased/crate***	***Average selling price/crate***	***Payment**** ***1. Cash*** ***2. Credit*** ***3. Advance payment***
	Producers			
	Wholesalers			
	Retailers			
	Roadside traders			
	Consumers			
	Others			

22. If credit, how long does it take you get the money after sale? 01. One day 02. Three day after sale 03. One week 04. One month 05. Others (Specify)……

23. What do you do, if your product (tomato) is not sold on time? 1. Took back home 2. Took to another market 3. Sold it at lower price 4. Sold on other market day

24. What customer relation did you adopt to attract your supplier? 01 = by giving better price in relation to others 02 = by use of standard weight 03 = by visiting them 04 = other (specify)……..

25. What customer relation did you adopt to attract your buyers……? 01 = by giving better price relate to others 02 = by visiting them 03 = quality of your product 04 =by giving credit 05=by fair scaling (weighting) 06=other specify……

IV. COST AND REVENUE STRUCTURE ALONG THE MARKETING CHAIN

26. Did you pay tax for purchase of tomato in the last season? 01=Yes 02=No. if Yes, how much?.....

27. Did you pay tax for selling of tomato in last season? 01=Yes 02=No. if Yes, how much?.....

28. Are there restrictions on the import of tomato from Burkina Faso to Ghana? 01=Yes 02=No. Give reason……

29. Did you pay import duty on tomato from Burkina to Ghana? 1. Yes 2. No If Yes, how much?.....

30. Please indicate the cost and losses made in the Purchase of Tomato for the 2016/17 season;

Activity	***Unit Cost of Tomato Crate/box***	***Number of Crates/box***	***Total Cost (GH cedi)***

Source: 01= if source is farm gate, 02= if source is wholesaler, 03= if retailer 04. If Others.

Source of Acquisition*	**Indicate whether sourced from, 1, 2, 3 or 4.**		
Purchasing Price			
Packaging			
Head Potters			
Mode of Payment**	**Specify payment mode:**		
Cost of transportation			
Tax/ Duty			
Postharvest losses (both Partial & Complete)			
Loading & Off-loading			
Others (Specify)			
Total Variable Cost			

Mode of payment: 01. Cash 02. Credit 03. Contract payment. 04. Others……

31. Who determine the price when you are buying? 1. Tomato producers' association 2. Tomato marketers' association 3. Bargaining 4. Wholesalers 5. Myself 6. Others……

32. Who determine the price when you are selling? 1. Tomato producers' association 2. Tomato marketers' association 3. Bargaining 4. Wholesalers 5. Myself 6. Others……

33. Do you have ready market for your sales? (1) Yes (0) No

34. If no, give reason. ……..……

35. Which month (s) did tomato peak and lowest in the year in terms of Supply; Demand and Price? Indicate below, please.

Activity	***Peak month (s)/Maximum***	***Lowest /Minimum***
Supply		
Demand		
Price		

36. How do you store/ package the tomato? 01. Crate [] 02. Box [ ] 03. Others……..

37. How long can your tomato be stored without going bad? …….

38. Do you have preference for some tomato varieties you buy over others? 1. Yes 2. No

39. Rank/indicate according to importance the varieties you prefer and give reason

Variety	***Rank***	***Reason***
KNM		
Burkina Faso (BF)		

01=If KNM & 02=if BF

40. Did you inspect the quality of the tomato when buying? 1. Yes 2. No.

41. What instrument do you use to measure tomato when purchase? 1. Weighting machine (kg) 2. Crate/Box 3. Others……..

V. REVENUE GENERATED

42. Indicate the amount of Revenue generated in last season in the table;

VARIETY	***Average price of a crate/box (Large size)***	***Quantity Sold***	***Average price of a crate/box (Small Size)***	***Quantity Sold***	***Total Revenue***
Total					

43. What is your opinion on the tax levied on tomato buyers in KNM relative to those buying from Burkina Faso?.....

THANK YOU FOR YOUR COOPERATION.