SOCIO-ECONOMIC ANALYSIS OF SMALL RUMINANT LIVESTOCK PRODUCTION IN NORTHERN GHANA

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A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, KWAME NKRUMAH UNIVERSITY OF SCIENCE& TECHNOLOGY, KUMASI-GHANA IN FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF AGRICULTURAL ECONOMICS, AGRIBUSINESS & EXTENSION FACULTY OF AGRICULTURE, KNUST-KUMASI

MAY, 2015

DECLARATION

I, Faizal Adams, the author of this thesis (Socio-Economics Analysis of Small Ruminant Livestock Production in Northern Ghana) do hereby declare that with the exception of references of other authors' work, which were duly acknowledged, the research work in this thesis is original and to the best of my knowledge contains no work previously published by another person nor work which has been accepted for the award of any other degree.

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DEDICATION

This thesis is dedicated to the almighty Allah, my parents, Mr & Mrs Abdul-Mumin Adams, and my wife, Zakiya and the entire Adams‘ family for their unflinching support towards making this project a success.

ACKNOWLEDGEMENT

My profound gratitude and appreciation go to the following persons and institutions who in diverse ways contributed immensely in making this project work a reality:

To Dr. Emmanuel Yiridoe (Associate Professor) of Dalhousie University (Agricultural Campus), who provided the opportunity to be enriched by postgraduate student study exchange at Dalhousie University, Canada. I owe Dr. Yiridoe a debt of appreciation for the invaluable assistance, patience, and positive and encouraging demeanor you offered from the beginning to completion of this project work.

To all the lecturers, students and non-teaching staff in the Department of Agricultural Economics, Agribusiness and Extension, Kwame Nkrumah University of Science and Technology, I wish to express my utmost gratitude to you all, and thank you for your untiring support toward completion of my work. Special mention must be made of my main supervisor, Dr. K. Ohene-Yankyera for his professional criticisms, support and excellent guidance which spurred me on, and ultimately contributed to the success of this work. Dr S. C. Fialor also deserves commendation for his priceless contributions and, advice in his capacity as a second supervisor. I am also grateful to Dr J. K. Bakang and Dr. Robert Aidoo for their able guidance and advice during my studies in the department.

The field/research assistants particularly Mr Ibrahim Hashmin and Solomon Antuona (Council for Scientific and Industrial Research, Wa, Upper West Region), staff of the Ministry of Food and Agriculture in the various study districts, Hamza Mohammed and Donald Akantami of the University for Development Studies (UDS), Tamale and Mr Seidu Akugri Musah (School for Life, Zibilla, Bawku West, Upper East Region) all deserve special thank you. I appreciate your assistance during the field component of the study. Much appreciation also goes to Mr Baba Issah Gariba, University for Development Studies for his insightful views and guidance during journeys in the remote areas of Northern Ghana for data collection.

My heartfelt gratitude also goes to all my family members especially my siblings, Safianu and Aziz Adams (UDS) for their assistance with survey research data entry.

I will also like to acknowledge my appreciation for funding under the Commonwealth Scholarship programme in Canada, administered through the Federal Department of Foreign Affairs and International Trade (DFAIT) Canada, which sponsored my student study exchange in Canada. I am also grateful for financial support provided by the Ghana office of the International Food Policy Research Institute (IFPRI), for a research grant for the field survey for this thesis. The Scholarship provided by the Kwame Nkrumah University of Science and Technology under the Vice Chancellor's Initiative to train lecturers for the University is also recognized.

Finally, to all my friends especially Michael Agyekum (PhD candidate, Auburn University, USA), Eric Asare (PhD Candidate, Viginia Technology University, USA), Ishmeal Hashmiu, Hussein Iddriss and Edward Tsingo (KNUST) for their support and constructive criticisms on this work. May the Almighty Allah bless you all.

LIST OF ABBREVIATIONS/ACRONYMS

AEAs	Agricultural Extension Agents
AFD	African Development Fund
CSFA	Comprehensive Food Security and Vulnerability Analysis
DM	Dry Matter
FAO	Food and Agriculture Organisation of the United Nations
FASDEP	Food and Agriculture Sector Development
GDP	Gross Domestic Product
GEPA	Ghana Environmental Protection Agency
GL	Generalised Leontief
GSS	Ghana Statistics Service
GV	Gross Value
GOG	Government of Ghana
GPRS	Ghana Poverty Reduction Strategy
HIV	Human Immuno-deficiency Virus

IFAD	International Fund for Agricultural Development
ILRI	International Livestock Research Institute
LACOSREP	Land Conservation and Smallholder Rehabilitation Project
LR	Likelihood Ratio
MDGs	Millennium Development Goals
MLGRD	Ministry of Local Government and Rural Development
MNL	Multinomial Logit
MOFA	Ministry of Food and Agriculture
NB	Negative Binomial regression
NCC	National Commission on Culture
NLSP	National Livestock Sector Project
NR	Northern region
NPK	Nitrogen Phosphorus Potassium
OLS	Ordinary Least Square
PPR	*Peste des Petits Ruminants*
PR	Poisson Regression
TRANSLOG	Trans Logarithmic
UER	Upper East region
UWR	Upper West region
WAD	West African Dwarf
WB	World Bank
ZIP	Zero-Inflated Poisson regression

ABSTRACT

The purpose of this study was to understand the socio-economics dimension of small ruminant livestock production and generate technical information appropriate for policy action on increasing small ruminant production in northern Ghana. Data was collected using a multi-stage sampling procedure, from a sample of 300 households, during the months of October to December, 2012. The study was sub-divided into four different empirical analyses. A first component of the analysis was based on categorical data models (Negative Binomial, Multinomial and binary logit) to assess socio-economic determinants of small ruminant production system. The result indicates that non-farm income (socio-economic attributes), age and household size (demographic factors), and extension support (institutional variables) are significant determinants of small ruminant production (Negative Binomial model). The results from multinomial logit also suggest that agro-ecological zone, risk attitude and income associated with small ruminant production are significant determinants of the likelihood that households will own and manage particular small ruminant species (i.e., sheep or goat). A second component of the empirical analysis employs replacement cost method (aggregate economic value) to estimate the total benefit of traditional free range system of small ruminant livestock. The analysis suggests that the annual aggregate benefit from sheep products was about Gh₵590 (US$311) per household in Northern region,

Gh₵517.23 (US$272.2) in Upper East region and Gh₵209 (U$110) in Upper West region. Over 51%, 80%, and 90% of the benefit in Northern, Upper East and Upper West regions, respectively were non-marketable (non-cash). Similarly, more than 60% of the aggregate benefit of Gh₵274.5 (US$144.7) from goat production in the Northern region was also nonmarketable. In addition, the study shows that the non-market component of goat products represent 99% in Upper East region of the aggregate value of Gh₵205.5, that is, US$108.2. For Upper West region, the non-market co-benefit was 128% (132.14, representing US$69.5) because the return on the market components was negative. Therefore, the traditional free range

system of producing sheep and goat is only economically viable when non-market functions (and associated values) of the animals are considered. In an analysis of gender contributions to production, a Cobb-Douglas production function reveals that the productivity of sheep and goat managed by adult male farmers was influenced by a set of different socioeconomic (household size and age) and institutional factors (extension access), compared with productivity associated with female-managed farms. On the other hand, Socioeconomic factors including age, marital status, and non-farm income, and institutional factors such as extension access have a significant influence on productivity of female small ruminant managers. Important constraints that limit small ruminant production among the sample of farmers studied include diseases and parasitic infection, theft, destructive habits of animals, and feed shortage. The odds of a farmer experiencing diseases and parasites infection and feed shortage constraints were significant for extension, age of respondents, production system, non-farm income source as well as herd size holdings of the farmer (ordinal logit model). The study confirms the importance of small ruminants as a livelihood savings mechanism in smallholder households. The aggregate economic value does not only demonstrate the importance of nonmarket functions of sheep and goat toward sustaining food security and poverty reduction in smallholder households, but also provides a practical proposal for any livestock related policies for farmers who depend on traditional livestock production system. In devising strategies (to choose households) to improve traditional small ruminant production, livestock technical programs must recognise important socioeconomic characteristics of the farm households.

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CHAPTER 1

1.0 INTRODUCTION

1.1 Background

Food insecurity and overall economic wellbeing have become a heightened concern in sub-Sahara African countries, especially Ghana. Official statistics suggest that 5% (or 1.2 million people) of the population in Ghana is food insecure, and another 9% (2 million) are vulnerable to food insecurity (Biederlack and Rivers, 2009; Hedzro-Garti, 2010). In addition, 98% of the food insecure live in rural areas of Ghana, where smallholder agriculture is the predominant means of sustenance (World Bank, 2008). The food security problem is linked to low animal production and livestock productivity in the country (Asafu-Adjei and Dantankwa, 2001; Cook, 2011; Honya *et al.*, 2007; Karbo and Bruce, 2000; Mahama, 2012; Oppong-Anane, 2011).

In Ghana, livestock represent a major economic activity in the lives and livelihoods of numerous rural smallholder farmers, traders, and processors, especially in northern Ghana (African Development Fund (ADF), 2001; Asafu-Adjei and Dantankwa, 2001; Turkson and Naandam, 2006). Livestock not only play a significant role in the socio-cultural aspects of the people but also, help to balance human nutrition (Adam *et al*., 2010). Most rural farming communities in northern Ghana use livestock as an important means to improve soil fertility (manure) and increase cultivated farmland area using draught power (ADF, 2001; Ghana Environmental Protection Agency (GEPA), 2002; Karbo *et al.*, 1997). Vulnerable households, especially rural women who represent half of smallholder farmers‘ population in Ghana (World Bank, 1992), depend on livestock, especially small ruminants, for economic sustenance (Duku *et al.*, 2011; International Fund for Agriculture Development (IFAD), 2004).

The Food and Agriculture Organisation (FAO) (2012b) estimated that the rural population in Ghana represents 62% of the total population of 24,000,000 and 77% are smallholder farmers with about 1 to 2 ha of farmland holdings (Karbo and Agyare, 1997). Such smallholder farmers depend on rainfall to produce food crops and livestock. Statistics suggest that 40.5% of Ghana's rural population manage some livestock. This implies that about 6.02 million households partly depend on livestock for their livelihood (Ghana Statistics Service (GSS), 2012).

Livestock productivity is negatively affected by high mortality and annual disease and pest outbreaks (Mahama, 2012), with an estimated annual economic loss of US$50 million in the country (Ministry of Food and Agriculture (MoFA) 2007). In addition, government budget allocation for livestock development is considerably low (MoFA, 2010; Oppong-Anane, 2011). As a result, Ghana is able to meet only 30% of the country's meat and meat products requirements, and the country relies heavily on imports to supplement the animal protein requirements of the population (ADF, 2001; Asafu-Adjei and Dantankwa, 2001; MoFA, 2007).

The food security needs and problems in Ghana are particularly critical for northern Ghana (Biederlack and Rivers, 2009; Hedzro-Garti, 2010), and complicated by widespread poverty and increasing poverty gap between rural and urban areas (Al-hassan and Diao, 2007). According to the Ghana Poverty Reduction Strategy (GPRS), in 2003, 90% of the population in the Upper East Region, 80% in the Upper West, and 70% in Northern Region were identified as extremely poor (Mackay and Aryeetey, 2004). About 63% of the extreme poor depend on the agricultural sector and engage in livestock production such as small ruminants. Majority are women for whom small ruminants tend to represent their most valuable assets, and provide an

important source of income (Canagarajah and Portner, 2003; Mackay and Aryeetey, 2004; World Bank, 1992).

The percentage of the food insecure population is highest in Upper West Region (at 34%), followed by 15% in the Upper East Region, and 10% in Northern region (Biederlack and Rivers, 2009). Majority of the poor and food insecure (i.e.70%), depend on smallholder agriculture (Mackay and Aryeetey, 2004), and 90% manage livestock as a strategy to mitigate crop failure and associated food shortage and hunger linked to drought (Quaye, 2008).

The disparities in poverty and food insecurity between Northern and Southern Ghana require special attention in Ghana's efforts to achieve the Millennium Development Goal (MDGs) of raising per capita income to US$1,000 by 2015 (Republic of Ghana, 2005; Mackay and Aryeetey, 2004). Al-hassan and Diao (2007) note that improving growth in the agricultural sector, rather than growth in the nonagricultural sector through, livestock (and crop) production will have a bigger effect on poverty reduction and food security in the region than growth in the non-agricultural sector.

In northern Ghana, income from crop farming is seasonal because production is primarily dependent on rainfall, which is uni-modal in distribution. Livestock production has the potential to substantially increase household income, particularly for the poor and food insecure in rural households (Asafu-Adjei and Dantankwa, 2001; Karbo and Agyare, 1997). Livestock production serves as insurance against food deficit during long drought periods (typically spanning from November to May), and also provides households with income to purchase inputs for crop production(Asafu-Adjei and Dantankwa, 2001).

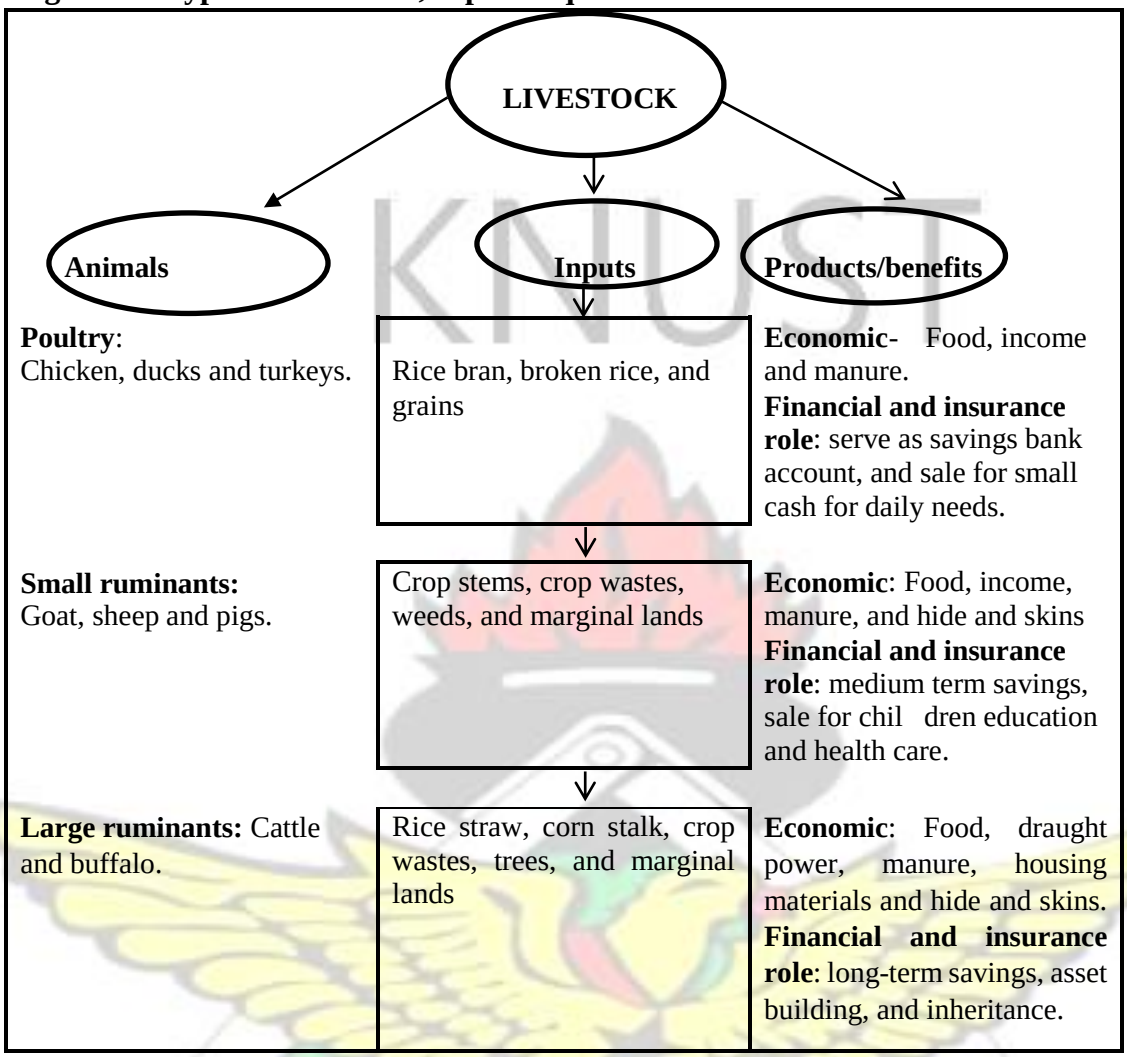
The linkages between livestock and crop farming in northern Ghana and in sustaining rural livelihoods also highlight the importance of livestock production toward food security and poverty reduction of the region (Karbo and Bruce, 2000; Asafu-Adjei and Dantankwa, 2001). Livestock in the region are often described as _walking bank‘ of capital, and serve as a source of financial security during crop failure, economic stress, disasters, and ethnic conflicts (Terril, 1985a). The three northern regions, together, produce 70% of cattle, 55% of small ruminants, 40% of pigs, and 20% of poultry in the country (Karbo and Agyare, 1997). However, livestock production depends on rudimentary technology and production systems (ADF, 2001). Thus, improving livestock production efficiency has the potential to improve the wellbeing of rural households and the food security problem in the region, as well as the rest of the country.

Various studies highlight the importance of emphasising small ruminant livestock production, (as opposed to large ruminant and non-ruminant production) not only for ensuring food security in rural regions, but also for helping to reduce poverty and increase overall household wellbeing (Devendra, 2001; Devendra and Chantalakhana, 2002; Dossa *et al.*, 2007; Lebbie, 2004; Otchere, 1986; Peacock, 2005). The emphasis is because sheep (*Ovis aries*) and goat (*Capra hircus*) (Wilson, 1991) are more efficient in converting non-grain feed into quality meat compared with beef, pork and poultry (Devendra, 1985; Peacock, 2005; Terril, 1985a). In smallholder agricultural economies, competition for productive inputs is lower for small ruminants than for other livestock (such as pigs, cattle and poultry) (Terril, 1985a). Capital investment in housing and materials (such as iron sheets and wood) are lower for sheep and goat production compared with other livestock (e.g. cattle) (Devendra, 1985). The smaller size of small ruminants also makes them more suitable for home

consumption among poor households, thereby helping to improve the nutrition and animal protein requirements and food security situation of rural households (Oluwatayo and Oluwatayo, 2012).

In tropical regions, sheep and goat often produce about twice as much meat per animal unit, compared with large ruminants such as cattle (Terril, 1985a). Small ruminant livestock are particularly relevant for smallholder agricultural systems in northern Ghana because of unique biological attributes, including short gestation period, high prolificacy, rapid growth rate, high feed use-efficiency from coarse roughages, and high tolerance to tannins and diseases, as well as marketability within one season (Lebbie, 2004; Peacock, 2005; Terril, 1985b). The different types of livestock animals and input requirements and potential benefits for rural households are summarised in Figure 1.1. The figure shows that small ruminant livestock depends on crop by-products and marginal lands to produce all the benefits associated with livestock production. Sheep and goat can serve as the only ruminant animals that economically vulnerable households typically manage to improve their social and economic status at the village (IFAD, 2004; Oluwatayo and Oluwatayo, 2012). Owning sheep and goat, especially by rural women, can serve as employment opportunity since the animals can be tethered around homes and fed with kitchen byproducts and on communal lands (Chen *et al.*, 1999; Okali and Sumberg, 1984).

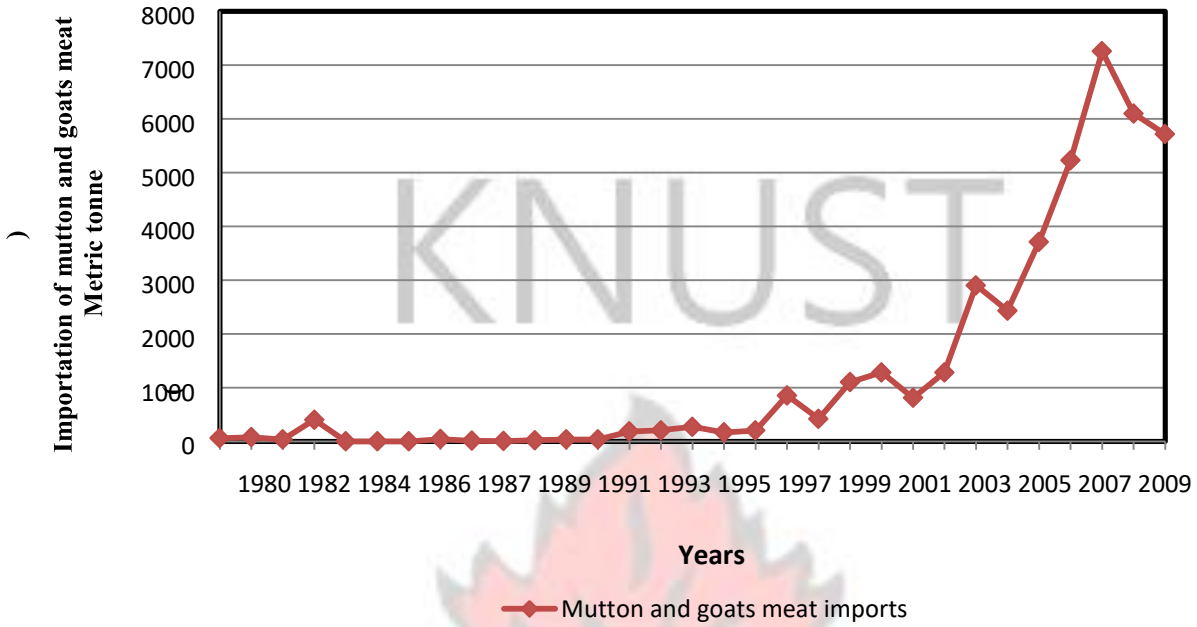
Figure 1.1 Types of Livestock, Input Requirements and Potential Benefits



Source: Modified from Devendra and Chantalakhana (2002) and Lebbie (2004)

Livestock statistics (Food and Agriculture Organisation, 2012) indicate that the country is a net importer of mutton and goat meat (Figure 1.2). In Ghana, local supply of small ruminant meat is low while demand far exceeds such supply (Adam and Boateng, 2012). The meat demand is expected to double with increased urbanisation and growth in purchasing power (Asafu-Adjei and Dantankwa, 2001; Baah *et al.*, 2012). This is partly because sheep and goat population remains stagnant over the years. However, meat from sheep production (16,914 metric ton) is lower than from goat (18,935 metric ton) among smallholder farmers in the country (MoFA, 2010).

Figure 1.2 Importations of Mutton and Goat Meat in Ghana, 2000-2009



Data source: FAO (FAOSTAT Database) Various Years

The factors that influence smallholders to manage these farm animals, and preference for or choice of animal species are unknown.

Production of sheep and goat in northern Ghana reflects average holdings of less than 10 animals per farmer (Oppong-Anane, 2011; World Bank, 1992). Small ruminant livestock tend to be raised to meet multiple objectives of farmers (Bosman, 1995). The animals are managed not only for marketable products (e.g. meat) but also for non-marketable products such as hide, manure, source of medium-term savings, insurance against crop failure, means of diversifying investment, and for social and cultural ceremonies (gifts, naming and ceremonies) (Bosman, 1995; Bosman *et al.*, 1996b; Moll, 2003; Terril, 1985a). Despite the diverse roles of small ruminants in rural livelihoods, livestock development policies tend to emphasis only marketable production while neglecting important non-tradable benefits (Behnke, 1985; Moll, 2003). The neglect of non-marketable products by policy makers has important implications for production (Bosman, 1995; Bosman *et al.*, 1996b; Moll, 2003). For

instance, livestock technical policies in sub-Sahara African countries over the past centuries principally focused on introduction of high yielding exotic breeds to increase meat availability for market (Asafu-Adjei and Dankwatah, 2001; Ayalew *et al.*, 2003) without recognising the multiple roles of livestock (Moll, 2003). The effect of such policy on smallholder livestock management (traditional livestock system) is minimal since smallholder farmers are less enthused about productivity in such a restrictive sense.

Besides helping rural farmers to increase their income opportunities and household nutrition, sheep and goat can provide farmers with manure, thereby generating savings from expensive inorganic fertilizers. To optimise these benefits, limitations associated with promoting small ruminant production among smallholders need to take into consideration the multiple functions or benefits sheep and goat offer. In addition, farmers' perspectives of important social and economic reasons why these animals are managed are important. According to Asafu-Adjei and Dankwatah (2001), livestock policies under the National Livestock Sector Project (NSLP) failed to positively influence smallholder household livelihoods because the policy neglected relevant social and economic aspects of livestock producers, which is necessary for technology adoption at the farm level.

The majority of the population in northern Ghana is rural, with a high illiteracy rate (GSS, 2012) and depends on traditional sheep and goat production methods. Although, the region abound with grassland that is suitable for sheep and goat production, there is limited understanding of the relationships among the biological, economic and social dimensions of small ruminant production systems. This knowledge gap undermines the potential impact of the animals on the very livelihoods of the people (Jahnke, 1982). A holistic knowledge of the production system is important for improving small

ruminant performance, and enhancing impacts on the poor and food insecure in the region (Ibrahim, 1998).

1.2 Economic Problem

Farmers, agricultural administrators and policy makers are interested in strategies to improve the traditional small ruminant livestock production systems in northern Ghana. In the northern part of the country, sheep and goat production is dominated by the traditional free range and extensive production systems (Turkson and Naandam, 2006). The most common breed raised by smallholders is the indigenous West African Dwarf (WAD) breeds of sheep and goat (Oppong-Anane, 2006; Oppong-Anane, 2011).

On the other hand, raising sheep and goat for smallholder needs comes with numerous challenges. Bosman *et al.* (1996a) for example, reports that smallholders managing traditional production systems may hold _unproductive‘ animals in their herd for non-market (insurance or savings and financing) functions, thereby negatively affecting biological productivity (meat) and returns to household resources used. Furthermore, farmers tend to sell their animals based primarily on marketable output considerations (Mahama, 2012), which can undermine the importance of the non-market functions. For example, Apori *et al*. (2010) observed that most smallholder farmers in northern Ghana tend to maintain sheep and goat in production beyond their prime or economically optimum maturity for marketing to satisfy such non-market outputs and functions of such livestock. To optimise livestock benefits for smallholders, the magnitude and economic impact of the nonmarket outputs of small ruminants need to be understood to guide decision-making in sheep and goat production. Furthermore, factors that influence farmers‘ decisions to own sheep and

goat require attention if specific strategies and policies are to be developed to enhance smallholder production in northern Ghana.

Sheep and goat farmers in northern Ghana are also faced with the challenge of improving the relatively low productive rates of the indigenous breeds (World Bank, 1992). As a result, the marketable attributes of the animals is low. The World Bank (1992) reports that the size and quality of breeds of sheep and goat sold in northern Ghana is low, resulting in livestock traders travelling to neighbouring Chad, Niger and Burkina Faso for larger size and better quality market animals. Thus, farmers are interested in technical knowledge that will improve the marketable attributes of their animals while also sustaining the non-market uses of such small ruminants (Turkson and Naandam, 2006).

The problem with farmers' inability to improve on marketable attributes of indigenous sheep and goat is also linked to problems faced by female farmers in the study area. Although women are important producers of small ruminant livestock, they have insufficient modern livestock technologies and resources to increase productivity (IFAD, 2004; World Bank 1992).

Smallholders in northern Ghana also face problems with important constraints which undermine farmers' efforts to increase the marketable attributes of their animals (Oppong-Anane, 2006; Turkson and Naandam, 2006; World Bank, 1992). A major reason connected with the inability to improve on traditional small ruminant systems is that policy makers have traditionally based their advice largely on meat production and neglected important non-market benefits of the animals. Livestock policies that consider non-market benefits of small ruminants in smallholder agriculture have been a problem for agricultural administrators and policy makers due to insufficient

information on the economic impact and magnitude of non-market outputs of small ruminants (MoFA, 2010; Moll, 2003).

1.3 Research Problem

Economic studies of sheep and goat that take into account only marketed products may result in less useful policy advice because smallholders are less concerned about productivity in a narrow sense (MoFA, 2010; Moll, 2003). The economic importance of non-market outputs of small ruminants is difficult to value by livestock technical staff and policy analysts (Moll, 2003; Ouma *et al.*, 2003; Scoones, 2003; Slingerland, 2000). Yet, such information can contribute to a better understanding of livestock production systems and formulation of effective policies for increased livestock productivity.

Livestock policies that assume household heads as final decision makers with regard to smallholder small ruminant production and decision-making can be costly (Al-Rimavi, 2002; Dossa *et al*., 2008; Duku *et al.*, 2011). Intra-household analysis will allow disaggregating households into constituent members in order to determine the factors that affect and influence each member‘s productivity and decision making (Baden *et al.*, 1994; Dei, 1994; LeMay, 2006). This will result in designing of specific policies to meet the needs and problems of specific groups of individuals within the farm household.

1.4 Research Questions

From the foregoing, four research questions are pursued in this study.

1) What socio-economic and institutional factors influence farmer‘s decisions to own small ruminant livestock and preference for or choice of small ruminant livestock type managed?

2) What is the overall economic value of small ruminant livestock production across the three regions in Northern Ghana?
3) How does gender contributes to small ruminant production in Northern Ghana?
4) What are the constraints to small ruminant production in Northern Ghana?

1.5 Purpose and Objectives of the Study

The purpose of this study is to understand the socio-economic attributes of small ruminant livestock production in three regions of northern Ghana. In this study, small ruminant livestock production refers to sheep- and goat-based farming systems. Specific objectives of the study include the following:

1) To investigate the relative effects of socio-economic characteristics and institutional factors which influence farmers' decisions to participate in small ruminant livestock production, and preference for or choice of small ruminant livestock type managed.
2) To estimate socioeconomic value of small ruminant livestock production and compare the estimates across the three regions in Northern Ghana. The socioeconomic value will account for both market benefits associated with managing small ruminant livestock (such as traded value of meat and hide) and non-market benefits (e.g., role of livestock as living savings strategy and insurance against unforeseen circumstances, social prestige and nutrient value of livestock manure)
3) To analyse the role of gender in small ruminant livestock production in northern Ghana. This includes analysing the relative roles of male-and female-spouses in household small ruminant production activities and decisions, and evaluation of the effects of socio-economic and institutional factors that influence small ruminant productivity of male and female small ruminant producers.

4) To examine production constraints to small ruminant production in northern Ghana. The constraints analysis also examines how farmer and non-farmer characteristics influence farmer‘s vulnerability to small ruminant production constraints.

1.6 Justification for the Study

Food security and poverty reduction strategies in northern Ghana have frequently been linked to improvement in smallholder livestock production especially small ruminant livestock (Karbo and Bruce, 2000). The food security and poverty reduction roles of sheep and goat in rural economy of northern Ghana are attributed to various reasons.

First, ownership of sheep and goat is widely distributed among vulnerable and poor households in northern Ghana. Second, the special features of sheep and goats including low input (capital) and management requirement coupled with high prolificacy permit small ruminants to play an important role in the livelihood of lowlevel income households compared with other agricultural activities. In addition, the several economic and social functions of sheep and goats such as cash provision to meet unforeseen and planned circumstances, for improvement in social ties, for use in religious or cultural rituals and the application of manure to improve soil fertility tend to have a positive impact on vulnerable household livelihoods.

Unfortunately, sheep and goat production in northern Ghana is below potential marked by low productivity, and high mortality rate (Baah, 1994; Baah et al., 2012).
Consequently, several small ruminant sector projects have been promoted to improve domestic production in Ghana. Some of the projects include the National Livestock Sector Project (1993 to 1999), the Livestock Development Project (2003 to 2009), among others

(Ministry of Food and Agriculture, 2007; Oppong-Anane, 2011). However, the impact of some of these initiatives on the traditional livestock production system has been limited (Ministry of Food and Agriculture, 2009). This so because the livestock programmes often place much emphasis on the technical aspects of production with little recognition to the socio-economic attributes of the livestock system. This study fills this gap by analysing the socio-economic determinants of small ruminant production decisions and estimation of economic value of small ruminant livestock under the traditional production system in northern Ghana. The study further concentrates on gender relations and constraints limiting small ruminant production in northern Ghana. Livestock initiatives can only have the maximum impact on traditional production systems if those programmes are consistent with the objectives and livelihood needs of the smallholder farmers (Udo et al., 2011). Smallholder households' needs associated with managing sheep and goat are influence by the socioeconomic circumstances of the farmers (Bosman,
1995).

To enhance the likelihood that small ruminant programmes are successful under the traditional production system, it is necessary to concentrate contemporary livestock research on understanding the socio-economic factors that influence smallholders' decision to keep the animals (Udo *et al*., 2011). This study provides important information to livestock technical staff as what socioeconomic factors influence smallholders' decision to participate in small ruminant production. Such technical information is important for customising and developing local farmerrelevant agricultural production and extension support programmes. The study also considers intra-household small ruminant activities and related decision considerations such as gender roles which is important to livestock production improvement strategies. Agricultural administrators tend to overlook the role women play in small ruminant's

production when designing livestock extension programmes. The determination of the relative role of men and women and the factors that influence gender in small ruminant livestock production can assist in developing relevant educational programmes to increase productivity (Rousan, 2007).

The study is also important in many ways. It provides empirical evidence to estimate the overall economic benefit of small ruminant livestock under the traditional system accounting for both market outputs (meat and milk) and nonmarket outputs (insurance and savings role, manure, hide and social status). Previous studies used the standard cost and benefit analysis to evaluate the traditional system (Moll, 2003; Ouma *et al*., 2003), however, such conventional analysis precludes the non-conventional utilities of smallholder livestock production objectives including manure, hide, savings, insurance and strengthening social relations. However, this technical knowledge (quantification of non-market attributes) is important to provide theoretical insight into the relevance of these attributes required for better understanding of the traditional livestock production system (Jahnke, 1982). Using replacement cost approach, this study therefore estimates the aggregate economic value for sheep and goat kept under the traditional production system in northern Ghana. This evaluation method is relatively unknown in Ghana. Therefore, the study contributes to literature on evaluation of traditional livestock systems in Ghana and also expands the literature on traditional livestock systems in Africa by examining constraints that limit sheep and goat production.

1.7 Outline of the Thesis

The study comprises of six chapters. Chapter One generally introduces the study, defines the economic and research problem, justification and also states the objectives of the study. Relevant literature informing the study is reviewed in Chapter Two.

Chapter Three discusses the theoretical, conceptual as well as the empirical models adopted for the study. In Chapter Four, the methodology employed in gathering data for the study is presented and discussed. Empirical results, including analysis and discussions are presented in Chapter Five. The last Chapter (Six) provides the study's summary. It also draws conclusions from the study and provides policy recommendations.

1.8 Chapter Summary

Chapter One presented the background to the study. It elaborated on the role of small ruminant production in the rural economy of Ghana. In addition, the chapter introduced the economic and research problem under investigation from which research questions are formulated. Finally, the objectives of the study are presented.

Thereafter, the relevant literature adopted for the study is presented in Chapter Two.

CHAPTER 2

2.0 LITERATURE REVIEW

This chapter is divided into five (5) sub-sections. First, a general review of agroecological zones and smallholder small ruminant production in northern Ghana is presented and discussed. Secondly, relevant literature on socio-economic determinants and estimation of aggregate economic benefits of small ruminant livestock are also reviewed. Lastly, the literature on gender determinants of smallholder small ruminant production and constraints limiting such production systems are also evaluated.

2.1 Agro-Ecological Zones and Smallholder Small Ruminant Production in

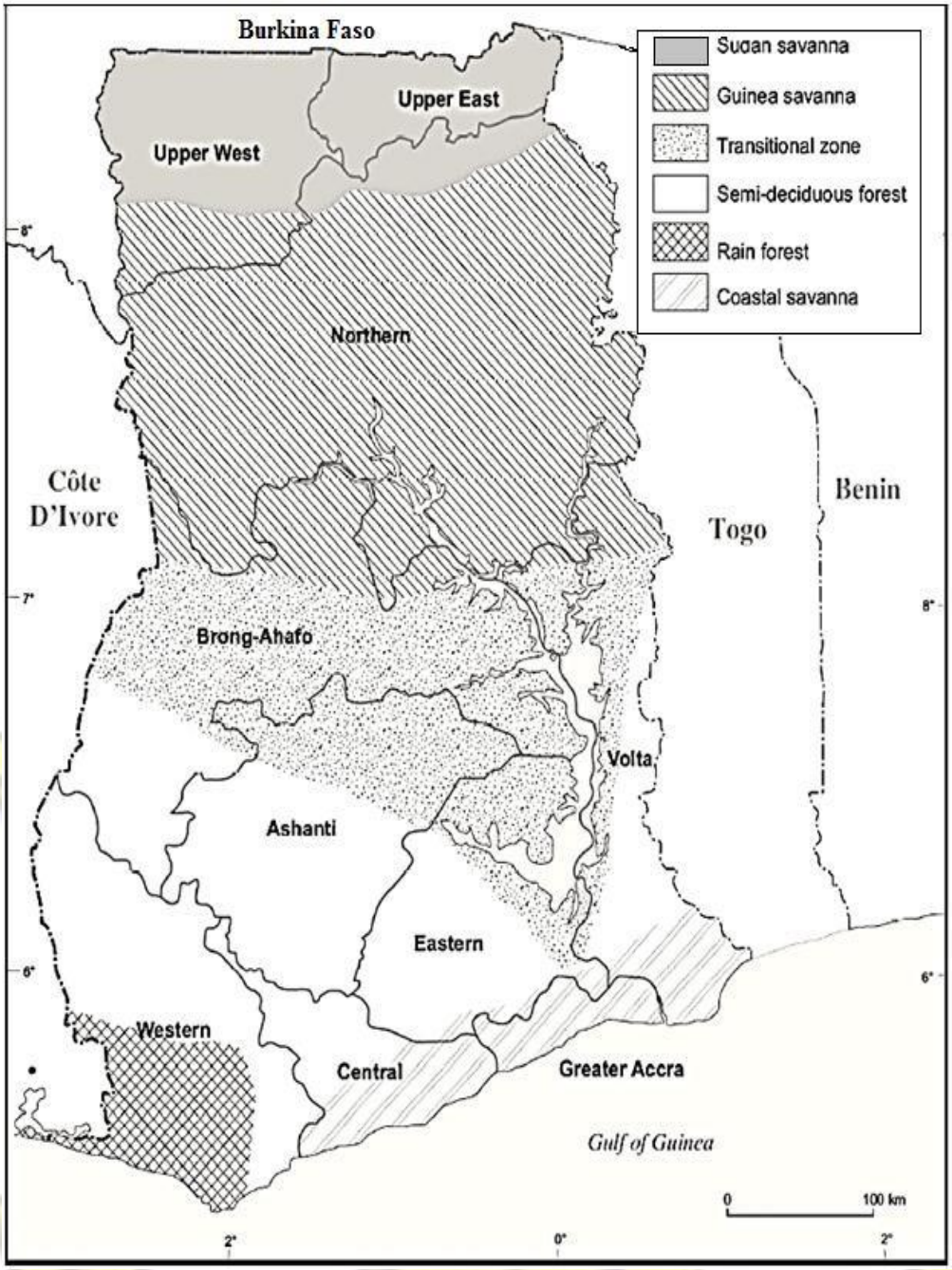
Northern Ghana

2.1.1 Description of Agro-ecological Zones in Northern Ghana

Agro-ecological zones in Ghana closely mirror the natural vegetation in the regions and are influenced by climatic conditions and soil type (FAO, 2005b; GEPA, 2002). There are six different types of agro-ecological zones in Ghana (Figure 2.1). However, only the Guinea and Sudan savannah zones of northern Ghana will be covered in this study.

The Guinea savannah agro-ecological zone (147, 900 km^2) lies south of the Sudan savannah (Karbo and Agyare, 1997). The zone covers most of the Northern region and lower part of the Upper West region (Canagarajah and Portner, 2003; Tsibey *et al.*, 2003). The Sudan savannah zone, on the other hand, covers the entire Upper East region and a large part (about 1,900 km^2) of the Upper West region (Codjoe, 2010). The key features and climatic conditions in the two agro-ecological zones are summarised in Table 2.1.

Figure 2.1 Map Illustrating Agro-Ecological Zones Of Ghana



Source: Quansah *et al.* (2001)

Table 2.1 Characteristics of the Guinea Savannah and Sudan Savannah AgroEcological Zones in Ghana

Zone	Average rainfall	Temp (^{0}C)	Soil characteristics	Proportion Growing to total land season area of days Ghana (%)	Main food crops

Guinea savannah	1100	24-38	Upland soils, light textured, good fertility and organic matter	63	180-200	Sorghum, maize
Sudan savannah	1000	25-36	Upland soils, coarse texture, low in fertility and organic mater	1	150-160	Millet, sorghum, cowpea

Source: FAO (2005a)

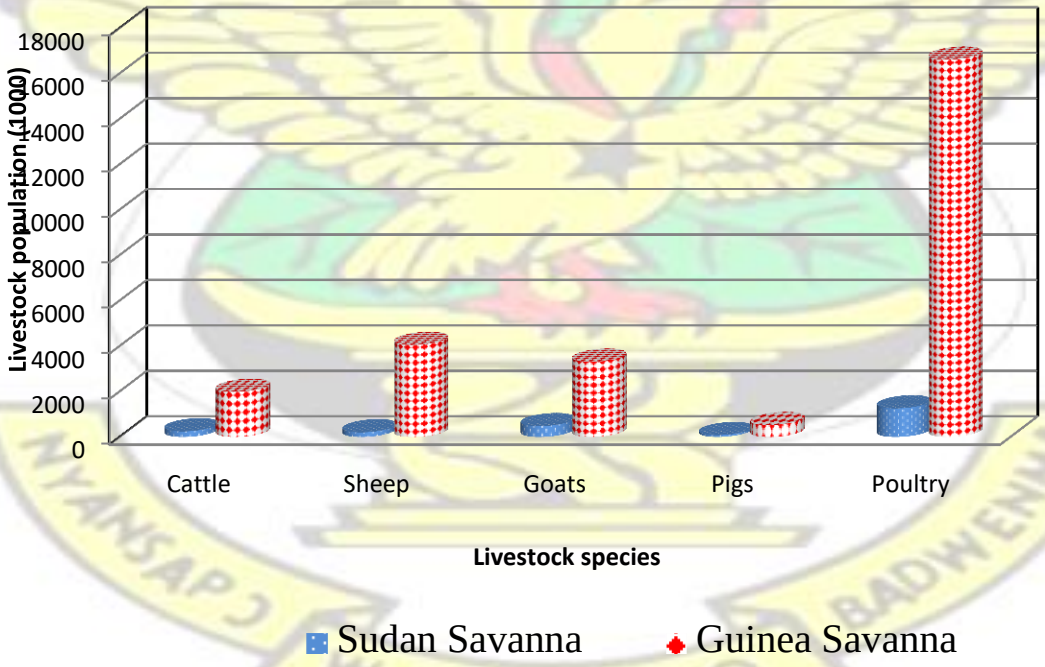
Differences in rainfall amount and intensity, as well as temperature and vegetation cover of the two zones, affect agricultural production in the two zones (Codjoe, 2010). This, in turn, influences production systems, risk coping strategies, production constraints, as well as differences in motivation and production objectives of smallholders. The Sudan savannah zone consists of short drought- and fire-resistant deciduous trees scattered in open savannah grassland. The grass cover is very sparse with frequent bare lands and severe surface soil erosion (GEPA, 2002). Common grasses found include *Andropogon spp*., *Heteropogen spp*., *Hyparrhenia spp*, *Aristida spp*, and *Loudetia spp*. Other browse species include *Leuceana leucocephela, Sesbania grandiflora, and Gliricidia sepium* (Husseini *et al.*, 2011). Tree cover is very low, with economically important shrubs such as *Anogeissus leiocarpus, Acacia spp., Terminalia microcarpa, and Vitellaria paradoxa*.

The Guinea savannah zone has ground cover grasses of varying heights with fireresistant, deciduous broad-leaved trees at the forest margins in the south. Moving northwards, the vegetation is dominated by grassland with interspersed shorter trees. In areas with less soil erosion, *Andropogen gayanus*is commonly replaced by *Hyparrhenia and Heteropogon spp.* while *Aristida, Sporobulus, Imperata* and *Cymbopogon gigantus* are common in heavily eroded areas. Trees found in this zone

include *Lophira lanceolata, Anogeissus leiocarpus, Afzelia Africana, Parkia filicoidea, Butyrospermum parkii* and *Antiaris Africana* (GEPA, 2002).

Annual rainfall and the main vegetation characteristics (grass availability and type) across the zones account for differences in livestock production systems and numbers (Wilson, 1991).The two zones, along with the coastal savannah, constitute the rangelands of Ghana. The dry savannah (Guinea and Sudan) produces about 70% of the nation‘s cattle, and about 75% of the small ruminants (Oppong-Anane, 2011). However, more livestock are raised in the Guinea savannah than in the Sudan savannah (Figure 2.2). Mapiye *et al.* (2009) observe that differences in the agroecological zones and socio-cultural factors affect the relative importance of livestock among smallholder farmers in the area.

Figure 2.2 Livestock Population in the Sudan Savannah and Guinea Savannah of Northern Ghana, 2011



Source: Oppong-Anane (2011)

2.1.2 Small Ruminant Production Systems in Different Agro-ecological Zones

The contribution of small ruminants (sheep and goat) to food security and poverty reduction is under-exploited in the Guinea and Sudan savannah of Ghana (Mahama, 2012; Otchere, 1986). Sheep and goat are raised by marginalised and landless smallholders not only for meat but also as an important source of wealth and savings, and as insurance against crop failure (Dossa *et al.*, 2008; Otchere, 1986).

Recent studies suggest that sheep and goat ownership patterns and flock size depend on smallholder farmers' level of engagement in crop and other agricultural production activities across gender, ethnicity and age-groups in tropical Africa (Adzitey *et al.*, 2010; Poku, 2009; Wilson, 1985). Livestock are commonly owned by both full- time and part-time farmers (Wilson, 1985). Individual household members including men and women or the household as a unit may own such animals (Dossa *et al.*, 2008), which may be housed close to homesteads and herded by younger family members (Asafu-Adjei and Dankwatah, 2001). Farmers are typically poor and depend on low input use and production technologies (Turkson and Naandam, 2006). The animals are often raised for multiple functions (Guitierrez, 1985; Moll, 2003).

A common characteristic of this livestock production system includes the integration of livestock into crop production, thereby helping to replenish soil fertility from animal manure. Crop residue is used to feed animals and to improve on environmental sustainability (Karbo and Agyare, 1997; Karbo *et al.*, 1993). About 5% of the farmers in the region undertake livestock production alone or crop production alone (ADF, 2001; Oppong-Anane, 2011). The major types of small ruminant production systems in northern Ghana include:

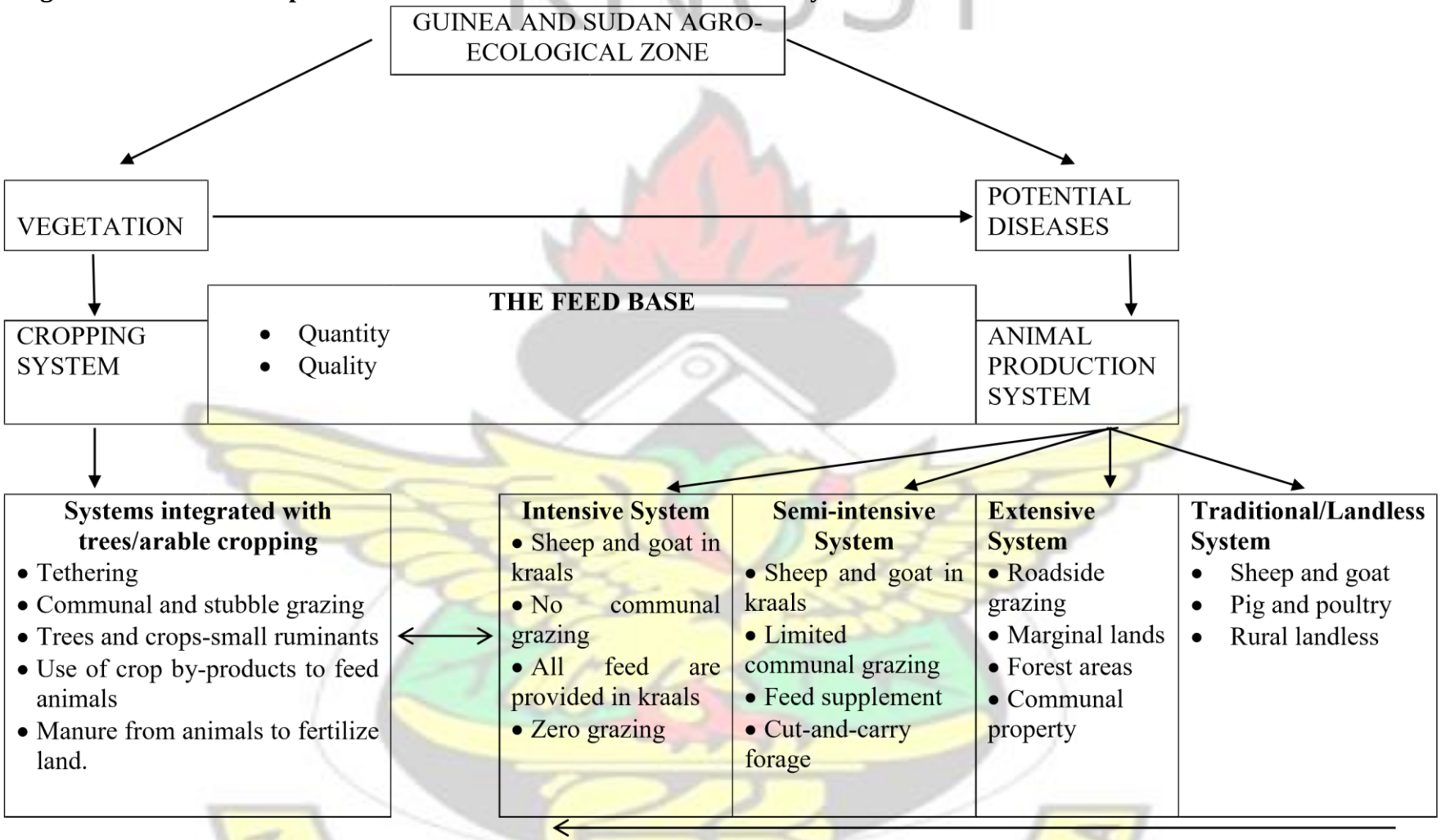
- Traditional or landless system

- Extensive system
- Semi-intensive system
- Intensive system

The small ruminant production systems within a larger context of farming systems in northern Ghana are illustrated in Figure 2.3. The four production systems lie in a continuum, moving from the traditional system to more intensive systems of raising sheep and goat in the region (Oppong-Anane, 2011). Moving along the continuum, the amount of grazing land reduces while intensity of zero-grazing tends to increase.

The four livestock systems are integrated with the main farming systems of tree or arable crop farming. For the traditional, extensive and semi-intensive systems, small ruminants are allowed to graze on farmlands after harvest, fed with crop by-products and tethered around the farmlands during cropping seasons. In return, manure from the animals is left to fertilize farmlands when the animals are grazing or during tethering. Under the intensive system, the animals are mostly fed through harvesting of crop by-products or grasses while manure is sometimes returned to farmlands. Beside this symbiotic relationship, smallholder farmers under the integrated livestock-crop system usually invest money from harvesting crops in small ruminant livestock at the end of the cropping season. The animals are kept until the beginning of the new cropping season where they (animals) are sold to purchase inputs for crop farming.

Figure 2.3 Schematic Representations of Small Ruminant Production Systems in Northern Ghana



Source*:* Modified from Devendra (2008)

2.1.2.1 Traditional or Landless Production Systems

In the traditional system, most of the animals are raised under free range. This poses a challenge for a systematic study of the production system (Sumberg and Cassaday, 1984). Animal holdings per individual or household tends to be low, ranging from 1 to 10 heads (ADF, 2001; World Bank, 1992), and goat tend to dominate sheep numbers (FAO, 2012a). Farmers who raise small ruminants under free range systems are typically resource-poor. As a result, use of feed supplements, veterinary care, good housing or quality breeds tend to be limited (ADF, 2001; Sumberg and Cassaday, 1984). Farmers‘ investment in livestock is through purchase, inheritance or as gifts to replenish the farm stock (Suleman, 2006). Animals commonly scavenge for food and water around villages or homesteads without a stock herder (Upton, 1984). The animals roam freely as a unit within the village, with high inter-breeding. Turkson and Naandam (2006) reports that the traditional landless and extensive systems are the dominant systems in northern Ghana and are characterised by low production cost and low-output, using natural pastures in open ranges and crop residues from farms. No forage is cultivated and animal droppings around homesteads are not returned to cultivated fields (Upton, 1984). In the traditional sheep and goat production systems in northern Ghana, inbreeding is common, with a high incidence of dystocia-related matters (i.e., stillbirths and abortions) because young females are mated before maturity (Upton, 1984). Mortality rate is high mainly due to poor housing, overcrowding, and poor ventilation, resulting in diseases such as pneumonia and diarrhoea, especially during the rainy periods (Terril, 1985b; Turkson *et al*., 2004).

Although most rural households in the Guinea and Sudan savannah agro-ecological zones own sheep, goat or both, the productivity of such animals is low mainly due to high mortality resulting from diseases and inadequate nutrition (Ademosun, 1992; Ockling, 1987). Both

species are the dwarf breeds, but goat are more prolific than sheep (Ockling, 1987; Upton, 1984; World Bank, 1992). Labour costs are low because scavenging animals receive little attention (Panin and Mahabile, 1997) and mortality from highway accidents is high (Alenyorege *et al.*, 2010).

In the three administrative regions of northern Ghana, the traditional small ruminant production system has been in existence for several centuries (Suleman, 2006). However, increasing urbanisation, loss of soil fertility and changing technology (Karbo and Agyare, 1997; Karbo *et al.*, 1999) have led to emergence of other forms of production systems such as the extensive, semi-intensive and intensive systems/backyard system (Oppong-Anane, 2011).

2.1.2.2 Extensive System

The extensive system is similar to the traditional free-roaming system except that the former receives more care and attention as well as feed supplements during some periods of the year (Devendra, 1985). The average number of animals per holding is not significantly different from the free-roaming system, with two to ten animals per household (Suleman, 2006). Under the extensive system, animals graze on marginal and communal lands (Asafu-Adjei and Dantankwa, 2001; Devendra, 1985). Several individuals who own sheep and goat may put their stock together as a single unit. During the long dry season, animals travel very far distances to find feed and water. During cropping seasons, the animals are not allowed on farmlands. Instead, they graze around houses (Asafu-Adjei and Dankwatah, 2001). In intensive cropping communities, animals are tethered and provided with cut-and-carry browses, kitchen by-products (such as cassava and yam peels, and groundnut haulms) with little or no mineral supplement provided (Karbo *et al.*, 1999; Ockling, 1987).

2.1.2.3 Semi-intensive System

Unlike the extensive system, grazing is limited in the semi-intensive system, and stall-feeding depends on family labour, time and feed availability (Devendra, 1985; Ockling, 1987). Grazing is normally done during late mornings or evenings, usually for about 4-6 hours. Simple kraals are commonly constructed from locally available materials such as timber, bamboo, tree branches and mud and roofed with leaves, split bamboo or metal sheets (Oppong-Anane, 2011). Cut-and-carry forage, household food waste, crop residues and crop by-products are common sources of feed under this system (Duku *et al.*, 2010).

Due to limited grazing on natural pasture under the semi-intensive system, sheep and goat tend to be deficient in essential minerals. Karbo *et al.* (1999) reveal that the use of mineral supplements such as saltlick, bone meal and dicalcium phosphate is not a common practice in the semi-intensive systems because the poor smallholder farmers cannot afford the supplements or live in rural areas where they have no access to such mineral supplements. On the other hand, alternative sources of mineral supplements from clay deposits in riverine areas are sometimes used (Karbo *et al.*, 1999).

One common characteristic of all the three systems discussed above is the rearing of local sheep and goat breeds, that is, the West African Dwarf and West African longlegged type (Karbo *et al*., 2007). The local breeds serve as short-term cash reserve against crop failure (Addah and Yakubu, 2008), a source of quality food (meat), and are also a store wealth for many poor and disadvantaged in rural and peri-urban communities in northern Ghana (Asafu-Adjei and Dankwatah, 2001; World Bank, 1992).

2.1.2.4 Intensive or Backyard System

In this system, animals held in kraals are not allowed to graze on communal lands. All feed are provided in the kraals (Oppong-Anane, 2011). The intensive system also depends on zero grazing, the use of crop residue and household waste (OppongAnane, 2006). Very few are found in northern Ghana. Under this system, sheep and goat are fattened to supply meat for urban markets during religious and other festive occasions. This production system is commonly practiced in urban and peri-urban areas. Access to veterinary service is improving, although some farmers still practice self-medication using various herbal remedies (Oppong-Anane, 2006).

A common characteristic of these small ruminant production systems includes the integration of livestock into crop production, thereby helping to replenish soil fertility from animal manure. Crop residue is used to feed animals and to improve on environmental sustainability (Karbo and Agyare, 1997; Karbo *et al.*, 1993). Only about 5% of the farmers in northern Ghana undertake livestock production alone or crop production alone (ADF, 2001; Oppong-Anane, 2011).

2.1.3 Breeds of Sheep and Goat in Agro-ecological Zones in Northern Ghana

Important considerations in the choice of animal breed for a specific agro-ecological zone include ability to adapt to local environmental conditions, management cost and potential to market the animals (Wilson, 1991). Resilient features of breeds are important for resistance to diseases and pests (Wilson, 1985).

The Guinea, Coastal and Sudan savannah zones, as well as the humid zone of Ghana, have varying levels of threats of tsetse-fly. Thus, small ruminant production is dependent on breeds which tolerate testse-transmitted trypanosomiasis (Mahama *et al.*, 2003; Oppong-Anane, 2011). The larger and long-legged Sahelian breeds are less

resistant to trypanosomiasis than the WAD breeds (Opasina and David-West, 1987). As a result, the Sahelien types are commonly found in the Northern and Upper regions of Ghana, where there are fewer tsetse problems (Mahama *et al.*, 2003). On the other hand, the more trypano-tolerant WAD breeds are widely distributed across the country (Mahama *et al.*, 2003; Ockling, 1987). Another category of breeds that are becoming important over time are cross-breeds between the trypano-tolerant and the Sahelien types, developed through various breeding programmes such as the National Livestock Services Projects (NLSP), Smallholder Rehabilitation Development Programme (SRDP), Land Conservation and Smallholder Rehabilitation Programme (LACOSREP) and Open Nucleus Breeding Schemes (ONBS) (Karbo *et al.*, 1997; Oppong-Anane, 2011). There are also some exotic breeds of sheep and goat in the country (Oppong-Anane, 2006). The various small ruminant breeds and proportions in the various ecological zones of Ghana are summarised in Table 2.2.

Table 2.2 Proportions of Small Ruminant Breeds/Crosses across Ecological Zones of Ghana (%)

Ecological Zones	Sheep			Goat		
	Djallonke	Sahelian	Crosses	Djallonke	Sahelian	Crosses
Sudan savannah	60	10	30	70	10	20
Guinea savannah	70	10	20	85	5	15
Transitional zone	80	5	15	85	1	14
Rain and Semideciduous forest	75	1	24	89	1	10
Costal savannah	62	3	25	65	3	22

Source: Oppong-Anane (2011)

The West African Dwarf sheep known as *djallonke* (World Bank, 1992) does not necessarily exhibit dwarf traits. It is the most common nation-wide, and often used in breed improvement schemes by individual farmers, or parastatal farms and breeding stations (Karbo *et al.*, 1997; Oppong-Anane, 2006). They are noted for their hardiness, typano-tolerance, prolificacy and ability to breed all year round. The djallonke sheep

have an average weight of 25kg-30kg for a mature adult male, while females weigh between 20 and 25kg (Oppong-Anane, 2006). They have fine hair and are normally black and white in colour, with the white coat dominating (Suleman, 2006). Average reproductive performance of the breed is 1.28 lambs/ewe/year and lamb mortality between birth and weaning is 0.3 (Mourad *et al*., 2001). Overall, mortality rate is about 21%, and off-take rate (proportion of animals sold or consumed per annum) stands at 38% for the djallonke sheep managed under the traditional production system (Opasina and David-West, 1987; World Bank, 1992).

The Sahelian breeds, on the other hand, are large with adult shoulder length at about 84cm. They have long-legs, long ears, as well as dangling long tail. Averagely, mature females weigh 45kg, and 55kg for male sheep (Javis, 1990).

The West African Dwarf and Sahelian goat breeds share similar adaptive features to the djalonke sheep. However, the WAD goat have achondro-plastic dwarfism with an average mature adult weight of 20kg-25kg, and female 18kg-22kg (Oppong-Anane, 2006). Reproductive performance characteristics of the WAD goat include about 2.2 kids/doe/year, overall mortality of 23.7%, and off-take rate of 38% (Opasina and David-West, 1987; Oppong-Anane, 2006).

2.2 Economic Importance of Small Ruminant Production

2.2.1 Provision of Market Products

According to Devendra and Chantalakhana (2002), the economic importance of small ruminants to the wellbeing of poor and landless households tends to be higher than is commonly reported and/or documented. In general, the contribution of sheep and goat to the livelihoods of economically vulnerable households includes ensuring food security, strengthening social and cultural relationships, employment and poverty alleviation. The economic contribution of small ruminants is particularly important to

the livelihood of the poor in promoting sustainable livelihoods in arid regions of sub-Sahara Africa, such as northern Ghana (ADF, 2001; IFAD, 2004; Otte *et al.*, 2010; World Bank, 1992). In such arid regions, sheep and goat are viewed as a form of financial and natural capital in vulnerable households (Herffernan *et al.*, 2003).

2.2.1.1 As Source of Financial Capital

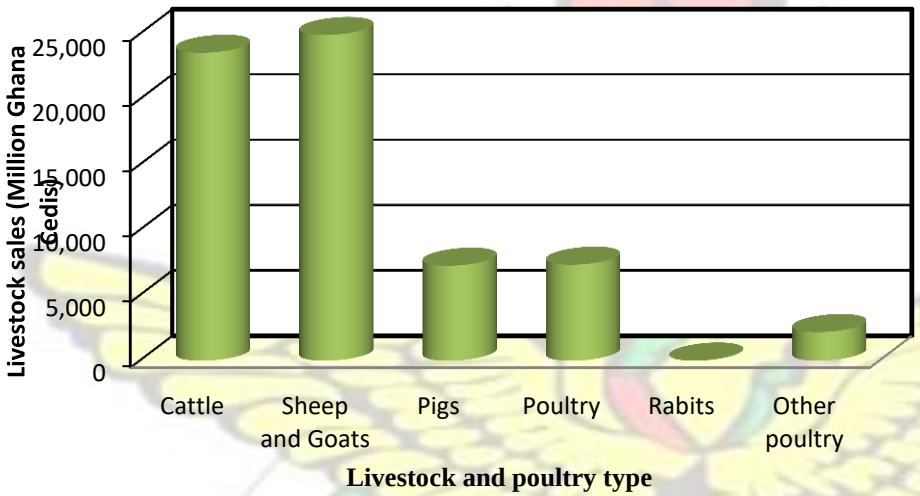
For many farm households in northern Ghana, sheep and goat serve as a major form of savings and investment, and security against deficits in household earnings and insurance to overcome unforeseen necessity of rural households including settling of medical bills and school fees (Oluwatayo and Oluwatayo, 2012), especially among rural women (Devendra, 1985). Few other agricultural outputs/products, including large livestock (such as cattle), can compete with small ruminants as a means of capital growth in poor and landless households. Initial capital investment for setting up a small business in sheep and goat is generally low, and the risk of loss from small ruminant deaths is low (Oluwatayo and Oluwatayo, 2012; Terril, 1985b). Moreover, due to the smaller average size of sheep and goat, they tend to be easier and quicker to sell than larger stock such as cattle, thereby serving as a potential source of ready or liquid cash in times of financial need.

Small ruminants are also biologically adaptable to cope with short spells of drought conditions better than cattle (Lebbie, 2004; Peacock, 2005). Moreover, the relatively short gestation periods for sheep and goat make them (small ruminants) better able to recover from drought or disease outbreaks. Thus, sheep and goat can generate continuous income to smallholder farmers before, during and after drought periods.

The Ghana Environmental Protection Agency (2002) reports that, on the average, 5.8 goat and 4.7 sheep per household in northern Ghana are sold annually, and 42% to 45% of income from farm households comes from livestock sales (Honya *et al.*, 2007; Karbo and Bruce, 2000).

Various studies suggest a growing market demand for sheep and goat meat than other livestock in urban areas across West Africa (Itty *et al.*, 1997; Lebbie, 2004; Peacock, 2005). Oppong-Anane (2011) for example, reports that an amount of 24,930,000 Ghana cedis is recorded from sheep and goat sales between 2005 and 2006 compared with 23,570, 000 Ghana cedis from cattle sales over the same period (Figure 2.4). Thus, increasing sheep and goat production presents an opportunity to increase income and sustain livelihoods of rural households.

Figure 2.4 Average 12-Month Livestock Sales in Ghana, Between 2005 And 2006



Source: Oppong-Anane (2011)

2.2.1.2 Natural Capital

Small ruminant production in Ghana is dominated by crop farmers (Karbo and Agyare, 1997; World Bank, 1992). Smallholder farmers who integrate small ruminant livestock with crop production enhance the sustainability of their farming systems (Devendra and Chantalakhana, 2002; Seyoum, 1992). Manure from sheep and goat help to improve soil fertility for farm households who cannot afford inorganic fertiliser (Devendra, 2001; Karbo *et al.*, 1999). Manure and urea from small ruminants provide major nutrients for crop production (Ayalew, 2000; Lebbie, 2004). However, the use of such manure is limited in the study area (Karbo *et al.*, 2007; Lebbie, 2004).

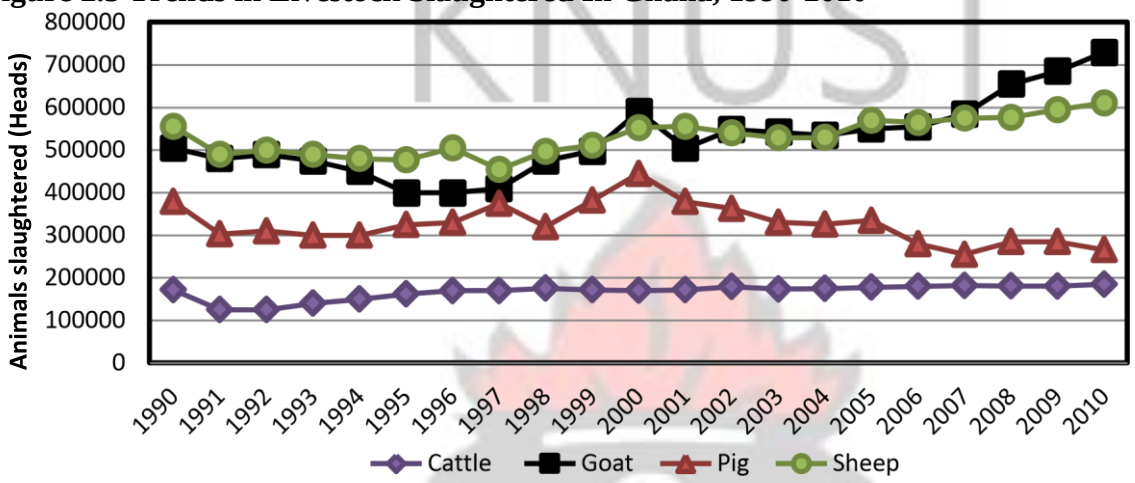
According to Devendra (1988), sheep and goat are also quite useful in helping to control soil erosion and bush fires. Devendra (1988) argues that in many smallholders farming communities, sheep and goat are allowed to browse (graze) on less productive and marginal lands covered with brushes and scrub trees. Such grazing practice helps to reduce potential fire hazards. Subsequently, the potential threat of rill and sheet erosion, when the land becomes exposed to rain and wind as a result of bushfire, is reduced (Devendra, 1988; Lebbie, 2004).

The contribution of sheep and goat to human nutrition in sub-Saharan countries such as Ghana is documented in various studies (Kosey, 2004; Oluwatayo and Oluwatayo, 2012; Otchere, 1986). Official statistics suggest that sheep and goat account for about 41% of total domestic meat produce in Ghana in 2010 (FAO, 2012b). However, both Libbie (2004) and Seynoum (1992) argue that data on small ruminant contribution to food production is usually underestimated in African countries, largely because the quality of agricultural statistical data reporting systems is generally poor (Yiridoe, 2006). A higher percentage of sheep and goat products used in rural households are typically not reported or documented in official statistical databases. Moreover, the flow and distribution of sheep and goat products in urban regions may be through informal rather than formal marketing systems.

Sheep and goat also have advantages over other livestock in converting feed such as straw and grasses, as well as other by-product such as kitchen scrap and other waste products into value-added high quality food products for human consumption (IFAD, 2004; Terril, 1985b). The meat of small ruminants is a source of protein in many local cereal-based diets and can improve the nutrition of vulnerable children and pregnant women (Terril, 1985b). The size of small ruminants which, on average, generate about 20kg to 35kg carcass weight (Oppong-Anane, 2006), allow rural households to

conveniently process them easily for home consumption with little or no need for preservation (Lebbie, 2004; Oluwatayo and Oluwatayo, 2012). Trend in livestock slaughtered in Ghana from 1990 to 2010 is presented in Figure 2.5.

Figure 2.5 Trends in Livestock Slaughtered In Ghana, 1990-2010



Source: FAO (FAOSTAT Database) Various Years

The data suggest that sheep and goat slaughtered had a rising trend, while pig products, in particular, remained fairly flat. By contrast, there was a declining trend for beef during the 20-year period (FAO, 2012).

Rural women who raise sheep and goat are often better-off in terms of income levels in a state of divorce or seasonal migration of husbands (Devendra, 1988). The income from the sale of sheep and goat by women can be used to buy more food or support children through school. Women's role as decision-makers tends to improve when their sheep and goat contribute to wealth in their households (IFAD, 2004).

2.2.2 Provision of Non-market Products of Sheep and Goat: Financing and Insurance Role

In most sub-Sahara African countries, the rural community forms the majority of the population and its main economic activity is smallholder agriculture, mainly crop farming and livestock production. Therefore, stimulating rural development has become a major priority among national governments of which Ghana is no exception.

One key area of such stimuli is the establishment of financial markets, to both harness and invest savings and provide credit to the smallholder farmers (Slingerland, 2000). However, various studies suggest that such markets are weak or non-existent in rural Africa or even if available, smallholder farmers face serious limitations in accessing services from them (Behnke, 1985; Binswanger and Rosenzweig, 1986; Moll, 2003).

In the absence of strong financial markets, livestock, including sheep and goat, are used as alternative forms of wealth accumulation (savings or financing) and riskcoping strategy (insurance). Livestock are used for both short and long term savings against future expectation needs and they play a financing role in a situation where banking institutions are absent or under-developed (Bosman, 1995; Moll, 2003) or in a case where households are not fully engaged in financial institutions (Ouma *et al.*, 2003). Income from the sales of livestock animals is used to improve the stability of smallholder farming through various purchases including inputs for crop production (Asafu-Adjei and Dankwantah, 2001).

As a source of insurance, capital invested in livestock serves as an assurance for unforeseen necessity of rural household (Bosman *et al.*, 1996b; Ouma *et al.*, 2003; Slingerland, 2000). The capital invested in livestock serves as a security to overcome deficits in household earnings and unexpected expenditures in the future (Ouma *et al.*, 2003; Slingerland, 2000). The financing role of livestock involves selling part of the herd into disposable income (and vice versa) by households to meet huge financial expenditure obligations such as medical care, school fees payment or to finance crop production through purchase of inputs. These functional roles of livestock management in rural settings have extensively been documented (Binswanger and Rosenzweig, 1986; Bosman *et al.*, 1996b; Moll, 2003; Slingerland, 2000) especially in rural Africa where formal financial institutions are non-existent or ill-functioning.

Slingerland (2000) provides comprehensive benchmarks upon which livestock are considered as the best asset in a mixed-farming system for financing and insurance role compared with other assets. These include liquidity ability, resistance to inflation, capacity for asset accumulation, accessibility and controllability. By liquidity, this refers to the ability of households to convert part of or the entire asset to generate immediate cash income that would be enough to meet the financial obligation when necessary without significantly changing the farm business operation. In this context, livestock especially small ruminants provide the best alternative. For instance, the sale of assets such as land, equipment or housing may affect the farm operation and in most cases markets for these assets may be unavailable as compared with livestock. In addition, livestock animals are easily convertible into cash (high market demand) when compared with root and cereal crops because the latter require more time for harvesting and/or storage facilities before sale. More relevantly, Panin (2000) shows that cattle production requires heavy capital commitment, hence is less liquid compared with small ruminant livestock which can be sold easily without affecting the household farming system.

Secondly, livestock are more attractive for financing and insurance role due to the animals' capacity to increase in value over time. This is evident owning to livestock capacity to grow and reproduce (Jahnke, 1982; Siegmund-Schultze *et al.*, 2011; Slingerland, 2000). In comparing annual crop and livestock production, crop production does not share this characteristic (Moll, 2003; Ouma *et al.*, 2003; Slingerland, 2000). Increases in the value of annual crop production have a time limit i.e., from sowing to maturity, beyond which the crop may deteriorate. However, livestock has the capacity to increase in live weight over time and reproduce to accumulate more assets for the household.

In addition, more convincing arguments exist that support using livestock as cash savings as against saving money in the bank (Ayalew *et al.*, 2003; Bosman, 1995; Bosman *et al.*, 1996b; Siegmund-Schultze *et al.*, 2011; Slingerland, 2000). Smallholder livestock production, especially sheep and goat rearing, are low-cost and inflation-proof which rather appreciates with inflation (Ayalew *et al.*, 2003). The interest rates on savings in banks is far below the annual rate of return on managing livestock (Slingerland, 2000) and can even be negative in practical terms due to inflation (Moll, 2003; Ouma *et al.*, 2003). Hence, saving in the bank may be unattractive to rural households especially in the face of high transaction cost and loss of purchasing power because interest rates will not be enough to offset inflation (Slingerland, 2000).

The accessibility and controllability of small ruminants by farm households and even individual members are relatively better than other assets in mixed farming systems. Little capital within the range of smallholder farmers is required for ownership of sheep and goat assets (Devendra and Chantalakhana, 2002; Terril, 1985b). In addition, property rights on assets such as lands are more frequently communal or on lease basis in rural Africa compared with livestock which are independently owned. This suggests that households can have full control over their livestock assets and can take independent decisions regarding their productivity. Lastly, savings in banks may lead to less control over household cash assets due to bureaucratic procedures, restrictive regulations and insufficient transparency which are not associated with tying up cash in livestock production (Slingerland, 2000).

Based on these qualities, raising livestock proves a better alternative for financing and insurance among smallholder mixed farming as compared with other assets. The capital embodied in livestock rather appreciates over time (Ouma, 2003). The animals help to regulate household consumption and savings over time by catering for immediate and

unforeseen cash needs of the household (Ayalew *et al.*, 2003; Jahnke, 1982). However, Siegmund-Schultze *et al.* (2011) hold a different view about the role of livestock as a form of insurance. They argue that once a household sells the whole herd to meet losses that occurred because of unexpected expenses, such wealth accumulation in livestock cannot be repeated in the near future. Slingerland (2000) also made similar observation emphasising that if rural households sell part or entire livestock flock without replacement, the consequence of such liquidation would have a negative effect on the farming system since the intermediate role of livestock as a source of manure and draught will be non-existent.

In the rural setting of developing countries like northern Ghana, agricultural production is dependent on rainfall which leads to seasonality in farm income (AsafuAdjei and Dantankwa, 2001; Binswanger and Rosenzweig, 1986). Siegmund-Schultze *et al.* (2011) have shown that rural households are risk-averse producers hence income from crop production during bumper harvests are invested in livestock to diversify the farm portfolio and reduce risk. Binswanger and Rosenzweig (1986) attribute this arrangement mainly due to the absence of or difficulties in the operations of formal insurance service providers in rural areas of Africa. They stress that the cost of information of insurance in village settings is high and this might raise insurance premium beyond the reach of smallholders. More so, the instability of agriculture in rural areas could lead to a total crop failure of a whole operational area which may lead to an abnormal claim.

2.3 Determinants of Smallholder Small Ruminant Production

In general, farm household production and livelihood decision choices are strongly influenced by socio-economic and demographic variables (Barrett and Reardon, 2000; Ellis, 1998; Ellis and Mdoe, 2003; Feldstein, 1987; LeMay, 2006), as well as

institutional or policy and technological factors (Barrett, Reardon and Webb, 2001; Binswanger and Rosenzweig, 1986; Ellis, 1998; Reardon, 1997). Some studies have investigated such issues for crop production (e.g., Abdulai and CroRelees, 2001; Junejo *et al.*, 2011; Udoh and Kormawa, 2009) and, to a lesser extent, large ruminant production (e.g., Barry, 2005; Thys *et al.*, 2005). However, the factors that influence smallholder farmers' decisions to manage important small ruminant livestock, especially sheep and goat, are not clearly understood (Duku *et al.*, 2011; Verbeek *et al.*, 2007). The dearth of knowledge is particularly critical for limited-resource regions such as northern Ghana (Turkson and Naandam, 2006).

Limited studies for small ruminant production systems for other countries suggest that, in general, the factors can be grouped into: i) general economic status factors (e.g., cultivated farmland size and non-farm income level); ii) demographic variables (e.g., age, gender, education and household size); and iii) sociological and cultural factors (e.g., faith and religious belief, and ethnic-related attributes) (Dossa *et al.*, 2008; Duku *et al.*, 2011; Ellis, 1998; Fakoya and Oloruntoba 2009; Mucuthi *et al*., 1992; Omandi *et al.*, 2008; Verbeek *et al.*, 2007). Important policy and institutional factors include access to credit from formal financial institutions, savings in formal financial institutions, and access to extension services (Dossa *et al.*, 2008; Oluwatayo and Oluwatayo, 2012). Details of the effects of selected factors that influence small ruminant livestock ownership and management are discussed below.

2.3.1 Demographic Factors

A large body of literature for various rural regions across Africa conclude that women are more likely to raise (and own) small ruminants than men (Curry, 1996; Devendra, 1988; Devendra and Chantalakhana, 2002; Duku *et al.*, 2011; Duku *et al.*, 2012; Lebbie, 2004). Unlike their adult male counterparts, women are typically not custodians of

lineage lands (Adolwine and Dudima, 2010; Apusigah, 2009; Kasanga and Kotey, 2001). Thus, such women are often constrained by farmland-use rights (Awumbila, 2007; Baden *et al.*, 1994; Sinn *et al.*, 1999). In general, women also tend to have limited non-farm employment opportunities, compared with men (Awumbila, 2007; Curry, 1996; Simth *et al.*, 2001). Women's constraints on lineage land use further limit use of such family land as collateral to secure credit in the formal financial market sector (Baden *et al.*, 1994; Chen *et al.*, 1999; Dossa *et al.*, 2008; Lebbie, 2004). The various constraints rural African women face tend to force them to consider less male-dominated livelihood survival options (Apusigah, 2009), including diversifying into small ruminant livestock (i.e., sheep and goat) and poultry (Oladele and Monkhei, 2008). Women also tend to have a distinct advantage over men in raising their own sheep and goat because such animals are commonly managed near homesteads, and can be fed with kitchen waste and other similar by-products (Okali and Sumberg, 1994).

In a multi-country study for sub-Sahara Africa, Ellis (1998) reports that younger household heads and other adult individuals who are more innovative and better educated tend to leave farming and engage in rural non-farm wage employment or migrate to urban locations for non-farm employment. Thus, older rural household heads and individuals, especially those with little or none on-farm employment opportunities tend to remain in rural and agricultural regions to undertake crop and livestock production (Dossa *et al.*, 2008).

Kunene and Fossey (2007) find that older individuals in rural sub-Sahara Africa tend to raise large numbers of small ruminants, compared with younger household heads because such older farmers tend to have higher household sizes (i.e., children and women) to shepherd and manage the small ruminant stock. Asafu-Adjei and Dantankwa (2001) also reports that the daily tasks associated with raising small ruminants in northern Ghana tend to be under the care of older household members because such

members are less inclined to migrate to distant locations for alternative employment outside agriculture. In a recent study of the profile of small ruminant farmers in urban Ghanaian communities, Baah *et al.* (2012) reports that the majority of such small ruminant owners are older household heads. Mahabile *et al*. (2005) also find that older household heads, along with a large household size, frequently manage livestock in Botswana. In a similar study for northern Benin, Dossa *et al.* (2008) reports that older household heads are more willing to acquire and raise small ruminants than younger household heads.

Livestock production in most parts of Africa is undergoing scientific and technological transformation (e.g., using new and improved breeds), and requires the collection and processing of new technical information (Marinda *et al.*, 2006). Thus, producers with relevant technical education in agriculture tend to adopt more innovative practices than their counterparts with little or no education (Adam *et al.*, 2010; Legesse *et al.*, 2013; Alene and Manyong, 2007). Thus, higher (technical) education influences household decisions to raise (and own) sheep and goat (Asfaw and Adamassie, 2004).

In agricultural household modeling, (general) education is sometimes evaluated as a proxy for human capital (Pender and Gebremedhin, 2006). Studies for sub-Sahara Africa suggest a positive relationship between a farmer‘s educational attainment and ownership of livestock (Alene and Manyong, 2007; Fakoya and Oloruntoba, 2009; Oluwatayo and Oluwatayo, 2012). Pender and Gebremedhin (2006) report that higher formal education, jointly with higher income, influence livestock ownership. Similarly, Ampire and Rothschild (2010) observe that higher general education and technical training in livestock husbandry help farm households to realize the profit potential of livestock production and, therefore, are more likely to raise such animals as a business.

In regions in sub-Sahara Africa with limited mechanised agricultural systems, a large number of individuals in households are often an important source of available labour for both on-farm and household work (Duku *et al.*, 2011). Various studies suggest a significant positive relationship between household size and small ruminant ownership (Duku *et al.*, 2011; Fakoya and Oloruntoba, 2009; Oluwatayo and Oluwatayo, 2012). Duku *et al.* (2011) for example, reports that the number of active adults and children in households in the transitional agro-ecological zone of Ghana increase the farm households' likelihood of raising sheep, goat or both.

Udry (1995) reports that households with higher number of individuals have a higher tendency to own livestock because such households tend to have adequate labour for tasks such as herding, watering and gathering supplemental livestock feed.

Similarly, Verbeek *et al.* (2007) note that the likelihood of livestock ownership is higher for households' with higher dependency ratio (defined as number of individuals in the household per small ruminant stock).

2.3.2 Institutional Factors

In rural African communities, access to formal credit and agribusiness insurance tend to be poor (Barrett and Reardon, 2000; Binswanger and Rosenzweig, 1986; Ellis, 1998; Slingerland, 2000). Consequently, rural households or individuals are forced to explore alternative financing options outside financial markets that reduce unforeseen consumption variability brought by income variability (Barrett and Reardon, 2000). Under such circumstances, rural households and individual members' income diversification emphasises liquid asset accumulation through livestock production (Evans and Ngau, 1991). Sheep and goat serve as an important source of finance and private insurance, as they can be sold very readily, and the proceeds used to smoothen cash fluctuations (Bosman, 1995; Moll, 2003; Slingerland, 2000). In rural regions, small ruminant livestock also serve as a medium-term cash reserve (Devendra and

Chantalakhana, 2002; Lebbie, 2004). Thus, rural and agrarian households and individual members with limited formal credit invest in such animals because they can be sold at any time to purchase farm inputs or expand cultivable farmlands (Bosman, 1995; Dossa *et al.*, 2008; Duku *et al.*, 2012). In locations where formal savings institution exist, smallholder farmers sometimes prefer to use livestock as a form of savings and finance due to high bank transaction costs, and low rate of return on bank savings and investments (Binswanger and Rosenzweig, 1986; Slingerland, 2000).

In a developing economy such as Ghana, an important element of extension service relates to provision of veterinary and livestock health management services (Mucuthi *et al.*, 1992). Various studies for developing countries have suggested a positive correlation between household heads' access to extension services (on one hand), and ownership of livestock and adoption of livestock production innovations (Adam *et al.*, 2010; Kalinda *et al.*, 2012). Morton and Matthewman (1996) claim that most rural farm households lack technical skills in livestock health management. Thus, availability or access to extension services can motivate and strengthen livestock production. Access to extension programmes by farm households can also help improve farmers' knowledge in using feed resources and management of animal diseases. Kalinda *et al.* (2012) find a positive relationship between farmers' access to extension information and services, and ownership of livestock.

2.3.3 Economic Factors

Non-farm income generally refers to income from non-agricultural activities, including non-farm rural wage employment, non-farm self-employment, and earnings outside agriculture (Ellis, 1998; Reardon, 1997). Various studies for rural regions in sub-Sahara Africa suggest a positive relationship between non-farm income and households' or individual members' decision to raise livestock (Barrett *et al.*, 2001;

Duku *et al.*, 2011; Mucuthi, 1992; Thys *et al.*, 2005). Farm households who are employed in the non-farm sector earn cash income that can be used to finance investments in crop and livestock production. Barret *et al.* (2001) for example, reports that participation in non-farm economic activities is positively correlated with household income and (livestock) wealth accumulation in sub-Saharan rural Africa.

2.4 Determinants of the Choice of Small Ruminant Type

The previous section examined a number of socio-economic variables that determine household's decision to own small ruminants. Different farming households may have preferences for different types of small ruminant livestock species (sheep alone, goat alone or both). It is therefore relevant to examine the determinants of the type of small ruminant species owned by household. Selected factors that influence preference for different small ruminant species are discussed below.

Two agro-ecological zones (i.e., Guinea savannah and Sudan savannah) dominate northern Ghana. The Sudan savannah zone is relatively more arid and has long drought periods compared with the Guinea savannah zone. Consequently, farm households in Sudan savannah zone are more likely to raise goat that are better able to tolerate stress from heat and drinking water deprivation, compared with sheep (Lebbie, 2004; Peacock, 2005).

In rural regions of sub-Sahara Africa, women traditionally undertake household chores such as food processing. Unlike sheep, goat tends to graze near homesteads and is also commonly provided with kitchen scraps and food by-products. Consequently, women are likely to have a higher propensity than men are to raise goat, all things being equal (Okali and Sumberg, 1986).

A key motivation for farm households to diversify their livelihood options is linked to risk perceptions and expected benefit of new or potential economic livelihood activities (Ellis, 1998; Evans and Ngau, 1991; Reardon, 1997). Sheep and goat have various inherent production risks and benefits (Lebbie, 2004; Ndamukong *et al.*, 1989; Okali and Sumberg, 1984). On the other hand, studies for agricultural systems in developing countries suggest that sheep production tends to be riskier than raising goat (Dossa *et al.*, 2008; Fakoya and Oluruntoba, 2009). For example, sheep are more susceptible to disease outbreaks and tend to be easily killed by moving vehicles than goat (Ndamukong *et al.*, 1989). In addition, free range sheep have the tendency to graze and stray away from homesteads, thereby exposing them to theft or being killed, compared with goat (Dossa *et al.*, 2008). By comparison, goat are inherently more aggressive, and in free range grazing systems typically graze near homesteads (Okali and Sumberg, 1984). Notwithstanding the higher risk associated with sheep production, especially under traditional extensive systems in African countries, studies indicate that the expected returns from sheep production is higher than for goat (Dossa *et al.*, 2008; Panin and Mahabile, 1997).

2.5 Factors Influencing Small Ruminant Productivity of Producers

Literature suggests that both men and women are agricultural producers whose productivities are strongly influenced by different sets of socio-economic and demographic characteristics (Epeju, 2010; Marinda *et al*., 2006) as well as institutional or policy factors (Hulela, 2010; Luquman *et al.*, 2006). Several studies have suggest such gender relations in productivity for crop production enterprise (Bindlish and Evenson, 1993; Epeju, 2010; Marinda *et al.*, 2006; Saito *et al*., 1994; Tiruneh *et al.*, 2001). However, the factors that influence livestock productivity of male and female producers, particularly sheep and goat, are not clearly established (Duku *et*

al., 2011; Hulela, 2010). Thus, intra-household data, including gender in small ruminant management hardly exist (Paudel *et al*., 2009). Such knowledge-gap is more important for sub-Sahara African countries in arid and semi-arid regions such as northern Ghana where women are equally relevant in managing family sheep and goat livestock.

Even though, studies for gender productivity differential are scanty in livestock production, important factors including economic attributes (i.e., non-farm income level), and farmer personal characteristics (i.e., age, marital status, education and household size), as well as policy and institutional factors (i.e., access to credit and extension service access) strongly influence such production differences (Cheng'ole *et al.*, 2003; Duku *et al.*, 2011; Hulela, 2010; Thomas-Slayter and Bhatt, 1994; Tiruneh *et al.*, 2001). The economic and personal characteristics of a farmer determine access to, and control of production resources, while institutional and policy structures often provide technical support to farmers (FAO, 2011). Consequently, selected factors that influence small ruminant productivity of both male and female farmers are discussed below.

2.5.1 Household Characteristics

Older small ruminant farm managers (i.e., both men and women) are more likely to increase small ruminant productivity than younger farm managers are, *ceteris paribus*. Studies which support this hypothesis suggests a positive relationship between a farmer‘s age and small ruminant productivity (Fakoya and Oloruntoba, 2009; Oluwatayo and Oluwatayo, 2012). In literature, farmer‘s age is used as a proxy to farming experience and is expected to influence small ruminant productivity positively (Elizabeth, 2006; Epeju, 2010; Marinda *et al.*, 2006). Oluwatayo and Oluwatayo (2012) report that farmers‘ wisdom and social status improve with age. As such, those farmers tend to control the productive resources required for increasing

production and productivity. Similarly, Marinda *et al.* (2006) also claim that older farmers gained more skills and experience in livestock farming and this may be related to increasing small ruminant productivity. Among women, Dossa *et al.* (2008) claim that older women in rural areas tend to increase small ruminant productivity more than younger females because the former tends to control productive resources. Al-Rimavi (2002) also made a similar observation where elderly women own and increase livestock productivity more than younger females.

In contrast, Legesse *et al.* (2013) report that younger farmers (male or females) tend to be more innovative and adopt new technology readily (to improve productivity) compared with older farmers. In support of this assertion, Polson and Spencer (1992) find out that younger farmers are more adventurous and are more willing compared to older farmers to adopt livestock technologies in order to increase productivity.

The effect of marital status on small ruminant productivity of both male and female farms is mixed. Such productivity is higher for married male and lower for married female farm managers. Marital status of a farmer is often used to indicate extra labour availability, especially of spouses and children (Epeju, 2010; Okali and Sumberg, 1984). In rural Africa, men are the custodians of children in the event of divorce or separation in a marriage. Even, where the family are still living together, married women are at disadvantage in using the household labour to carry out livestock management activities such as feeding, herding, among others. In addition, women are compounded with more domestic responsibilities through childcare and husbands‘ farm activities to the extent that they (women) have no or little time for small ruminant production and are, therefore, unlikely to increase productivity.

Small ruminant productivity is higher for both male and female managers with larger household size. The household size of a farmer is used as a proxy for labour availability

to undertake various small ruminant production activities. Duku *et al.* (2011) observe that the large household sizes in the transitional zone of Ghana are related to increasing small ruminant production. Small ruminants in northern Ghana and other parts of West Africa are maintained around the homestead (IFAD, 2007) and under the management of various household members irrespective of who owns the animals (Okali and Sumberg, 1984). Hence, households that have larger family sizes can increase their small ruminants holdings and productivity since there will be more labour available for feeding, herding and construction of pens (Verbeek *et al.*, 2007). In a study conducted in Nigeria, Fakoya and Oloruntoba (2009) report a positive relationship between household size and small ruminant productivity using a semi-log and log-log production functions.

Small ruminant managers with higher education are more likely to increase small ruminant productivity compared with farmers with lower educational background. The effect of education on small ruminant productivity of both men and women is mixed. Some studies report that high level of education of farmers is tied to higher adoption of new technologies required for increased small ruminant productivity (Fakoya and Oloruntoba, 2009). Farmers with less education face constraints in assimilating and utilising scientific knowledge and skills required for adoption of technology to increase agricultural productivity (Epeju, 2010).

In a study from Nigeria, Fakoya and Oloruntoba (2009) and Oluwatayo and Oluwatayo (2012) report a positive relationship between a farmer‘s formal education and an increase in small ruminant productivity. It is argued that farmers with a high formal educational level have the idea and knowledge to assess the risk in livestock production in order to increase productivity (Marinda *et al.*, 2006). In addition,

education helps farmers to adopt better livestock management practices and thus, aim at increasing productivity (Oluwatayo and Oluwatayo, 2012).

In contrast, Quisumbing (1995) observe that male farmers with less education but having access to technical training helps to improve farm productivity. Quisumbing (1995) also reports an increase in agricultural productivity for female farmers with at least primary education compared with females with higher or no education. In support of this hypothesis, Sulo *et al.* (2012) observe a positive relationship between female farmers with at least primary education and adoption of improved agricultural technologies for increasing productivity. On the other hand, Dossa *et al.* (2008) find no or little relationship between education and small ruminant ownership and the likelihood to increase productivity in southern Benin.

2.5.2 Institutional Factors

Farmers with higher access to extension contact are more likely to increase small ruminant productivity than farmers with no or less extension access. Frequent contacts with extension service are expected to increase small ruminant production and productivity (Adam *et al.*, 2010). Extension education improves farmers access to information on new farming technologies (Elizabeth, 2006; Marinda *et al.*, 2006) so as to increase productivity. In addition, such education provides data on input and output markets to farmers (Marinda *et al.*, 2006) in order to increase productivity. Hence, extension education is expected to positively influence small ruminant productivity. Consistent with this hypothesis, Oluwatayo and Oluwatayo (2012) report a positive relationship between a farmer‘s (women) access to extension service and small ruminant productivity in Nigeria. Similaly, Zhang *et al.* (2012) find out that extension contact positively influence small ruminant technology adoption leading to increased sheep and goat productivity.

In contrast, Quisumbing (1995) reports a negative relationship between extension contact and agricultural productivity of women. Budak *et al.* (2005) reveal that female small ruminant farmers are constrained in accessing extension education and even if available, women's benefit from such education is less significant since most women feel much unease around male extension agents.

Small ruminant productivity is higher for small ruminant managers (i.e., male and female farms) who access credit facility from formal institutions more readily. Ayoade *et al.* (2009) observe that access to credit is highly related to increased livestock productivity, particularly among female farmers. Credit access enables farmers to participate in livestock production through the purchase of inputs to increase productivity. Consistent with this hypothesis, Adam *et al.* (2010) report a positive correlation between farmers who access formal credit and adoption of small ruminant technologies relevant to increasing productivity. Epeju (2010) also makes a similar observation where both male and female farmers' access to credit is a precursor to increasing agricultural productivity of which livestock is no exception.

Other body of literature (Bosman *et al*., 1996b; Slingerland, 2000) argue that farmers' access to credit positively influences livestock productivity indirectly. Sheep and goat production in the traditional production system is adjunct to crop production, hence farmers use sourced credits (cash) to finance crop production. Only extra income after crop production is used to invest in livestock production (SiegmundSchultze *et al.*, 2011). In a related literature, Ayalew *et al.*, (2003) find that in smallholder farming, the use of credit to finance only livestock production is minimal since the animals are raised for smallholder needs rather than for market demand.

Small ruminant farm managers (i.e., both men and women) with cooperative association membership are more likely to increase productivity than farmers without

membership. Livestock producer cooperative societies serve as a discussion forum where farmers share ideas and knowledge on livestock production (Ayoade *et al.*, 2009). Membership of such associations also links farmers to markets and crucial service providers, which help to raise farmers‘ productivity (Legesse *et al.*, 2013). Cooperative associations thereby create awareness among members on modern technologies in farming and, in addition, serve as a conduit to access extension education required for increasing productivity (Fakoya and Oloruntoba, 2009).

Oluwatayo and Oluwatayo (2012) show a positive relationship between a farmer‘s membership of a cooperative association and small ruminant productivity in Nigeria, especially for women farmers. The authors note that farmers are able to secure informal loans from the association to invest in their small ruminant business.

2.5.3 Economic Factors

Small ruminant productivity is higher for male and female small ruminant managers who access non-farm income employment. According to Reardon *et al.* (1994), nonfarm income could serve as an alternative financing option to invest and increase livestock production in sub-Sahara African countries. In support of this claim, AlRimavi (2002) reports that extra income from the non-farm economic activity is used to purchase more breeds, inputs and to access veterinary assistance to increase small ruminant productivity. Likewise, Diiro (2013) for example, finds a significant positive relationship between adoption of agricultural technology and increased purchased of farm inputs necessary for improved productivity for farmers with non-farm income.

2.6 Constraints to Small Ruminant Production

Among the important constraints report to limit small ruminant production in tropical Africa include diseases and pest attacks, poor nutrition, inadequate water supply, unimproved breeding stock, poor marketing, inadequate capital, lack of credit, natural

disaster, policy problems and insufficient veterinary and extension services (Dossa *et al.*, 2007; Fakoya and Oloruntoba, 2009; Oladeji and Oyesola, 2008; Otchere, 1986; Wilson, 1985). Various studies (Oppong-Anane, 2006; Turkson and Amakye-Ansah, 2005; Turkson and Naandam, 2006; World Bank, 1992) suggest that the major constraints for sheep and goats production in Ghana are disease, housing, feeding, lack of knowledge on management, high mortality, lack of drugs, and destructive nature of animals. Above all other constraints, parasitic disease infection and feed shortage (Ademosun, 1992; Duku *et al.*, 2010; Ockling, 1987) have frequently been mentioned as the top two constraints that impede small ruminant production both in Ghana and other sub-Saharan African countries. Sheep and goats' diseases/parasites and feed constraints often lead to high mortality rates and morbidity thereby undermining the overall economic benefits from the animals.

Even though parasitic disease menace and feed shortage have frequently been acknowledged and often described in the extant literature (Dossa *et al.*, 2007; Oladeji and Oyesola, 2008; Turkson and Amakye-Ansah, 2005; Turkson and Naandam, 2006) there are few, if any, research undertaken to show how farmers' socio-economic, production as well as institutional characteristics influence smallholder's vulnerabilities to these constraints in northern Ghana. The socio-economic and institutional conditions of farmers are the pre-conditions for adoption of any technical interventions or innovations at the farm level (Dossa *et al.*, 2008; Ibrahim, 1998; Verbeek *et al.*, 2007). However, such characteristics (socio-economic and institutional factors) that are required for a better understanding of smallholder farmers' production circumstances in Ghana are frequently ignored (Duku *et al.*, 2010). Consequently, smallholder farmers are frequently under-served from interventions and programmes designed to promote meat production and increase income earnings among farmers (Mapiye *et al.*, 2009).

2.7 Factors Influencing Smallholders' Vulnerability to Production Constraints:

Disease and Feed Shortage

Animal feed shortage and disease/parasite prevalence may vary from one agroecological zone to another or from farm to farm and this has become a heightened concern for researchers and livestock policy analysts. Several reasons have been suggested to explain this trend depending on the researcher‘s academic knowledge, area of expertise and exposure to livestock production. For instance, Bosman *et al.* (1996a), Duku *et al.* (2010), and Hamadeh *et al.* (2001) consider increased population pressure on arable lands, and indiscriminate bush fires as the major factors affecting feed shortage of smallholder livestock holders. In addition, Duku *et al.* (2010) show that smallholder livestock managers‘ knowledge, skills and perceptions are very relevant in managing feed constraints for small ruminant production. Similarly, Ockling (1987) notes that livestock feed shortage may be attributed to smallholder farmers‘ inability to make available supplementary feeding during the dry season. Ockling (1987) also supports the fact that systematic bush or grass burning by farmers during dry seasons remains a threat to livestock feed availability in that season (dry season).

At the same time, various studies (Ademosun, 1992; Adeoye, 1985; Salem and Smith, 2008) also suggest that climatic conditions and type of management systems are the key factors influencing the incidence of diseases and parasites constraints among smallholder small ruminant holders in sub-Sahara African countries.

Ademosun (1992) claim farmers‘ skills and knowledge in maintaining high sanitation and practising of good husbandry assume an important role in disease and parasite management. In addition, Turkson (2003) and Ockling (1987) also attribute the prevalence of diseases and parasitic infection to an ineffective veterinary service delivery to smallholder livestock managers. While poor livestock housing encourages

diseases and parasites infection (Dei *et al.*, 2007), the extensive system of scavenging animals exposes such animals to hazardous conditions including diseases and parasites as well as theft (Oladeji and Oyesola, 2008). Shumba (1992) however, finds feed and parasitic disease constraints to be significantly influenced by farmers‘ access to institutions and technology in livestock production. Livestock institutions provide the technical know-how and also encourage the application of new management practices to alleviate these constraints.

The above reviews are relevant but not exhaustive in devising strategies conducive to overcoming constraints in smallholder sheep and goat production. Smallholder livestock production constraints especially feed shortage and disease menace is really influenced by other numerous factors that can be classified as macro- (national-level) and micro- (farmers-level) factors (Ngategize, 1989). Macro-level factors include national pricing policies, natural disasters, livestock policies, research and livestock foreign trade (imports and exports). On the other hand, factors such as production, socio-economic and policy variables influence small ruminant production constraints at the farmer-level (Gutierrez 1985; Shapiro *et al.*, 1992). In order to provide a pragmatic recommendation that will inform policy at the macro-level, initial examination of constraints at the farmer-level is relevant. This is so because, small ruminant production constraints depend on farmers‘ objectives (Mapiye *et al.*, 2009) which are influenced by the farmers‘ personal characteristics (age, gender and education), production (agro-ecological zone, herd size and management system), socio-economic (non-farm income status) and policy factors (extension and credit access). A summary of the effects of selected factors, which influence small ruminant production and management constraints are discussed below.

2.7.1 Production Factors

A livestock production system refers to the type of management system a farmer practices. In northern Ghana, two management systems of raising sheep and goat are identified (Turkson and Naandam, 2006). These include the extensive system and a few semi-intensive systems. Animals, which are allowed to graze freely throughout the day without housing, are considered to be under the extensive system. On the other hand, if an animal is confined but released later to be herded or allowed to graze on its own and brought back during the night, such system is described as semiintensive. Turkson and Naandam (2006) stress that the production systems directly or indirectly affect sheep and goat production constraints. The propensity to disease infestation is higher in the extensive system than the semi-intensive system (Adeoye, 1985). Under the former system, animals are poorly nourished and are exposed to harsh environmental factors that predispose the animals to diseases and parasite infections (Oladeji and Oyesola, 2008). Farmers under this system are often poor. Consequently, feed supplementation is not practiced (Karbo *et al.*, 2007; Upton, 1985). Smallholder farmers under semi-intensive system normally house such animals to reduce exposure to hazardous environmental factors leading to diseases and parasite infections. In addition, the animals are often provided with feed supplementation.

Agro-ecological zone is expected to affect farmers‘ probability of experiencing a production constraint. Two agro-ecological zones (Sudan and Guinea savannah) are identified to be associated with northern Ghana. Both zones have different climatic and altitudinal conditions, soil and vegetation properties. Diseases and parasites are well-known to thrive best in humid conditions (Ockling, 1987). Given that, Sudan savannah is relatively drier than the Guinea savannah (FAO, 2005a), the incidence of diseases such as trypanosomiasis and worm infestation will be much higher in Guinea savannah.

On the other hand, feed availability will be more profuse in Guinea savannah than in the Sudan savannah because of the higher rainfall and green shrubs in the Guinea savannah zone. The expectation is that, farmers in Sudan savannah zone will experience higher probability of feed shortage than farmers in the Guinea savannah zone.

The effect of households' herd size on feed and disease/parasite constraints is mixed. Farmers with smaller herd size can be assumed to be effective in managing their flock in terms of meeting the animals' medication and feed requirements. For instance, Mapiye *et al.* (2009) find a lower probability of experiencing disease threat for farmers with smaller cattle size than farmers with larger herd size. On the other hand, farmers with larger herd size are considered to have higher turnover. Hence, such farmers are capable of generating enough income to buy inputs including drugs and feeds for their animal production. Farmers with larger herd sizes normally have frequent contacts with extension service for advice on disease control and other husbandry practices compared with farmers with smaller herd size. Oluwatayo and

Oluwatayo (2012) report a positive relationship between a farmer's herd size and income from sheep and goat production. Extra income from sales of the animals is used to buy more drugs and feeds to maintain the herd size.

2.7.2 Farmer Characteristics

Gender is a socio-cultural distinction between males and females (Curry, 1996). Rural female farmers are limited in accessing productive resources such as land, capital, and extension service delivery (Marinda *et al.*, 2006). Such women also face serious challenges in accessing off-farm income sources (Awumbila, 2007; Mupawaenda *et al.*, 2009). Given that disease and feed preventive measures and control demand some amount of capital investment and extension education,

Smallholder sheep and goat‘ female managers become at a disadvantage. Hence, it is expected that, women compared with the men will be more prone to production constraints such as feed shortage and disease and parasites attacks (Mapiye *et al.*, 2009).

The age of a farmer is frequently used as a proxy for determining general farming experience and thus has an effect on farmers‘ odds of experiencing feed shortage and disease and parasite problems. Based on the premise that older farmers are more experienced in assessing risk in livestock activities than youthful farmers, it can be concluded that such older farmers may have a lower odds of experiencing feed shortage and diseases and parasites problems (Marinda *et al.*, 2006). In a study for dairy cattle production, Mapiye *et al.* (2009) observe that a youthful household head is more susceptible to feed shortage and disease and parasites menace than an older household head. In the Ghanaian context, a youth is a person between the ages of 15 and 35 years old (Ministry of Youth and Sport, 2010).

Formal education is expected to have a positive effect on farmers‘ odds of experiencing constraints in livestock farming activities. Educated farmers are perceived to be more knowledgeable in managing production risks and better equipped to adopt new technologies for constraints reduction (Marinda *et al.*, 2009). Mapiye *et al.* (2009) report a higher odds ratio for uneducated farmers for experiencing diseases/parasites and feed shortage constraints. Mapiye *et al.* (2009) conclude that uneducated farmers are more prone to diseases and parasites infections as well as feed shortages compared with educated farmers.

This represents an alternative source of income for farmers to finance their farming activities. Therefore it is expected that smallholders with non-farm employment opportunities can generate enough income to buy inputs such as drugs and feeds to increase production (Barrett *et al.*, 2001; Ellis, 1998; Reardon, 1997). On the contrary,

it is reported that smallholder farmers with non-farm employment opportunities might have less time for the management of their sheep and goat especially monitoring the disease and parasites conditions of the animals. They may also lack the time for engaging in feed conservation practices to safeguard shortage of feeds during the long dry season (Ndamukong *et al.*, 1989). Mapiye *et al.* (2009) document a higher odds ratio for unemployed livestock farmers with respect to feed shortage. On the contrary, the authors unearth a lower odds ratio of diseases and parasites prevalence for unemployed livestock farmers.

2.7.3 Policy Factors

Access to extension service is expected to reduce the odds of farmers experiencing feed shortage and diseases and parasites attacks. Livestock extension serves to educate farmers on the best farm management practices such as improved husbandry methods, use of good livestock inputs as well as prevention of diseases and pests attacks on the farm (Bosman *et al.*, 1996b; Elizabeth, 2006; Marinda *et al.*, 2006). It follows then that, livestock farmers who have stronger ties with veterinary extension agents become less susceptible to diseases or parasites outbreaks (Turkson, 2003). In a study for Zambia, Kalinda *et al.* (2008) report a strong relationship between extension training and livestock ownership. Kalinda *et al.* (2008) conclude that farm households with access to extension training have higher probability of receiving financial credits to purchase inputs including veterinary drugs and feeds than households without extension training.

A farmer‘s membership of livestock a co-operative association is expected to lower the probability of such a farmer‘s susceptibility to diseases/parasites and feed constraints (Ayoade *et al.*, 2009). Co-operative membership serves as a channel for education on good animal husbandry including feed conservation and diseases and parasites prevention and control measures. Such co-operative associations also serve as

a conduit to access credits. Such money may be channeled into buying drugs and feeds in order to increase animal production (Legesse *et al.*, 2013; Oluwatayo and Oluwatayo, 2012).

It is expected that a farmer's odds of experiencing feed shortage and disease/parasite constraint is lower for a farmer with access to credit facility (Kalinda *et al.*, 2013). Bosman *et al.* (1996b) argue that a farmer's access to credit allow such a farmer to purchase inputs including veterinary drugs and feeds. Availability of credit increases the tendency of a farmer to increase overall animal production (Fakoya and Oloruntoba, 2009) and turnover (Oluwatayo and Oluwatayo, 2011). Such an increase in production will require pragmatic measures to prevent diseases/parasites menace and ensure feed availability for the animals.

2.8 Summary of Literature Review

The literature has shown that small ruminant production is important to the livelihood of marginalised and vulnerable households in rural Ghana, yet its potential is limited by various factors. Attempts by Livestock technical staff to improve the situation often place much emphasis on the technical aspects of production with little recognition to the socio-economic attributes of the livestock system. These technical aspects include the extent to which veterinary inputs are utilised, the introduction of high-yielding breeds and the type of animal husbandry. The socio-economic literature reviewed show that the impact of most of these technical aspects in livestock development interventions to the traditional system has been minimal because such programmes often do not reflect the production objectives and livelihood needs of local smallholder farmers. Farmers' production objectives and household livelihood needs associated with managing small ruminants are influenced by social and economic factors, as well as policy and institutional variables. Hence, the need to expand the broad range of

technical aspect of livestock production to socio-economic dimensions that captures factors that influence farmers‘ decision to participate in small ruminant production, gender (intra-household analysis) and constraint analysis cannot be overemphasized.

The economics of small ruminant assumes that smallholder farmers manage small ruminants not only for marketing purposes (sales) but also to perform important nonmarket functions. Livestock administrators tend to over emphasise on market products and have overlooked the importance of non-market products in managing smallholder livelihoods. Conventional cost and benefit analysis used in most economics studies of livestock evaluations provides a useful framework for valuing market products without non-market co-benefits. Therefore, the aggregate valuation method that built on the traditional cost and benefit analysis to include evaluation of non-market functions of small ruminants is adopted for this study.

For the determinants of small ruminant production, the literature reveals that depending on whether the dependent variable is discrete or categorical, the Logit, Probit or Poisson/Negative Binomial can be applied. In this study, the Poisson/Negative Binomial is applied since the dependent variable is categorical, measured as the number of animals owned. In addition, Cobb-Douglas production function is used to analyse factors that influence small ruminant productivity

(measured as the monetary value of average stock and difference of sales and purchases) of both male and female farms. The ordinal logit, on the other hand, is used to determine socio-economic factors that influence small ruminant constraints, where the dependent variable is measured on a 4-point Likert scale that assesses the degree to which smallholders are affected by important constraints (feed and disease and parasites). The chapter that follows discusses the theoretical and conceptual frameworks adopted for the study.

CHAPTER 3

3.0 THEORETICAL AND CONCEPTUAL FRAMEWORKS

This chapter presents the theoretical and conceptual compositions of the determinants and estimation of economic benefits of small ruminants. To analyse gender and small ruminant production, the Cobb Douglas production function is also presented which is followed by a review of ordinal logit used to analysed constraint to small ruminant production.

3.1 Determinant of Smallholder Small Ruminant Production

3.1.1 Utility Maximisation Theory

The decision of farm households to keep small ruminant livestock (i.e., sheep and goat) is investigated using discrete choice models (Bates, 1988; Dossa *et al.*, 2008; McFadden, 1973). In this study, it is assumed that household level livestock production decisions are made by the head of each household, consistent with existing culture in northern Ghana, while individual family members make decisions about their personal livestock production choices and private investments. The probability that a decision-maker (i.e., farm household head) chooses a particular alternative (e.g., ruminant species raised) can be investigated as a function of various observable variables. In general, the probability that individual n chooses alternative i, P_{ni}, is expressed (according to Greene, 2002) as:

$$P_{ni} = \text{Prob}(\text{individual } n \text{ chooses alternative } i) = G(x_{ni}, x_{nj}\gamma_j \neq i, s_{n,}, \beta) \quad (1)$$

where x_{ni} is a vector of attributes of alternative i faced by individual n, $\gamma_j \neq i$ is a vector of variables associated with alternatives (other than i) faced by individual n, s_n is a vector of characteristics of individual n, and β is a set of estimated parameters.

The theoretical basis for investigating the choice behaviour of farm households is consistent with random utility (RU) maximisation (Greene, 2003; Lancaster, 1966). The RU model is premised on a basic assumption that when economic agents (e.g., households) are faced with a choice (between two or more goods or services, or production opportunities), they tend to choose one option over the other(s) (Greene, 2003; Ouma *et al.*, 2003). The economic agent chooses the alternative for which the perceived utility (net benefit or well-being) is higher than other available options. Although the utility of farm households are not directly observed, their actions are observed through the choices they make. Suppose that Y_j and $Y_k$represent a household head's utility for two alternatives, denoted by U_j and U_k , respectively. The corresponding random linear utility model may be specified as:

$$U_j = \beta'_j X_i + \varepsilon_j \text{ and } U_k = \beta'_k X_i + \varepsilon_k \quad (2)$$

where$U_j$and $U_k$denote perceived utilities associated with participation in alternative (j) and alternative (k), respectively;$X_i$represents the vector of explanatory variables that influence the desirability of the alternative;β_j and $\beta_k$are regression parameters to be estimated; and ε_j and ε_k are disturbance terms (or unobserved effects) assumed to be independently and identically distributed (Maddala, 2001). The random utility modeling framework has been applied to various studies involving dichotomous choice or participation decision considerations (e.g., Dossa *et al.*, 2008; Duku *et al.*, 2011; Lubungu *et al.*, 2012).

Farm household head's participation decisions in alternative j result in a set of optimal participation choices I*(Z), in which the probability of the decision maker's participation is represented as (Greene, 2003):

$$\Pr(j) = \Pr(I_j^* = 1) \quad (3)$$

$$\Pr(U_j > U_k, k \neq j) \quad (4)$$

$$P(\beta'_j X_i + \varepsilon_j - \beta'_k X_i + \varepsilon_k > 0/x, k \neq j) \quad (5)$$

$$P(\beta'_j X_i - \beta'_k X_i + \varepsilon_j - \varepsilon_k > 0/x, k \neq j) \quad (6)$$

$$P(X^* X_i + \varepsilon^* > 0/x, k \neq j) = F(\beta^* X_i) \quad (7)$$

where P is the probability function, and U_j, U_k and X_i are as defined above. In addition, $\varepsilon^* = \varepsilon_j - \varepsilon_k$ is a random disturbance term, $\beta_j^* = \beta_j - \beta_k$ is a vector of parameters, interpreted as a net-influence of the vector of independent variables influencing the decision to raise small ruminant livestock, and $F(\beta^* X_i)$ is a cumulative distribution function of ε^* evaluated as $\beta^* X_i$. The distribution of F depends on the error term ε^*. If F is assumed to be normally distributed, then equation (7) is consistent with a binary decision choice or model and can be investigated using a probit model (Greene, 2003). On the other hand, if F exhibits a logistic distribution, the logit model can be applied.

3.1.2 Choice of Econometric Models

In this study, there were two separate research issues facing decision makers: i) size of livestock herd, and (ii) a discrete choice problem about raising sheep alone, goat alone, or both sheep and goat. Consideration of a limited set of positive values of discrete count outcomes in small ruminant production (as opposed to categorical variable outcomes on stock owner versus non-owner) is important and relevant because most farm households in northern Ghana raise a few sheep, goat or both (Adam and Boateng, 2012; Amankwah *et al.*, 2012; Quaye, 2008). Count data models such as Poisson regression and negative binomial (NB) models are appropriate (Greene 2008; Greene 2003; Maddala, 2006), and commonly used in such applications (Famoye, 1993; Famoye *et al*., 2004; Hellerstein and Mendelsohn, 1993;

Rashwan and Kamel, 2011). On the other hand, the multinomial logistic regression technique is used to model and analyse the discrete choice about the likelihood of livestock type raised.

3.1.2.1 Count Data Models: Poisson and Negative Binomial Regression

The probability of choosing *K* activities given *n* independent trials is represented by the binomial distribution (Dusen, 2000):

$$(Y = K) = \begin{bmatrix} n \\ k \end{bmatrix} P^k (1-p)^{n-k} \quad (8)$$

where $\begin{bmatrix} n \\ k \end{bmatrix} = \frac{n!}{k!(n-k)!}$ and p is the probability of choosing *k* activities.

The random utility modeling of a repetition of a series of binomial choices asymptotically converges to a Poisson distribution as *n* becomes large and *p* becomes small (Hellerstein and Mendelsohn, 1993):

$$\lim_{n\to\infty} \begin{bmatrix} n \\ k \end{bmatrix} P^k (1-P)^{n-k} = \frac{e^{-\lambda} u^k}{k!} \quad (9)$$

where $p = \frac{\mu}{n} and\ \mu$ is the mean of the distribution, (e.g., mean sheep, goat or both herd size managed per farm household head). The above model can be used to determine the probability that a household chooses sheep and goat herd size *k* given a parameterμ, the sample mean.

3.1.2.2 Standard Poisson and Negative Binomial Regression Models

The standard Poisson regression (PR) model associated with the Poisson distribution in equation (9) is a nonlinear regression model (Winkelmann and Zimmermann, 1998), which links the effects of various explanatory variables X_i (i.e., socio-economic and policy and institutional factors) on a scalar dependent variable Y_i.

Y_i is a random variable that takes on non-negative values (*i*=0, 1, 2, 3…..n), where *n* represents number of observations. If Y_i follows a Poisson distribution as in equation (9), the probability density function for the Poisson regression is represented as:

$$f(y_i|x_i) = \frac{e^{-u_i} {u_i}^{y_i}}{y_i!}, y_i = 0,1,2 \dots\dots\dots\dots\dots n \quad (10)$$

where the mean parameter is a function of the regressors X_i, which is the *i*th row of covariate matrix, and a parameter vector, $\beta = (\beta_1,\ \beta_2, \beta_3 \dots\dots\dots\dots\dots\dots\dots \beta_x)$ are

unknown *K*-dimensional vector of regression parameters.

For the PR model in equation (10), the mean and the variance of the scalardependent variable Y_i are equal, which Famoye *et al.* (2003) refered to as equi-dispersion (α): $v(y_i|x_i) = u_i(x_i, \beta) = \exp(x_i \quad \beta)$ (11)

Famoye *et al.* (2003) and Rashwan and Kamel (2011) claim that equi-dispersion of the mean and variance is unattainable in real sample data situations. Given that in real sample data the variance is normally greater than the mean, the standard Poisson model will result in regression estimates that are consistent but inefficient, thereby resulting in invalid inferences based on the estimated standard errors (Famoye *et al.*, 2003). In such situations, the PR model is not appropriate and the Negative Binomial Regression (NB) model is preferred (Winkelmann and Zimmermann, 1995; Winkelmann and Zimmermann, 1998).

Suppose Y_i is a count data response variable that is described by a binomial probability distribution. For the small ruminants' production decision, the response variable Y_i, $(i = 0, 1, 2, 3, \ldots\ldots\ldots\ldots\ldots\ldots n)$ is defined as the number of sheep, goat or both managed by a household. The probability function of Y_i is given by (Winkelmann and Zimmermann, 1995):

$$f(y_i|u_i, \propto) = \frac{\Gamma(y_i+\alpha^{-1})}{\Gamma(y_i+1)\Gamma(\alpha^{-1})}\left[\frac{\alpha^{-1}}{\alpha^{-1}+u_i}\right]^{\alpha^{-1}}\left(\frac{u}{\alpha^{-1}+u}\right)^{y} \quad (12)$$

where $y_i = 0, 1, 2, \ldots\ldots\ldots$, and $\mu_i = \mu_i(x_i) = exp(x_i\beta)$, with x_i as $(k-1)$ dimensional vector of covariates, including socio-economic and institutional variables influencing sheep, goat or both production decisions. Socio-economic factors considered in this study include cultivated farmland size, non-farm income, gender, age, education and household size. Important institutional factors included access to formal credit, participation in formal savings in a bank and

access to extension services. On the other hand, $\Gamma(.)$ represents the gamma function, $\mu_i > 0$and $\propto > 0$.

The mean and variance of Y_i are given as:

$$E(Y_i|x+i) = \mu_i\,, V(Y_i|x_i) = \mu_i(1+\alpha\mu_i)^2 \quad (13)$$

The NB model in equation (13) represents a generalisation of the standard PR model in equation (10) given that α is $V(Y_i \mid x_i) > E(Y_i \mid x+i)$. When the dispersion parameter α = 0, the probability function specified in equation (12) reduces to the Poisson regression model represented in equation (10). When$\alpha < 0$, the NB model assumes a count data specification with under-dispersion. Both α and the regression coefficients are commonly estimated using maximum likelihood methods (Famoye, 1993).

Another important type of Poisson regression model that accounts for overdispersion of α is the Zero-Inflated Poisson regression model (ZIP). In some count data situations, the data may contain excess zeros than what is appropriate for Poisson distribution and modeling (Ridout *et al.*, 2001), in which case the ZIP regression model is used to account for the excess zeros (Lambert, 1992; Ridout *et al.*, 1998), and eliminate the problem of over-dispersion. In this study, the NB model was applied to the data on sheep and goat herd size and related variables.

3.1.2.3 Test of Goodness Fit and Parameter Dispersion

The log-likelihood statistic is commonly used to assess the goodness-of-fit of Poisson regression models. A model with high log-likelihood statistics is preferred. The choice between the NB and PR models is commonly based on a test of dispersion parameter (α) (Famoye *et al.*, 2003):

H_0: α = 0 and H_a: α ≠ 0 (14)

Rejection of the null hypothesis (H_0) implies the NB model is preferred over the PR model. Famoye *et al.* (2003) recommend two alternatives for testing the hypotheses in equation (14). One option is to consider the asymptotically normal Wald type *t*statistic, defined as the ratio of the estimate of α to its standard error. The second option involves the use of the likelihood ratio test statistic, based on an approximation of the chi-square distribution with one degree of freedom when the null hypothesis is not rejected as in equation (14).

3.1.2.4 Count Data Model: Multinomial Logit Model

Multinomial logit (MNL) models (unordered categorical outcomes) are frequently used in applications involving several alternative choices (i.e., involving the probability of choosing category 1, 2, 3 or more) (Hoffman and Dancan, 1988; Park and Kerr, 1990). The MNL model framework has been used in economic applications to investigate factors influencing adoption of technology type (Akinola *et al.*, 2011; Nkonya *et al.*, 1997), production system type (Burton *et al.*, 1999), intensity of deforestation (Krushna and Kant, 2005; Müller *et al.*, 2012), and adaptation to climate change (Hassan and Nhemachena, 2008; Seo and Mendelsohn, 2008). The multinomial logit model identifies the odds of two or more categories relative to one category, as a linear function of various explanatory variables (Gujurati, 2004; Greene 2003; Maddala, 2006).

Given this background, the multinomial logit (MNL) is appropriate to determine factors that influence farmers decision to raise either sheep alone, goat alone or both. Thus, the dependent variable was investigated with *j*=3 categories (i.e., respondent raised goat alone, sheep alone, or raised both). Therefore, *y* represented small ruminant type raised (i.e., sheep alone=1, goat alone=2, or both sheep and goat=3), while ***x*** represented smallholder farmers‘ personal and economic variables (e.g., gender of

farmer, goat and sheep production risk perceptions, and perceptions about the relative profitability of goat and sheep production), as well as farm-related factors, including agro-ecological zone in which the farm is located. The multinomial logistic model of livestock type raised, with *j* categories of dependent variable can be represented as:

$$log\frac{Pr(Y=j)}{Pr(Y=j^*)} = \propto +\beta_1 x_1 + \beta_2 x_2 + \cdots \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + \beta_k x_k \quad (15)$$

where *j* represents a given category (i.e., sheep alone, goat alone, or both sheep and goat), and j^* is the reference category or base outcome. Goat alone ownership was considered as the reference category with zero co-efficient ((Mahapatra and Kant, 2005; Norušis, 1999). Goat ownership was the reference category because the population and ownership of goat livestock are substantially higher than that of sheep in northern Ghana (FAO, 2012b). In addition, α is the constant term and β the parameter estimates.

The suitability of the MNL regression method is examined with respect to a binomial logistic model used in previous studies (see for instance Dossa *et al.*, 2008). Mathematically, the binary logistic model for the small ruminant type is as follows:

$$log\frac{Pr(\text{Joint}-\text{sheep and}-\text{goat ownership})}{Pr(\text{otherwise})} = \propto +\beta_1 x_1 + \beta_2 x_2 + \cdots \ldots\ldots\ldots + \beta_k x_k \quad (16)$$

Both binary logistic and multinomial logit have similar statistics and interpretation of results except that the binary logit has only one logit (Mahapatra and Kant, 2005). Inferences about the coefficients (β) can be explained as the change in the log odds with respect to a unit change in the explanatory variable, assuming other factors are held constant. Hence, a positive or negative coefficient increases or decreases the log odds. Moreover, expressing the log odds (parameter estimates) in odds (exponentiation the coefficient (e^{β})) is better for easier interpretation and understanding.

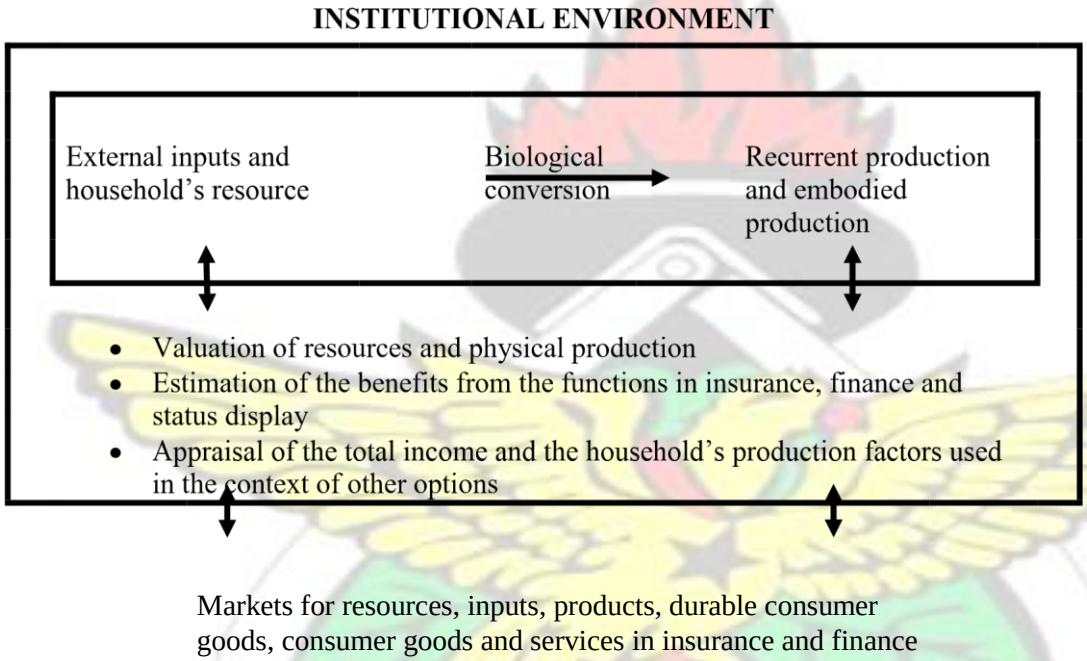
3.2 Economic Benefit of Small Ruminant

3.2.1 Conceptual Framework

In economic evaluation of smallholder livestock production systems, all reasons for managing the animals must be valued regardless of whether the products are marketed, home-consumed or managed for future use (stock) (Ayalew *et al.*, 2003).

The schematic framework for the estimation process is provided in Figure 3.1 (Moll, 2003).

Figure 3.1 A Conceptual Framework for the Livestock System in a Wider Context



Source: Adopted and modified from Moll (2003)

To begin with, the bio-physical input-output data of the small ruminant system needs to be identified and quantified. The quantification method adopted for this study is based on annual averages per type of animal (i.e., sheep and goat) in the production system (Moll, 2003). The entire biophysical process deals with reproduction, growth and mortality on one hand and inputs utilized as well as outputs achieved from the production system on the other hand. The resources (inputs) used in the production process can be categorised into: 1) external or purchased inputs; and ii) household's production factors such as family labour, land, and capital invested in the sheep and

goat production. External inputs include medicines and drugs, feed supplements and fodder, hired labour, and veterinary services. Through biological conversion (by animals), the inputs are converted into products usable by the farm household. Products from biological conversion can be divided into recurrent and embodied production (meat). Recurrent production depends on the livestock species, sex, age and season. Products in this category include manure and milk. Embodied production, on the other hand, refers to changes in body weight, or changes in numbers of the animals (sheep and goat) at the herd level. It is usually part of the livestock production that is not consumed immediately but managed as an investment.

Given this background, the small ruminant economic valuations in this study will comprise three steps. First, the resources and physical products (recurrent and meat products) will be evaluated. Second, the secondary role of small ruminants to satisfy future needs including insurance, and financing role will also be accounted for especially, in smallholder production where formal insurance and credit markets are lacking or inaccessible. Thereafter, the unit benefit per household production factors will be determined by dividing the total benefit by individual household factors (capital and labour).

Various studies have suggests different valuation methods to assess the aggregate benefits of smallholder livestock production. For instance, Bosman *et al.* (1996b) used both biological and monetary evaluations while Ayalew *et al.* (2003), Behnke (1985), and Moll (2003) used monetary valuation process only. In addition, Ouma *et al.* (2004) used monetary and contingent evaluation methods while Siegmund-Schultze *et al.* (2011) applied the corporate stock concept to traditional livestock management. While consideration of biological attributes of small ruminants in the valuation process presents better and accurate results, its data requirements are relatively expensive and

time consuming. On the contrary, using contingent valuation and corporate stock concept are less time consuming. However, the methods have been criticised as being arbitrary. Hence, the monetary valuation method which is relatively not time consuming and also uses opportunity costs of households non-tradable inputs and products presents better estimate. In this study, therefore the monetary estimation methods proposed by Ayalew *et al.* (2003) and Moll (2003) are used. In smallholder production systems, most inputs and outputs are not traded, hence direct price estimation of such resources and products are difficult (Panin and Mahabile, 1997). Consequently, inputs and products used by farm households are valued at their relevant opportunity costs (i.e. the price farmers would have to pay if the resource or produce were to be purchased) at markets where supply and demand conditions resulted in prices (Abdulai and Regmi, 2000; Jacoby, 1989).

In this study, the only recurrent product considered is manure and this product can be classified as a non-market physical product. Milk, especially goat milk is not considered because indigenous goat in the study area is not a milk-producing breed. The benefit realised from manure (i.e., recurrent non-market physical product) of sheep and goat in a period of time *t*, ${Y_t}^m$ is defined as:

$${Y_t}^m = ({r_{jt}}^m {P_{jt}}^m) \quad (17)$$

where

${r_{jt}}^m$ is the quantity of manure, *j*, in period *t*.

${P_{jt}}^m$ is the price of manure, *j*, in period *t*.

Manure is often ignored in the calculation of the total benefits from livestock production probably because they are not widely marketed or that a practical quantitative method of their evaluation does not exist (Ayalew *et al.*, 2003). However,

they represent a major benefit to the farm households. For instance, manure from sheep and goat are used to replenish soil fertility and increase crop production (Powell and Williams, 1993).

Embodied production is divided into: i) non-market physical products and ii) market physical product. The non-market physical product represents sheep and goat slaughtered by the household for home consumption (during festivals, naming ceremonies, etc) and animals used as gifts (in-kind) in strengthening social relations. Another important non-market physical product that is worth estimating is the skin/hide derived from sheep and goat that are often excluded in the evaluation of smallholder livestock production systems. In many rural farm households, the hide/skin from small ruminants are used for various purposes including religious functions (by Muslims as praying carpet or mat), sleeping carpet, making drums, leather for bags and shoes and most importantly, by kings for sitting on.

The benefit derived from non-market physical products (animals for home consumption and in-kind as well as hide/skin) in period *t*, ${Y_t}^k$, is defined as

$${Y_t}^k = ({r_{jt}}^k {P_{jt}}^k) \quad (18)$$

where

${r_{jt}}^k$ is the quantity of non-market physical product *j* in period *t*, with *j* = number of sheep, goat or both slaughtered for home consumption and gifts as well as quantity of hide/skin. ${P_{jt}}^k$ is the price for non-marketed physical product *j* in period *t*, with *j* as defined above.

The market physical product (meat) in year *t*, ${V_t}^e$ is also estimated as

$${V_t}^e = (O_i - IN_i + \text{netchange in stock}) * P_{mi} - \sum X_i P_i \quad (19)$$

where O_i is Outward transfers through only sales of *i* animal (age, sex and particular specie)

IN_i Inward transfers including purchases and exchanges (gifts) of *i* animal (age, sex and particular specie). The net-change in stock per year of evaluation refers to increases in stock through births. Non-cash costs such as mortality and theft will be expressed in monetary value at the current price per unit animal. P_{mi} current price per unit animal; X_i quantity of external input, P_i price of external input *i*. The quantified benefit from meat (production) value could be negative due to the non-cash cost of mortality and other losses (predators) and theft. Other losses could be morbidity, but this will not be accounted for in this research.

The aggregate (total benefit) of the non-market physical products (i.e., manure, animals slaughtered for home-consumption and in-kind as well as hide/skin), and market product (meat), over period *t*, results in *Gross Value* (GV_t), for period *t*;

$$GV_t = Y_t^m + Y_t^k + V_t^e \quad (20)$$

The gross value yields the total physical production of the small ruminant system realised by using household production factors. This is just a component of the livestock production that is employed in analysis but for traditional livestock owners, the objective of managing the animals is far more than this indicator (Ayalew *et al.*, 2003; Moll, 2003).

Farm households sell part of their herd size to fulfill immediate consumption requirements; hence such farmers make rational decisions by balancing present requirement against unforeseen or future consumption (Bosman *et al.*, 1996b).

Smallholder farmers‘ motive to dispose of all or part of their herd as and when needed brings into mind two additional benefits of livestock management, which are ignored,

in the gross value calculation. These are the financing and insurance role of sheep and goat.

As noted earlier, the financing role played by livestock is represented by the ability to convert part of the herd into disposable income (and vice versa) which helps farmers to control income and expenditure over a period of time. In this case, the benefit resulting from financing of livestock must be solely based on the outflow of the stock (Bosman *et al.*, 1996b; Slingerland, 2000). Therefore, the benefit derived from financing over a specified period, *t*, is determined by the sale price of outward transfers and financing factor; $B_t{}^f$:

$$B_t{}^f = (\text{Total outflow} * Pm) * b_f \quad (21)$$

where

The total outflow includes sheep and goat sold, consumed at home and used for gifts. Pm is the current price per unit animal, b_f is the financing factor in the study area, calculated from the opportunity cost of alternative ways of financing such as, transaction cost of operating a savings account, or obtaining a credit, the cost incurred when goods are stored over a period of time, among others. Ayalew *et al.* (2003) stated that interest rates from informal credit markets in rural Africa are highly variable and hence, taking opportunity cost of credit from formal credit markets serves as a better proxy for financing factor.

The estimation of small ruminants as insurance benefit on the other hand is based on the premise that the whole flock is available to provide security through selling on the spot when in times of need (Moll, 2003). Hence, the insurance benefit $B_t{}^i$ is related to the monetary value of annualised current stock of the animals over period *t*;

$$B_t{}^i = ((\text{average flock} - \text{sales}) * Pm) * b_i \quad (22)$$

where, Pm is defined as above and b_i is the insurance factor estimated from the opportunity cost of insurance. Ayalew *et al.* (2003) and Bossman *et al.* (1996) used the opportunity cost of informal insurance as a proxy for the insurance factor in their calculations representing 0.0825 and 0.01, respectively. However, Moll (2003) recommended an insurance factor ranging from 0.05 for quite stable situations with less weather risk to 0.2 for situations with severe risks where no alternative options of insurance exist. Karlan *et al.* (2012) in a study of agricultural credits and risks in northern Ghana recommended an insurance factor of 0.08 that is equivalent to the 0.083 of informal insurance factor provided by Ayalew *et al.* (2003). In the determination of agricultural insurance by Karlan *et al.* (2012), a random variation of prices at which farmers were willing to purchase rainfall index insurance was determined to be 8%. Given that this factor falls within the range of insurance factors provided by Moll (2003) in situations with no alternative insurance options, this study, therefore, adopts the 0.08 as the opportunity cost of insurance for small ruminant production.

The estimation process is done for average household sheep and goat flocks managed in the three regions under a period of one year. Therefore, the annual household aggregate benefit in raising sheep and goat is:

$$TB = GV_t + {B_t}^f + {B_t}^i \quad (23)$$

Household production factors (land, labour and capital) are used in the realisation of the total benefit. Subsequently, allocating the aggregate benefit over the production factors helps to determine the return per production inputs used. Some inputs might be absent or not relevant to small ruminant production (Moll, 2003). In rural areas of northern Ghana, sheep, goat, or both productions are mainly managed on the free range or extensive production system. Hence, accounting for land as a household factor for small ruminant production is unrealistic (Karbo and Agyare, 1997) and the use of labour

for herding is minimal (Panin and Mahabile, 1997). The most important limiting input, in this case, is capital (Ouma *et al.*, 2003; Panin and Mahabile, 1997) which is valued to determine returns per unit capital invested. Given that capital has an opportunity cost, it will be appropriate to compare sheep and goat production with the returns from other enterprises (Bosman *et al.*, 1996b).

3.2.2 Evaluation of Individual Resources and Products in Sheep and Goat Production

Since input and output markets for sheep and goat are imperfect, an explanation and summary of the valuation processes of some resources and outputs adopted for the study are presented in Table 3.1.

Table 3.1 Methodological Approach for the Evaluation of Inputs and Outputs in Small Ruminant Production

Manure	The manure values of sheep and goat were determined from the key nutrients that are released to the soil from the model developed by Fernandez-Rivera *et al.* (1993). The resulting key nutrients in manure estimated were then compared with similar nutrients in inorganic fertilizer that farmers in the study area applied. Key nutrients in manure: Nitrogen and Phosphorus (Ayalew, 2000). Fernandez-Rivera *et al.*, (1993) model: Goat: $F = \frac{26.5 gDM}{W^{0.645}\ kg}$ Sheep: $F = \frac{32.0 gDM}{W^{0.645}\ kg}$ Where ***W*** represents the average body weight of sheep and goat in kilograms and ***F*** is the daily faecal dry matter (DM) output in grams. Schelcht, Fernandez-Rivera and Hiernaux (1997) estimated the nitrogen content in this faecal dry matter as 1.5583% and Somda *et al.* (1993) estimated phosphorus content to be 0.55% of the DM. The resulting nitrogen and phosphorous in grams will be compared to their equivalent in NPK (15:15:15) to determine the monetary value of manure. The bag of NPK was divided by three (3) to determine the price per soluble nutrients and the rate applied is used to estimate the equivalent from manure as determined.	(Ayalew, 2000; Fernandez-Rivera et al., 1993; Schlecht *et al.*, 1997; Somda *et al.*, 1993)

Variables	Methodology	Sources
Hide	The monetary value of hide will be determined by finding the product of the number of animals at slaughter age by the average equivalent skin price (solicited from skin local dealers in the study area). The estimation is done for each animal species (sheep and goat).	(Scoones, 2003)
Capital Invested in production	It represents the cash tied up in the rearing of the animals. Estimation: (number of animals in the flock multiplied by average price of purchase and sales price). This is done both at individual species basis and in combining the two to get the total capital invested in small ruminant production per year	(Ayalew *et al*., 2003; Panin and Mahabile, 1997)

Source: Author's own compilation

3.3 Gender and Small Ruminant Production

3.3.1 Theoretical Model on Productivity Analysis: Cobb-Douglas Function

Various production functions have been used to analyse productivity of firms. The functions used include linear production function, Generalized Leontief (GL) functions, quadratic production function, Cobb-Douglas production function and semi-log production functions. Of these, the trans-logarithmic and Cobb-Douglas production are the most commonly used functional form in empirical studies on production functions and frontier analysis (Battesse, 1997; Ceoli, 1995). The mathematical expressions of these two functional forms are similar (Debertin, 2012) but the Cobb-Douglas model gives a better Likelihood-Ratio test (LR) for a crosssectional data of sample farmers (Theodoridis *et al*., 2006). In addition, the translog function does not constantly produce elasticities of substitution of one (1) (Debertin, 2012)

The translog functional form is a parametric production function which is first developed by Christensen *et al*. (1973). It has been widely used in empirical analysis of firms' production structure due to its simplicity and the fact that it places no apriori restrictions on elasticities and return to scale (Kumbhakar, 1997; Kumbhakar *et al*., 1997; Youn, 1992). The model is mostly used in the estimation of cost functions and

input demands but not as much popular in the estimation of efficiency frontiers (Debertin, 2012; Theodoridis *et al.*, 2006). One area in which the model performs more efficiently than other traditional production functions is in the estimation of multiple output-multiple input technologies.

Consider a production function:

$$Y = F(X, T) \quad (24)$$

Where *Y* is the output level, *X* is the vector of inputs whose elements are $X_i (i = 1, \ldots \ldots n)$ and *T* is the time index employed to measure technical change. The function satisfies the usual regularity conditions.

Suppose the production function (24) is approximated by a trans logged form:

$$InY = \alpha_o + \sum_i \alpha_i InX_i + \delta_T T + 1/2 \sum_i \sum_j \beta_{ij} InX_i + \sum_i \gamma_{iT} InX_i T + 1/2 \delta_{TT} T^2 \quad (25)$$

Where $\beta_{ij} = \beta_{ji} (i \neq j)$

The translog production function (25) is non-homothetic and imposes no restrictions on production technology. That is to say that the marginal rate of technical substitution is not homogenous of degree zero in inputs. Translog functions usually contain large number of parameters even for relatively smaller input and output levels. Consequently, its estimation with ordinary least square comes with severe limitations (Banker *et al.*, 1986). Among them are the following:

1. Inconsistent parameter estimates due to high multi-collinearity.
2. Problems of low degrees of freedom

The Cobb-Douglas functional form, on the other hand, is first tested empirically by

Charles Cobb and Paul Douglas in 1922 after it had been used by Wicksteed and Wicksell (Douglas, 1976). The Cobb-Douglas functional form has become the most widely used and important tools in the estimation of production functions (Battesse and Broca, 1997; Cheng'ole *et al.*, 2003). Its logarithmic transformation into linear logs of inputs makes it a simplified tool for econometric estimation (Marinda *et al.*, 2006). The functional form is specified as:

$$Y = AX_0^{\beta 0}X_1^{\beta 1}X_2^{\beta 2} \dots\dots\dots X_n^{\beta n}\varepsilon \qquad (26)$$

where Y is output, X_s are the inputs or factors affecting productivity, β_s are the parameters and ε is a multiplicative stochastic error or residual term. In its logarithmic transformation, equation (26) becomes:

$$InY = \beta_0 + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \cdots\dots\dots + \beta_n InX_n + \varepsilon \qquad (27)$$

The natural log transformation in equation (27) allows estimation with the ordinary least squares method, satisfies the assumption of the error term being normally distributed, having constant variance and a mean of zero.

The Cobb-Douglas functional form has attained popularity in production and productivity analysis because:

1. There is the possibility of allowing diminishing marginal returns to occur without losing too many degrees of freedom
2. It is simple and computational-friendly. Its regression coefficients represent the elasticities of production.
3. It yields a combination of statistical measures of goodness fit, e.g. coefficient of determination (R^2) and adjusted R^2 , the F-ratio value, statistical significance and the signs of the estimated regression coefficients (Cheng'ole *et al.*, 2003).

3.3.2 Limitations of Cobb-Douglas Functional Form

In spite of its popularity, Cheng'ole *et al.* (2003) and Coeli (1995) pointed out the following limitations in using the Cobb-Douglas functional form:

1. It becomes problematic in cases of positive and negative marginal productivities or where there are ranges of both increasing and decreasing marginal productivity.
2. The Cobb-Douglas function assumes a unit elasticity of input substitution implying an infinite output level (increasing input level increases output indefinitely).

Nonetheless, many studies (Battesse and Broca, 1997; Greene, 2004; Keith and Gardner, 1964) in estimation of production functions find Cobb-Douglas functional forms as the most appropriate because its advantages far exceed its disadvantages. For instance, Keith and Gardner, (1964) argue that the Cobb-Douglas functional form is ideal in estimating production functions especially in developing countries because it allows diminishing marginal returns and variables with _zero values' (dummy variables). This study, therefore, adopts the Cobb-Douglas production function because of its advantages over the other functional forms. Hence, equation (27) is adopted in estimating the productivity differences between male and female small ruminants' mangers in northern Ghana.

3.4 Constraints to Small Ruminant Production

3.4.1 Ordinal logit

The ordinal logit model is used to examine the odds of a farmer experiencing sheep, goat or both feed shortage, as well as disease and parasite problems. The ordinal logit model, unlike the logit model, is used to model a polytomous or heterogeneous ordinal response to a set of predictors (McCulloagh, 1980). Heterogeneous response variables

include variables measured on an ordinal scale usually with a Likert-scale. Consider a simple logit model as:

$$log\left[\frac{P_j}{1-P_j}\right] = \beta_0 + \sum_{j=i}^{k} \beta_j X_{ij} \quad (28)$$

where P_j is the probability of a household experiencing small ruminant feed shortage and diseases and parasites problems, $\left[\frac{P_j}{1-P_j}\right]$ is the odds ratio, which refers to the odds of farmers experiencing small ruminant feed shortage or diseases and parasites constraints, β_0 Intercept, β_j are the parameters of the explanatory variables and X_{ij} are the explanatory variables including the socio-economic, institutional and biophysical factors affecting farmers' production constraints (feed and disease and parasites constraints). The dependent variable is a dichotomous variable (0 and 1). In the case of more than two events occurring (such as ordinal scale variables 1, 2, 3, and 4), the standard binary logit is extended to accommodate the ordinal nature of the dependent variable by defining the probabilities differently. That is the probability of such event and all other events that are ordered is considered. The model can, therefore, be written as:

$$f\left[\gamma_j(X)\right] = log\left\{\frac{\gamma_j(X)}{1-\gamma_j(X)}\right\} = \frac{log\{[p(Y \leq \gamma_j : X)]\}}{[p(Y > \gamma_j : X)]} + a_j + \beta X,\ j = 1, 2 \ldots . k \quad (29)$$

where $\gamma_j(X) = e^{(\alpha+\beta x)}/\left[1 + e^{\alpha+\beta x}\right]$ and j indexes the cut-off points for all categories (k) of the outcome variable.

3.5 Chapter Summary

The chapter discussed the theoretical and conceptual framework guiding the study. The discrete choice and random utility model informing the use of Negative binomial and multinomial logit (MNL) models that are used to assess the determinants and the type of small ruminants are discussed. In addition, the aggregate economic evaluation method that estimates the total benefit of traditional livestock system is also presented.

In another theoretical foundation, the Cobb-Douglas production function used to determine the productivity of both male and female small ruminant farmers is also examined. Finally, the determinants of constraints that limit small ruminant production are also examined through the Ordinal Logit model.

CHAPTER 4

4.0 RESEARCH METHODOLOGY

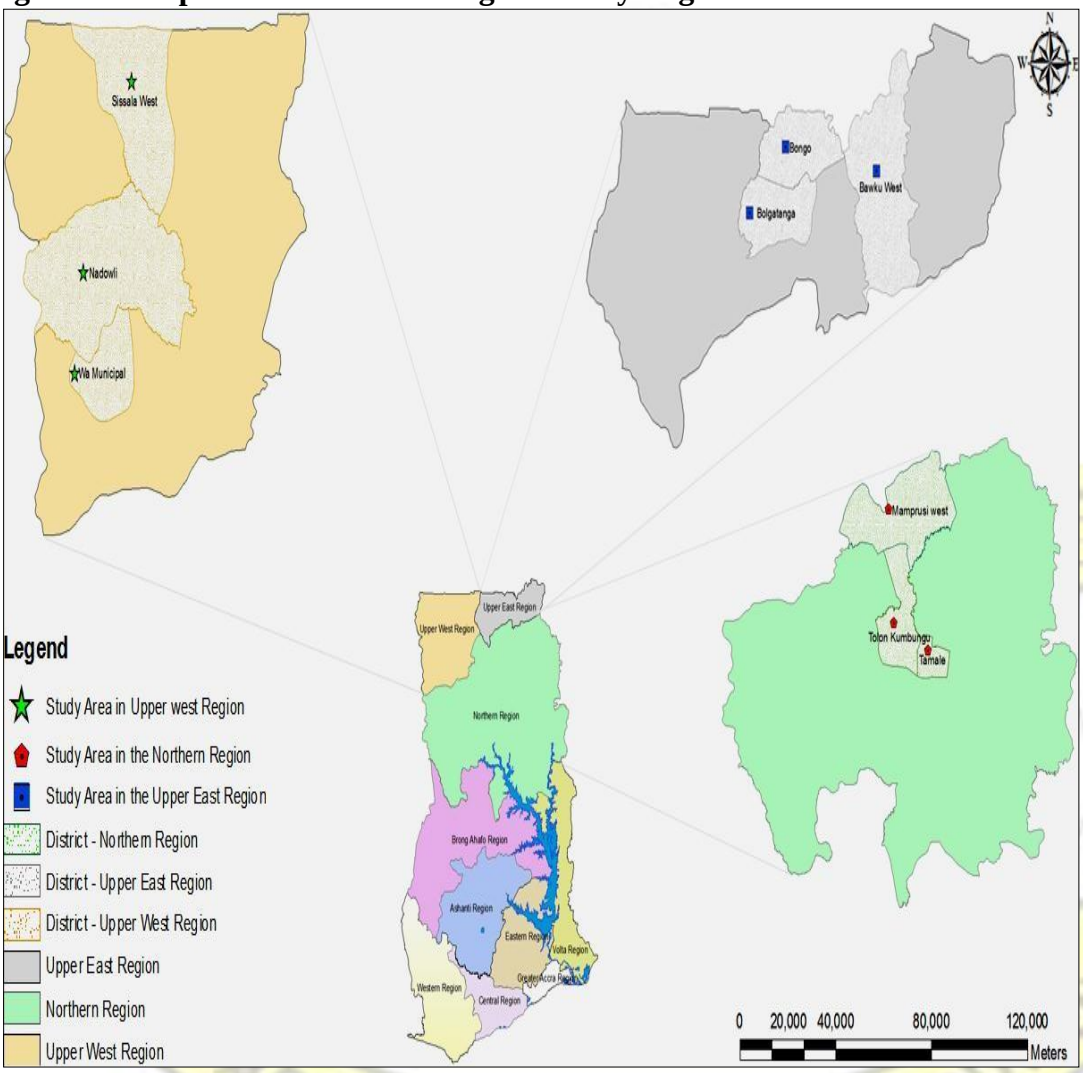
This chapter describes the study area and the methods employed for data collection. The chapter begins with a rationale for selecting the study sites and a general description of the area. This is followed by the sampling approach adopted and the methods of data collection and analysis.

4.1 Study Area

The study is conducted in the three administrative regions of northern Ghana, namely: Northern Region (NR), Upper West Region (UWR), and Upper East Region (UER) (Figure 4.1). Northern Ghana covers latitudes 8^0- 11^0 N and longitudes 0^0 -3^0 W (Blench, 2007). The three regions, considered together, represent about 64% (or 149, 800 km^{-2}) of the total land area of Ghana (or 238,539 km^2) (GEPA, 2002). The 2010 population and housing census estimates indicate that the total population of the three regions is 4,228,116, representing 17.1% of the national population. Of the total population (combined for the three regions), 49% are males and 51% are females (GSS, 2012). Among the three regions, NR has the highest total population (2,479,461 persons), followed by the UER (1,046,545), and then the UWR (702,111). The majority of the population (80%) in the three regions lives in rural areas. In addition, the male to female household head ratio is lowest in the UWR (3:1), followed by the UER (4:1) and the NR (9:1) (GSS, 2012).

As with the rest of the country, agriculture is the dominant economic activity in the three regions, involving crop and livestock production (MoFA, 2010). Northern Ghana also accounts for a significant proportion of the country‘s large ruminant (i.e., 77% cattle) production, and 55% of small ruminant production, along with poultry (guinea fowls and chickens) and pigs (Karbo and Bruce, 2000).

Figure 4.1 Map of Ghana Illustrating the Study Regions and Sites



Modified from: Akudago *et al.* (2007)

Quaye (2008) reports that a high percentage of households in northern Ghana depend on small ruminant production to cope with famine during drought periods: 81.6 % for UWR; 96% for UER; and 70.8% for NR. Specific districts selected from each region

together with such districts‘ pedo-climatic conditions and demographic characteristics are represented in Table 4.1.

Table 4.1 Pedo-Climatic Conditions, Agro-Ecological and Population Characteristics in the Study Area

Agro-ecological zone	Region	Districts	Mean Rainfall (mm)	Mean Temp (°C)	Soil Characteristics	Population	Male: Female Proportion
Guinea savannah	Northern	Tolon	1100	35	Coarse lateritic upland soils and soft clay	125,430	48.3% male and 51.7% female
		Mamprusi West	600	34	Sandstone, shale, siltstone , mudstone	91,415	49% male and 51% female
		Tamale	1100	33	Sand, clay and laterite ochrosols	293,881	50% male and 50% female
Sudan savannah	Upper East	Bawku West	850	35	Birimian and granite soil formation, low fertility	107,111	46% male and 54% female
		Bongo	1000	21	Coarse sandy (colluvia), coarse sandy loan	77,885	46.7% male and 53.3% female
		Bolgatanga	950	45	Birimian and granite soil formation, low fertility		49% male and 51% female
	Upper West	Sissala West	1100	33	Savannah ochrosols and terrace soils	44,440	49.2% male and 50.8% female
		Nadowli	1100	32	Savannah ochrosols, sandy and laterite	82,716	47.7% males and 52.3% females
		Wa Municipality	1120	47	Lateritic soils and savannah orchrosols soils	98,675	49% male and 51% female

Source: Ministry of Local Government and Rural Development (2006)

4.2 Study Population, Sample Size and Technique

4.2.1 Study Population and Sample Size

The target population for the study was farm households in the three Northern regions of Ghana. The sampling unit was the household, defined as a group of people living together and eating from the same pot. They also share a common resource with one person as the head. In order to improve precision and to minimize sampling bias, the Cochran's sample size formula for continuous data was adapted to determine the sample size for the study. The estimated minimum sample size was 267 farm households but a total 300 of farm households are used in this study. The study used a structured questionnaire with 4-point and 5-point scales to collect data from farm families. Hence, the estimation of the sample size using Cochran's formula for a 5point likert-type scale questions is given as:

Cochran's formula:

$$N_o = \frac{t^2 * s^2}{d^2} = \frac{(1.96)^2(1.25)^2}{(5*0.03)^2} = 266.8 \quad (30)$$

where;

No is the sample size.

t-value for selected alpha level of 0.05 = 1.96. Alpha (confidence) level of 5 percent indicates that, the level of risk the researcher is willing to take that true margin of error may exceed the acceptable margin of error.

S* is estimated standard deviation in the population. It is the estimate of variance deviation for the point scale calculated by using the scale ratings inclusive range divided by the number of standard deviation that include almost all of the possible values in the range. For the 5-point scale,

$$s = \frac{5(number\ of\ points\ on\ the\ scale)}{4(number\ of\ standard\ deviation)} \quad (31)$$

d* is the acceptable margin of error for mean being estimated. It is given as: the numbers of points on the primary scale * acceptable margin of error. Acceptable margin of error for continuous data is 0.03 (3%) i.e. the error the researcher is willing to accept due to sampling error.

4.2.2 Sampling Procedure

A multi-stage (three-stage) sampling design is used (William and Bousmaha, 2001) to select districts, communities and farmers for data collection. The first level of the multi-stage sampling involved purposively sampling of three districts from each of the three regions. The purposive sampling strategy is relevant because of two considerations. First, the districts considered are within the two northern agroecological zones since some of the districts especially in Northern region are found in the transitional zone of Ghana. Second, logistic considerations especially rural road accessibility to villages and farm communities to administer the surveys are important (see also, Yiridoe *et al.*, 2006). Specifically, Tamale Municipality, West Mamprusi, and Tolon-Kumbungu districts are selected to represent Northern Region, while Bongo, Bolgatanga and Bawku West districts were selected from the Upper East Region. Finally, Wa Municipality, Nadowli and Sissala West districts represented the Upper West Region.

At the second stage, two farming communities under each district were randomly (simple random) selected from each region making six communities. The excel ―rand‖ command for simple random selection is applied to choose the farming communities. A third level of the sampling involved selecting (simple random) farm households for the interviews. A list of farm households in each community is obtained from local

district assemblies and agricultural office officials. The lists are entered into excel and the ―rand‖ command is used to randomly select 300 farm households from the various lists to represent the survey sample in all the three regions (22% from UWR, 26% from UER and 52% from NR of the surveyed sample reflecting the proportion of farm households in the various regions) (GSS, 2012). The districts, selected communities and sample size for each region is shown in Table 4.2.

Table 4.2 Selected Districts, Communities, and Sample Sizes for Each Study Region

Region	Selected districts	Selected communities	Sample size
Northern	West Mamprusi Tamale Tolon Kumbugu	Kpasenkpe and Nayoku Vitting and Kamina Barracks Tolon and Chirifoyili	151
Upper West	Wa Municpal Nadowli Sissala West	Kpongu and Kolpong Sankana and Takpo Siybele and Tiiwi	68
Upper East	Bolgatanga Bongo Bawku	Zuarungu Dachio and Sherigu Dorungu-Agobgabis Adaboya and Gowire-Tingre Aneigo and Yarigu	81
Total			**300**

4.3 Types and Sources of Data

Both primary and secondary data are used in this study. Important secondary data are obtained from various sources, including journal articles, unpublished databases and information from Ministry of Food and Agriculture offices, district assemblies, relevant books and internet sources. These data help to describe the study areas and also provide sufficient information to the background of the study.

Primary data are collected from the sampled households in the study areas. The survey used a cross-sectional data collected from October to December 2012. Two sets of data

are collected during the survey. The first set was on a random sample (300) of farm households selected in the study areas. Specific information collected includes typical demographic characteristics and farm-related data. In addition, data on whether farm households owned one or more sheep and goat are collected. Specific reasons, why some households do not raise small ruminants, are also collected. The second set of data was on only households who owned and managed a sheep, goat or both. In each of these households, owners of small ruminants are also interviewed if they were different from the household head.

4.4 Data Collection and Analysis

To achieve the objectives of the study with a higher degree of validity and reliability, a combination of quantitative and qualitative research approaches are used. The qualitative method adopted was participant observation to have a first-hand information and deep understanding of the traditional small ruminant system that engulf the whole of northern Ghana. On the other hand, a structured questionnaire was developed to collect quantitative data from the sampled households.

4.4.1 Pilot Survey and Questionnaire Administration

Before the actual data collection process, the survey questionnaire is pre-tested in the study area. The objectives were to examine the strength and weakness of the questionnaire in line with the objectives set for the study. Furthermore, it also provided the opportunity to update the questionnaire with essential data that are not previously considered. Ten (10) farm households in West Mamprusi of Northern region are randomly selected for the pre-testing. The pre-tested questionnaire is revised for actual data collection. The survey is carried out for three (3) months spanning from October to December 2012. The questionnaires administered in all the study communities are carried through face-to-face interviews with farmers. Data captured on the

questionnaire were divided into five components (see appendix 1). Component one captured information on the general farmer and household background. Component two is devoted to farming information whiles data for economic value estimation of livestock are collected in component three. Gender and constraints data on small ruminant livestock also formed component four and five, respectively. The last component (five) centered on access to financial institutions.

4.4.2 Empirical Specification of Factors Determining Investment Decisions and Type of Livestock in Small Ruminant Production

4.4.2.1 Determinants of Decision to Own Small Ruminant Livestock

Specifically, the determinant of households to own small ruminants is specified as:

$$SMR = \beta_0 + \beta_1(NONINC) + \beta_2(AGE) + \beta_3(GENDER) + \beta_4(EDU) + \beta_5(HHS) + \beta_6(CREDIT) + \beta_7(SAV) + \beta_8(EXTN) + \varepsilon \quad (32)$$

where: SMR represents the number of small ruminants owned by household; $NONINC$ equals 1 if household is engaged non-farm income, 0 otherwise; AGE = age of household head(years); $GENDER$ dummy variable which equals 1, if household head is male, 0 otherwise; EDU formal education, equals 0 if none, 1 if head has primary, Junior or Senior High Secondary, and 2 if completed tertiary; HHS is household size $CREDT$ equals 1 if accessed credit, 0 otherwise; SAV equals 1 if household head has a formal savings account, 0 otherwise; $EXTN$ dummy variable which equals 1 if household had access to extension services, 0 otherwise.

Following from the empirical model, the following hypotheses are presented Table 4.3

Table 4.3 Statement of Hypothesis on Determinants of Small Ruminant Ownership

No.	Hypotheses	Source

1.	Women are more likely to raise (and own) small ruminants than men. Thus, probability of raising sheep and goat by farmers is higher for women than men, *ceteris paribus*	(Curry, 1996; Devendra, 1988); Devendra & (Chantalakhana, 2002); Lebbie, 2004)
2.	Older individuals in rural sub-Sahara Africa tend to raise larger numbers of small ruminants, compared with younger household heads. The probability of raising sheep and goat by farmer increases with the age of farm household heads, *ceteris paribus*	(Kunene and Fossey, 2007 ; Baah *et al*,. 2012 Mahabile *et al*., 2005; Dossa *et al.*, 2008)
3.	The probability of raising sheep and goat by farmers increases with the level of education of household heads, *ceteris paribus*.	(Asfaw and Adamassie, 2004; Alene and Manyong , 2007; Fakoya and Oloruntoba, 2009; Oluwatayo and Oluwatayo, 2012)
4.	The probability of managing sheep and goat by farmers is higher for households with a higher number of family members, *ceteris paribus*.	(Duku *et al.*, 2011; Fakoya and Oloruntoba, 2009; Oluwatayo and Oluwatayo, 2012)
5.	The probability of raising sheep and goat by farmers increases with non-farm income of households, *ceteris paribus*	(Barrett *et al.*, 2001; Duku *et al.*, 2011; Mucuthi, 1992; Thys *et al.*, 2005 Adam *et al.*, 2010 Kalinda *et al.*, 2012)
6.	Rural and Agrarian households with limited formal credit rather invest in small ruminant production. The probability of farmers' decision to own and raise sheep and goat is higher for farm household heads with little or no access to credit and savings from formal financial institutions ,*ceteris paribus*	Dossa *et al.* (2008)
7.	The probability of managing sheep and goat by farmers is higher for households with access to extension services, *ceteris paribus*.	(Adam *et al.*, 2010; Kalinda *et al.*, 2012)

4.4.2.2 Determinants of the Choice of Small Ruminant Type

The empirical model that examines determinants of type of small ruminant species owned by household is presented in equation (33).

$$TSMR = \beta_0 + \beta_1(GENDER) + \beta_1(AGZone) + \beta_3(RISP) + \beta_4(BENP) + \mu \qquad (33)$$

where $TSMR$ represents the type of small ruminant owned, that is, 1, If household owns sheep, 2 if owns goat and 3 if owns both; $GENDER$ equals 1 if household head is a male, 0 otherwise; $AGZone$ is dummy variable representing agro-ecological, which equals 1, if household is located in Sudan-Savanna, 0 otherwise; $RISP$ equals 1 if household perceives sheep to be riskier, 0 otherwise; $BENP$ equals 1 if household perceives sheep to be more profitable, 0 otherwise.

4.4.2.3 Computation of Risk and Benefit Perception

A 4-point Likert-type scale was employed to calculate the average. For the perception of risk in each sheep and goat production, the scale was weighted in order of importance from; 1=very low, 2=low, 3=high and 4=very high on five livestock risk attributes. The risk characteristics include the animal's tendency to be easily missing, stolen, lost, destructive nature and death rate. An index denoting the level of perceived risk for particular species was estimated by taking the farmer's average score over all the relevant risk attribute statements. For instance, if a farmer scores 3, 3, 4, 2, and 4 for the above risk attributes to sheep production, such farmer scores 3.2, that is, (3+3+4+2+4) /5= 3.2. Index closer to 4 or above 2.5 ((1+2+3+4) /4=2.5)) indicates the production of sheep is riskier. Therefore, the 3.2 index calculated means sheep production is riskier for the farmer. It was treated as a dummy variable and coded; 1=sheep riskier and 0=otherwise. The same methodology applied to the calculation of farmer's profit perception. However, only two livestock benefit attributes (easier to sell and income return) were considered. The study therefore postulates the following hypotheses in Table 4.4

Table 4.4 Statements of Hypotheses Tested On Type of Small Ruminants Managed

No.	Hypotheses	Source
1.	Women are likely to have a higher propensity than men	Okali and Sumberg,

	to raise goat, all things being equal. In rural regions of sub-Sahara Africa, women traditionally undertake household chores such as food processing. Unlike sheep, goat tend to graze near homesteads and are also commonly provided with kitchen scraps and food by-products	1986
2.	The Sudan savannah zone is relatively more arid and has long drought periods compared with the Guinea savannah zone. Consequently, farm households in Sudan savannah zone are more likely to raise goat that are better able to tolerate stress from heat and drinking water deprivation, compared with sheep, all things being equal.	Lebbie, 2004; Peacock, 2005
3.	Sheep production tends to be riskier than raising goat. Farming households who perceive raising sheep to be more riskier than goat, have higher tendency to raise goat, all things being equal.	Dossa *et al.*, 2008; Fakoya and Oluruntoba, 2009
4.	Expected returns from sheep production is higher than for goat. Households with higher perceived returns from sheep production are more likely to raise sheep relative to goat, all things being equal.	Dossa *et al.*, 2008; Panin and Mahabile, 1997

4.4.3 Methods of Computing Cost and Total Benefits of Small Ruminants

4.4.3.1 Computing of Cash and Non-Cash Costs of Small Ruminant

The costs incurred for sheep and goat production under the traditional system are categorised into (i) cash costs and (ii) non-cash costs. Both costs are calculated on per household and animal unit basis for the two small ruminant species. The cash costs identified include veterinary services, medicines/drugs, dipping services, the purchase of feed supplements and fencing. However, the non-cash costs are animals lost due to mortality, theft or missing. The number of the animals lost/died, accounting for differences in sex and age is multiplied by the price per kilogram to obtain the total non-cash costs for a particular small ruminant species. The price per kilogram of both sheep and goat meat in Northern region is Gh¢7.7 while it is Gh¢5.0 in the Upper East and West regions. Table 4.5 presents the summary of the small ruminant structure and average weights of the species used in the calculation.

Table 4.5 Small Ruminant Structure, Average Weights Of Species And Price/Kg Used In Calculation

		Regions		
		Northern	Upper East	Upper West
Structure	**Average weight (kg)**	**Average Price/kg (Gh¢)**		
Sheep flock			5	
Lambs	8.5	7.7	5	
Ewes	25	7.7	5	
Rams	30	7.7	5	
Goat flock		7.7	5	
Kids	5.1	7.7	5	
Does	22	7.7	5	
Bucks	25	7.7	5	

4.4.3.2 Computing of Total Benefits of Small Ruminants

The total benefits are grouped into physical and socio-economic products (Table 4.6). The physical represents the tangible benefits of small ruminant livestock, which is subdivided into market and non-market products. Conversely, the socio-economic benefits are computed from the financing and insurance role played by livestock in the traditional system. Therefore, the aggregate benefits are computed from the market and non-market benefits to the household.

4.4.4 Empirical Specification on Gender Productivity in Small Ruminant Production

Following the theoretical foundation, the empirical model adopted for this study in estimating the productivity of small ruminants by gender is specified as:

$$In(PRODT) = \beta_0 + \beta_1 ln(AGE) + \beta_2 ln(MSTATS) + \beta_3 ln(EDU) + \beta_4 ln(EXTN) + \beta_5 ln(CREDT) + \beta_6 ln(INCOME) + \beta_7 In(COOP) + \beta_8 ln(HHS) + \beta_9 ln(NONINC) + \xi \quad (34)$$

Table 4.6 Components for Calculation of Total Benefits for Traditional Small Ruminant System

Total benefits	Description	Calculation
Physical products		

Non-market products	• Average number of animals consumed • Average number of animals given out as gift or shared agreements	• Average weight of animals multiplied by price per kilogram and number of holdings per household
	• Quantity of manure is based on the number of animals hold per household to determine the dry matter weight of each animal and finally estimate nitrogen and phosphorus[1].	• Average nitrogen and phosphorus content produced per household for sheep is 0.021kg and 0.0073kg, respectively. The nitrogen and phosphorus content is also 0.0167kg and .0059kg, respectively for goat. This was compare with the prevailing market price of NPK of Gh¢45.0. The Gh¢45.0 was divided by 3 to determine the value for each nutrient per household
	• Quantity of hide was based on the number of animals at slaughter age hold per household	• The average price for sheep skin on the market was Gh¢1.2
Market products	• Average number of outward transfers (i.e., animals sold, consumed, given birth or given as gifts less animals purchased and received as gifts	• Average weight of animals multiplied by price per kilogram and number of holdings per household
Socioeconomic products	• **Financing role**: This is based on monetary value of all outward transfers multiplied by the opportunity cost of alternative way of financing • **Insurance**: This is based on the product of the difference between average animal holdings and average sales multiplied by opportunity cost of insurance	• The interest rate of 20% on credits is used as the opportunity cost of alternative way of financing • The opportunity cost of insurance was 0.08, insurance factor for agriculture and risk in Northern Ghana.

where *ln* represents natural logarithm, *PRODT* is the dependent variable representing the productivity of small ruminants per year per farmer measured in monetary value (Ghana cedis). It is computed as:

$$PRODT = (outflow - inflow + net\ change\ in\ stock) * monetary\ value\ per\ unit\ animal$$

where outflow refers to number of small ruminants used in outward transfers including, number of sheep and goat sold, number slaughtered at home for consumption (accounting for animals used for naming ceremonies, marriages, festivals and religious functions) and number given out as gifts to strengthen social relations by the household in the past one year. Similarly, inflow refers to number of small ruminants used in inward transfers such as number of sheep and goat purchased for breeding purposes and number received as gift or shared arrangements by households in the past one year. Net change in stock on the other hand, means the number of sheep and goat born in the past one year. The monetary value per unit animal is calculated from the average prices of purchases and sales at the farm gate. *AGE* denotes the age of farm managers (years). It is a continuous variable; *MSTAT* is the marital status of sheep, goat or both farmers. It is a binary variable; it takes a value of 1 if married and 0 if otherwise; *EDU* indicates farmers' formal education level. It is a continuous variable; *EXTN* denotes extension contact with smallholder and whether they discuss small ruminant production. It is a binary variable; it takes the value 1, if a farmer had extension visit for the past year, and 0 if otherwise; *CREDT* represent access to formal credit. It is a binary variable; it takes a value of 1, if the farmer has claimed credit for the past three (3) years and 0 if otherwise; *NONINC* is the non-farm income source of the farmer. It is a binary variable; it assumes a value of 1 if the farmer has non-farm employment and 0 if otherwise. *COOP* represents whether the smallholder belongs to any farmer group/association or not. It is a binary variable; it takes a value of 1, if he/she belongs to an association and 0 if otherwise. *HHS* is farmers' household size in numbers. It is a continuous variable. $\beta_1, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8 > 0$ for both male and female owners while $\beta_2 < 0$ for female

and $\beta_2 > 0$ for male farmers and□ is the error term which is assumed to be normally distributed, has a mean of zero and also a constant variance. The statement of hypotheses for these variables are stated in Table 4.7

Table 4.7 Statements of Hypotheses on Gender Productivity in Small Ruminant Production

No.	Hypotheses	Source
1.	Older small ruminant farm managers (i.e., both men and women) are more likely to increase small ruminant productivity than younger farm managers are, *ceteris paribus*	Fakoya and Oloruntoba, 2009; Oluwatayo and Oluwatayo, 2012 Elizabeth, 2006; Epeju, 2010; Marinda *et al.*, 2006
2.	Whereas the relationship between marital status and productivity of males is expected to be positive, that for a female is expected to have negative, *ceteris paribus*	Al-Rimavi (2002), Elizabeth (2006) and Oluwatayo and Oluwatayo, 2012
3.	Higher level of formal education of farmers is related to higher tendency to adopt new technologies required for increased small ruminant productivity. Therefore farmers with higher education level are likely expected to increase small ruminant productivity compared with farmers with lower educational level, *ceteris paribus*.	Fakoya and Oloruntoba (2009) and Oluwatayo and Oluwatayo (2012) Quisumbing (1995) Sulo *et al.* (2012)
4.	Farmers contact with extension service are expected to increase small ruminant productivity. Farmers with use the contact to access information on new technologies that increases productivity, *ceteris paribus*.	Adam *et al.*, 2010 Elizabeth, 2006; Marinda *et al.*, 2006 extension farming
5.	Credit access enables farmers to participate in livestock production through the purchase of inputs. Thus small ruminant productivity is higher for farmers who access formal credit facility than those without access, *ceteris paribus*	Adam *et al.* (2010) Bosman *et al*., 1996b ; Slingerland, 2000
6.	Small ruminant productivity is higher for male and female small ruminant managers who access non-farm income employment, *ceteris paribus.* Non-farm income could serve as an alternative financing option to invest and increase livestock production in sub-Sahara African countries	Reardon *et al.*,1994 Al-Rimavi, 2002
7.	Small ruminant farmers with cooperative association are expected to increase small ruminant productivity than farm managers without membership, *ceteris paribus*.	Legesse *et al.*, 2013; Fakoya and Oloruntoba, 2009
8.	Larger household sizes increases labour availability for feeding, herding and construction of pens, hence	Verbeek *et al.*, 2007; Facoya and

likely to increase small ruminant productivity of both male and female farms, *ceteris paribus.*	Oloruntoba, 2009	

The ordinary least squares (OLS) method is applied in the estimation of equation (34) (Cheng'ole *et al.*, 2003; Marinda *et al.*, 2006). The analysis aims to assess socioeconomic and institutional factors that influence female-managed, and male-managed small ruminant production. In addition, another production function, that is, a pooled regression for all farm managers is also calculated with gender of respondents (farm manager or household head) as a dummy variable in the model.

4.4.5 Determination of Male and Female Spouses' role to Small Ruminant Production Activities and Decision-Makings

A contribution index developed by Ayoade *et al.* (2009) is adapted to determine the contribution of both males and females to the management of household small ruminant production activities and decision-makings. The index is calculated on a 3point Likert scale. The 3-point scale is weighted in order of importance from; Never contributed = 1, rarely contributed = 2, always contributed = 3. Both male and female spouses in the household are asked to indicate their level of participation on eleven (11) small ruminant management activities. In addition, such respondents are also asked to indicate their level of participation in six (6) small ruminant management decision-making activities. Table 4.8 shows the variables which are used to measure the 11 management practices and 6 management decision-making activities. The mean score for each of the activities is calculated and the grand mean score of all the activities is divided by the number of activities to determine the level of participation of both men and women in household small ruminant management activities and decision-makings.

Table 4.8 The Eleven Small Ruminant Management Activities and Six DecisionMaking Activities for Male and Female Spouses

	Never contributed	Occasionally contributed	Always contributed
Management practices			
Herding and/or tethering Feeding/providing fodder to animals Cleaning barns/pens Provision of drinking water Caring for sick animals Construction of livestock housing Marketing of animals Castration of animals Taking sick animal to veterinary Discussions in extension visits Fodder harvesting			
Decision-making on activities			
Selecting animal type (sheep or goat) Type of small ruminant breed Health care Sale or marketing of animals Use of income or products from animals Ownership of animals			

4.4.6 Empirical Specification on Factors Influencing Smallholders' Vulnerability to Production Constraints

Following the conceptual framework, the empirical model concerning feed shortage and diseases and pests problems is based on equation (35).

$$In\left[\frac{\gamma_j(X)}{1-\gamma_j(X)}\right] = \beta_0 + \beta_1 GEN + \beta_2 AGE + \beta_3 EDU + \beta_4 NONINC + \beta_5 AGZone + \beta_6 PSYST + \beta_7 EXTN + \beta_8 COOP + \beta_9 CRDT + \beta_{10} HdSize + \varphi \quad (35)$$

where $In\left[\frac{\gamma_j(X)}{1-\gamma_j(X)}\right]$ is explained above which defines the odds ratio of sheep and goat farmers experiencing feed shortage on the explanatory variables. When calculated for each parameter, the odds represent the ratio of households experiencing sheep and goat feed shortages compared with those households that did not experience feed shortages.

A similar model is performed on the incidence of diseases and pests. The dependent variable that is, feed shortage is determined to reflect severity (1 = Very low severity, 2 = Low severity, 3 = High severity and 4 = Very high severity) to which a household is affected during the past year. The same coding is applied to diseases/parasites incidences. *GEN* equals 1 if farmer is female, 0 otherwise; *AGE* equals 1if farmer is a youth (between 15 and 35 years), 0 otherwise; *EDU* is a categorical variable which equal 1 if no formal education, 2 if primary, Junior or Senior Secondary, 3 Completed college/university; *NONINC* equals 1 farmer has no non-farm income, 0 otherwise; *AGZone* equals 1 if farmer is located in the Guinea Savanna, 0 otherwise; *PSYST* dummy variable which equals1 if free range or extensive system, 0 otherwise; *EXTN* equals 1 if farmer has no extension contact, 0 otherwise; *COOP* equals 1 if farmer is not a member of cooperative association, 0 otherwise; *CRDT* equals 1 if farmer has not assessed credit, 0 otherwise; *HdSize* categorical variable with 1 equals small (less than 10 animals), 2 medium (10-20 animals) and 3, high (above 20 animals); $\beta\ \beta_o \ldots_{10}$ are parameters to be estimated, ε is the error term. The statement of hypotheses to be tested for these variables are illustrated in Table 4.9

4.5 Data Analysis

The data collected are coded and entered into Microsoft Excel version 2007 and used with Statistical Package for Social Science version 16 (SPSS 16), Stata 12.0 and Gretl version 1.1 software for analyses. Analytical techniques applied include frequency tables, t-statistics, pie charts, histograms, central tendencies (means) and measures of dispersion (standard deviation) as well as various regression models such as Poisson, Negative Binomial, Multinomial logit, Binary Logit and Ordinal Logit.

Table 4.9 Statement of Hypotheses on Constraints in Small Ruminant Production

No.	Hypotheses	Source

1.	The probability of experiencing diseases/parasites and feed constraints is higher for the extensive production system compared with the semi-intensive production system, *ceteris paribus*	Turkson and Naandam, 2006
2.	The probability of experiencing diseases/parasites is higher for households in Guinea savannah zone while the probability of experiencing feed shortage is higher for households in Sudan savannah zone, *ceteris paribus*	FAO, 2005
3.	With smaller herd size, households tend to have higher probability of experiencing diseases/parasites and feed shortage	Mapiye *et al.* (2009) Oluwatayo and Oluwatayo, 2012
4.	The probability of experiencing diseases/parasites and feed constraints is higher for female small ruminant producers compared with male producers, *ceteris paribus*.	Mapiye *et al.*, 2009
5.	The probability of experiencing diseases/parasites and feed constraints is higher for youthful household heads compared with older household heads, *ceteris paribus*.	Marinda *et al.*, 2006 Mapiye *et al.*, 2009
6.	The probability of experiencing diseases/parasites and feed shortage is higher for uneducated farm households compared with educated households, *ceteris paribus*.	Mapiye *et al.*, 2009
7.	The probability of experiencing diseases/parasites and feed shortage is higher for unemployed households compared with employed households in northern Ghana, *ceteris paribus*	Barrett *et al.*, 2001; Ellis, 1998; Reardon, 1997
8.	All things being equal, households with extension contact tend to have lower tendency to experience disease/parasite and feed shortage	Turkson, 2003 Kalinda *et al.*, 2008
9.	The probability of experiencing diseases/parasites and feed shortage is higher for households without co-operative association membership compared with households who have access to co-operative association, *ceteris paribus*.	Ayoade *et al.*, 2009
10.	Households with access to credit compared with those without access are less likely to experience diseases/ parasites and feed shortages, *ceteris paribus*	Kalinda *et al.*, 2013 Bosman *et al.*, 1996

4.6 Chapter Summary

A detailed description of the study area, as well as the method of data collection is presented in this chapter. Two districts in each of the three Northern Regions (Northern, Upper East and West) were selected for the study. Using a structured questionnaire, multistage sampling technique is employed to gather data, based on households recall. The chapter concluded by stating the various empirical models and hypotheses used in the study.

CHAPTER 5

5.0 ANALYSIS AND DISCUSSION OF RESULTS

This chapter presents and discusses the results of the study. The chapter is organised into five sections. The first section deals with the demographic characteristics of respondents and farm characteristics of the study area. The second section concentrates on factors influencing investment decision and type of livestock in small ruminant production followed by estimation of the socioeconomic benefits of small ruminants. In the fourth section, the result on gender and small ruminant production is presented and discussed while the last section concentrates on constraints to small ruminant production.

5.1 Description of the Survey Data

5.1.1 Demographic Characteristics of Survey Respondents

Illustrated in Table 5.1 are the socio-economic and institutional characteristics of small ruminant households in northern Ghana. The result shows that male household heads are dominant (83.3%) across the three areas. The household head gender distribution in this study is similar to the 80% male household heads reported in a recent nation-wide survey by FAO (2012). The finding implies that men are the owners of small ruminants in the household. Another reason may be attributed to societal customs and norms in sub-Sahara African countries where males control household productive assets. The large proportion of male household heads is therefore very crucial for transferring and adoptions of technology since men are mostly the decision-makers in most African societies (Turkson & Naandam, 2006). Similarly, the data show that more than three quarters (83.7%) of the farmers were married. The highest are from UWR (85.3%) followed by UER (72.5%) before NR (82.1%). This result implies that farmers

have extra family members (i.e., spouses and children) to contribute to household small ruminant management practices.

Table 5.1 Demographic Characteristics of Respondents

	Regions							
	Northern region		Upper East		Upper West		Overall	
	N	%	N	%	N	%	N	%
Gender of household head								
Male	125	82.8	65	80.2	60	88.2	250	83.3
Female	26	17.2	16	19.8	8	11.8	50	16.7
Formal Education								
Education0[a]	119	78.8	40	49.4	44	65.7	203	67.9
Education1	29	19.2	31	38.3	20	29.9	80	26.8
Education2	3	2.0	10	12.3	3	4.5	16	5.4
Access to formal credit								
Credit access1	17	11.3	9	11.1	2	2.9	28	9.3
Credit access0	134	88.7	72	88.9	66	97.1	272	90.7
Access to non-farm income								
Non-farm income1	62	41.1	48	59.3	26	38.2	136	45.3
Non-farm income0	89	58.9	33	40.7	42	61.8	164	54.7
Marital Status								
Married 1	124	82.1	69	85.2	58	85.3	251	83.7
Unmarried 0	27	17.9	12	14.8	10	14.7	49	16.3
Cooperative association								
Membership 1	20	13.2	8	9.9	5	7.4	33	11.0
Membership 0	131	86.8	73	90.1	63	92.6	267	89.0
Access to formal savings								
Savings access1	40	26.5	33	40.7	15	22.1	88	29.3
Savings access0	111	73.5	48	59.3	53	77.9	212	70.7
Access to extension education								
Extension access1	36	23.5	32	39.0	28	41.2	113	34.6
Extendion0	115	76.2	49	61.0	40	58.8	187	65.4

a) Continuous variables

Variables	Mean	Std[c]	Mean	Std	Mean	Std	Mean	std
Age	51.18[d]	13.8	51.6[d]	14.8	52.1[d]	16.8	51.5	14.8
Family size	12.0[d]	7.2	9.4[e]	8.8	10.0[f]	6.07	10.8	7.5
SMR_NUM	19.7[d]	14.1	16.4[d]	15.3	16.1[d]	15.7	17.9	14.9

[a]Refers to base category or omitted category in the analysis. Std denotes standard deviation while means with different superscripts are significant at 5% level.

In addition, it may explain the rationale behind the positive relationship between animal ownership and married farmers. The result is consistent with 72.5% of married small ruminant farmers reported by Fakoya & Oloruntoba (2009) in Osun-state, Nigeria

Education is relevant if farmers are to access and apply livestock technology appropriately (Marinda *et al.*, 2006). However, the data suggests a high illiteracy rate (67.9%) among small ruminant families for the three regions. The implication of this result is that farmers‘ ability to understand and apply livestock technology will be hindered by the limited educational background of the respondents. This therefore calls for more extension education to salvage the situation. Among the three regions, farmers that are more uneducated are reported for NR (78.8%) compared with UWR

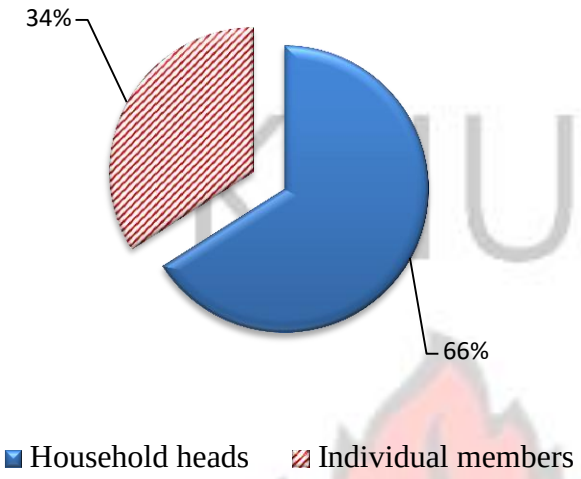
(67.7%) and the least is UER (49.4%). These results concur with findings from the GSS (2010) report where UER (69.9%) has the least uneducated adults before UWR (70.1%) and finally, NR (71.2%). However, the current study suggests that a substantial number of the surveyed respondents (45.3%) engage in non-farm economic activity with 41.1% from NR, 38.2% from UWR and 59.3% in UER. The implication of this result is that most small ruminant farmers have other sources of income to smoothen household consumption aside farming. This finding may have positive or negative implication for small ruminant production. On one hand, farmer‘s income from such secondary sources may be used to invest in small ruminant production. On the other hand, because livestock is labour-intensive year round activity, farmers, who are sustained by such non-farm activities, may have little time available for small ruminant production.

One important way to improve traditional livestock production is to link farmers to a relevant institution. Institutions such as agricultural extension services educate farmers on adoption of new technologies. However, the data reports that 59.0% of the farmers do not access extension education. Given the high illiteracy rates in the study area, farmers are forced to rely heavily on traditional methods of livestock rearing.

NR is the worst affected (65.2% without extension), before UER (61.0%) and lastly, UWR (58.8%). In addition, access to formal financial services is also limited across the regions. From the 300 farm households interviewed, a little above 11% access formal credit both from Northern and Upper East regions while less than 10% access such facility in the Upper West region. Similarly, access to savings account (bank) is limited in all the regions. The result is consistent with the assertion made by Binswanger and Rosenzweig (1986), Moll (2003) and Slingerland (2000). These authors conclude that in rural Africa, formal financial institutions are absent or inaccessible; hence, smallholder farmers use livestock as an alternative form of insurance and investment (financing) to cope with the vicissitudes of life. It is not surprising therefore that 83% (n=249) of the households manage one or more sheep, goat or both. In a related study, Quaye (2006) reports that 82.1% of farm households in northern Ghana manage sheep, goat and pigs to cope with food insecurity during long periods of drought. Among such farmers (i.e., farm households owning small ruminants), the result suggests that only about 34% (n=85) are individual family members (i.e., mainly adult children and female spouses) while majority representing 66% (n=165) are domestic unit heads (Figure 5.1). This finding implies that household level production decisions are made by household heads which is

consistent with existing culture in northern Ghana.

Figure 5.1 Distribution of Small Ruminant Ownership between Household Heads and Individual Family Members



The average family size of farmers is approximately 11 persons, which is higher than the 4 persons reported for the national level (GSS, 2012). There is a significant relationship for household size among farmers from NR (12) compared with both UER (9) and UWR (8). The high proportion of family size in northern Ghana is relevant for smallholder agriculture given that such agricultural system requires family labour to carry out farming activities. The mean age of farmers is 51.8 years, which is closely related to the 47.5 years reported by Duku *et al.* (2011) in the transitional zone of Ghana. Farmers' age across the three regions did not show significant relationship. The low mean age gives an indication of the presence of the youth in small ruminant production to carry out the drudgery activities involved in small ruminant production.

5.1.2 Farm Characteristics

5.1.2.1 Land Tenure and Farm Size

The primary source of farmland (75.5%) in the study area is through family/lineage /inheritance (Table 5.2). Only few farmers (18.1%) depend on communal lands for crop farming while purchase of land is negligible (1.2%). In support of this finding, Blench (2006) reported that land tenure system in northern Ghana is mainly based on lineage

and usually not offer for sale. Adolwine and Dudima (2010) also made similar observations in Sissala East district of Upper West region. This form of land acquisition leads to land security and as such, farmers may be motivated to take pragmatic land conservation practices and managements. During in-depth discussions with respondents, it is indicated that a larger proportion of the land is allocated to arable crop and tree farming. Allocation of land purposely for cultivation of fodder or forage crops for livestock production is non-existent. According to Ayalew et al.

(2013) and Karbo et al. (1999) only small amount of farm lands are allocated to forage compared with crop production largely due to increasing urbanization and population growth in sub-Sahara Africa. Hence, smallholder livestock producers depend on free communal lands or open range system for animal feeding.

Table 5.2 Farm Household Land Acquisition and Total Land Size (Acres)

	Regions							
	Northern		**Upper East**		**Upper West**		**Overall**	
	N	%	**N**	**%**	**N**	**%**	**N**	%
Land acquisition								
Lineage/family	91	75.8	53	74.6	44	75.9	188	75.5
Lease/sharing	5	4.2	1	1.4	0	0.0	6	24.4
Purchase	2	1.7	1	1.4	0	0.0	3	1.2
Free communal land	20	16.7	13	18.3	12	20.7	45	18.1
Do not own land	2	1.7	3	4.2	2	3.4	7	2.8
Total land holdings(acres)								
Land size	6.3±4.47[a]		3.55±3.33[b]		11.12±12.87[c]		6.69±7.75	

Note: Means across the rows with different superscripts (a, b and c) are significantly different at p< 0.05 level on one-way ANOVA test of means.

The average land holding per farmer in the study area is 6.69±7.75 acres. Among the three regions, a significant difference in average land holdings is reported (Table 5.2). Mean farmland holding in UWR is significantly higher than holdings in NR and UER. The observed disparities may be attributed to high human population in NR than UWR. Even though, UER is the least populated, land for crop production in the region

is limited (scarce) due to the presence of iron pans which hinders crops cultivation (Obeng, 2000). The other reason might be due to differences in land size among the three study areas (i.e.; NR occupies 29.5%, UWR, 7.7% and UER, 3.3% of the country's land size) (GSS, 2010). The mean total land holding (6.69±7.75 acres) reported in this study is slightly lower than 9.88 acres reported by Chamberlin (2007) for the three regions.

5.1.2.2 Crop Types and Use of Crop Residues

Major crop categories grown in the study area include cereals (42.6%) and leguminous crops (31.5%) and tuber crops (14.9%) (Table 5.3). The most important cereal crop grown is maize (53.4%), followed by millet (22.7%), before the rice (14.8%), sorghum (4.7%), and guinea corn (4.4%). The proportions of tuber crops in the study area are yam (78.2%), cassava (18.4%) and sweet potato (3.4%). Cassava is only grown in NR (23.8%) and UWR (18.4%) and not in UER. No farmer is reported to grow sweet potato in UER and UWR. The type of legume crops grown among the three regions is mixed. While the majority of the farmers from UWR (55.7%) and NR (52.0%) grow cowpea, nearly 60% from UER cultivated groundnuts. Other legume crops grown among the regions include groundnuts (45.2%) and soya beans (6.8%).

The findings of this study agree with the reports by Karbo and Agyare (1999) and Quaye (2003) in northern Ghana.

Table 5.3 Farm Households' Classification of Crops Grown

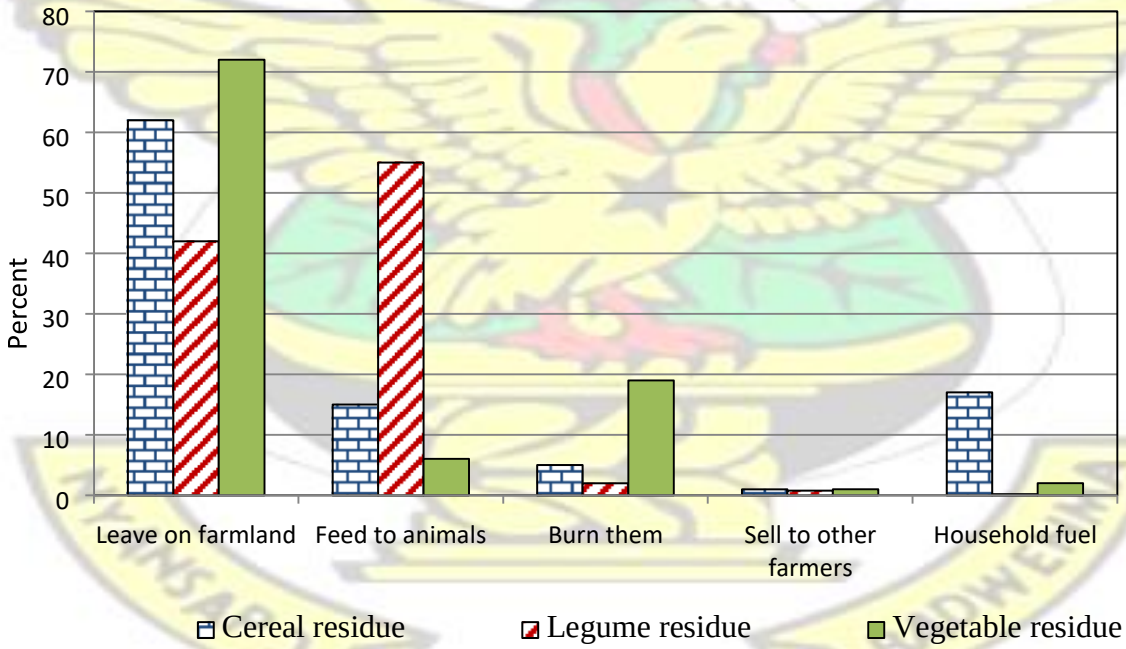
	Regions							
	Northern		**Upper East**		**Upper West**		**Overall**	
	N	%	**N**	**%**	**N**	**%**	**N**	%
Classification of crops grown								
Cereal crops	96	41.9	64	49.2	55	37.7	215	42.6
Tuber crops	35	15.3	13	10.0	27	36.0	75	14.9

Legume crops	269	30.1	41	31.5	49	33.6	159	31.5
Vegetable crops	24	10.5	11	23.4	12	25.5	47	9.3
Tree crops	4	1.7	1	0.8	3	2.1	8	1.6
Forage crops	1	0.4	0	0.0	0	0.0	1	0.2

**Respondents chose more than one category of crops hence the number of responses is greater than the sample size.*

Among the categories of crops grown, residues of leguminous crops (haulms) are mostly used to feed animals (Figure 5.2). The reason for this observation might be due to the nutritional importance of leguminous haulms in animal feed. The haulms of leguminous crops contain a high amount of nitrogen than most cereal straws. Hence, most farmers harvest and processed such haulms into hay to feed animals later in the long dry season.

Figure 5.2 Uses of Crop Residues by Farmers



5.1.2.3 Small Ruminant and Other Livestock Composition

In northern Ghana, the predominant farming system is mixed-farming (Blench, 2006; Karbo & Agyare, 1999). Livestock including small ruminants are raised as an adjunct

to crop farming. The major breeds in this area are the indigenous West African Dwarf or Djallonke breed (Oppong-Anane, 2006). Majority of the farmers (49.4%) raised sheep and goats together while 37.8% and 12.9% reared goat and sheep alone, respectively (Table 5.4). The distribution of small ruminant ownership is similar to the findings by Karbo *et al.* (2007) in UER. The high proportion of goats alone ownership compared with sheep is more profound in UWR (52.5%) and UER (37.1%) than NR (30.8%). The differences could be attributed to the adaptive nature and socio-cultural importance of goat in both UER and UWR than the Northern region. Studies (including, Lebbie, 2004; Peacock, 2005) suggest that goat adapt very well in arid regions and are tolerant to drought conditions than other livestock except camels.

Table 5.4 Small Ruminant Ownership and Other Livestock Composition

	Regions							
	Northern		**Upper East**		**Upper West**		**Overall**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Small ruminant ownership								
Sheep	21	17.5	5	7.1	6	10.2	32	12.9
Goat	37	30.8	26	37.1	31	52.5	94	37.8
Both sheep and goat	62	51.7	39	55.7	22	37.3	123	49.4
Small ruminant holdings	Mean±SD							
Sheep	13.06±8.82[a]		10.82±10.67[a]		11.64±9.98[a]		12.14±9.60	
Goat	13.04±9.91[a]		9.71±7.35[b]		12.38±9.98[a]		11.89±9.32	
Other livestock holdings								
Cattle	12.31±16.19[a]		8.50±7.71[a]		15.14±7.81[a]		11.42±12.88	
Donkey	2.00±0.00[a]		4.60±2.30[b]		2.00±0.00[a]		3.08±1.93	
Pigs	0.00±0.00[b]		3.50±2.12[a]		9.0±4.25[a]		6.25±4.19	
Poultry	15.19±10.13[a]		18.56±16.64[a]		18.38±16.34[a]		16.93±13.87	

Means across the rows with different superscripts are significantly different at 5% the level of significance (rejection of null-hypothesis), SD=standard deviation

The mean size of sheep holdings (12) is similar across the three regions. However, a significant difference is reported for goat holdings (12). NR has the highest number of goat‘s holdings (13), followed by UWR (12), and the least being UER (10). In this

current study, the holdings of sheep and goats per farmer are lower than the 26 sheep and 22 goats reported by Turkson & Naandam (2006) in East Mamprusi of northern Ghana.

Other livestock animals owned by the respondents include cattle (11) and poultry (17), donkeys (3) and pigs (6). Predictably, no farmer from NR is said to own pig. This observation supports the fact that Muslims dominate in NR and hence the prohibition of pig rearing in Islamic religion and communities.

5.1.2.4 Small Ruminant Production Systems among the Three Regions

Illustrated in Table 5.5 are the proportions of small ruminant productions systems practice in northern Ghana. The result shows that both sheep and goat livestock are primarily reared under the free range and extensive production systems. The practice of intensive and intensive system is limited in the study area. Turkson and Naandam (2006) also report similar production systems in Mamprusi of Northern region. Consistent with literature, this finding implies that smallholder farmers do not required land before venturing into small ruminant business. In addition, systematic study into such production system is difficult since the animals are allowed to roam freely and scavenge for food and water while exposing them diseases and pest attacks.

Table 5.5 Proportions of Sheep and Goat Production Systems among Three Regions of Northern Ghana

Component	Regions			
	Northern	**Upper East**	**Upper West**	**Overall**
Sheep production systems				
Free range (no shepherd)	42.3	75.0	60.0	**52.3**
Extensive system (with shepherd)	34.6	25.0	40.0	**34.1**
Semi-intensive (tethering of animals)	11.5	0.0	0.0	**6.8**
Zero grazing (cut and carry system)	11.5	0.0	0.0	**6.8**
Intensive system (commercial system)	0.0	0.0	0.0	**0.0**
Goat production systems				

Free range (no shepherd)	61.0	57.1	86.7	**67.7**
Extensive system (with shepherd)	24.4	25.0	13.3	**21.2**
Semi-intensive (tethering of animals)	12.2	17.9	0.0	**10.1**
Zero grazing (cut and carry system)	2.4	0.0	0.0	**1.0**
Intensive system (commercial system)	0.0	0.0	0.0	**0.0**

5.2 Factors Determining Investment Decision and Type of Livestock in Small Ruminant Production

5.2.1 Determinants of Decision to Own Small Ruminant Livestock

The Poisson Regression (PR) and the Negative Binomial (NB) regression parameter estimates based on household-heads' socio-economic and institutional characteristics are summarised in Table 5.6. Comparing the sample mean 15 of the response variable (number of small ruminants managed) with its sample variance 228, the data suggests a case of over-dispersion.

Table 5.6 Poisson Regression Model Results of Household Head's Small Ruminant Livestock Production Decisions

	--------Poisson Regression ----			------Negative Binomial Regression --		
Variable	Coefficient (β)	SE of β	Z-test	Coefficient (β)	SE of β	Z-test
Household status	-0.0092*	0.0016	-1.74	-0.0034	0.0051	-0.67
Non-farm inc.	0.2255***	0.0309	7.35	0.2309**	0.1053	2.19
Age	0.0048***	0.0011	4.58	0.0067**	0.0034	2.00
Gender	-0.0917**	0.4368	-2.22	-0.1556	0.1456	-1.07
Household size	0.0333***	0.0016	20.57	0.0334***	0.0054	6.19
Extension access	0.5622***	0.0314	17.90	0.7618***	0.1065	7.15
Constant	1.8396***	0.0714	25.75	1.6992***	0.2364	7.19
Goodness of Fit and Model Performance Statistics						
Number of observations		300				300
LR chi-square		774.96***				80***
Pseudo R^2		0.142				0.0364
Log likelihood		-2343.5				-1059.85
Delta (Δ)				15.86***	1.75	8.96

****denotes significance at 1%; ** significant at 5%;* significant at 10%. Stata 12.0 reports only one Pseudo R^2*

The value for the estimated dispersion parameter from the NB model is positive confirming over-dispersion of the data. The NB model suggests a dispersion parameter

(Δ) which is treated as varying rather than fixed parameter (α), hence resulting in smaller confidence intervals and a more precise estimate (see, Geedipally and Lord, 2008). The coefficient for testing the null hypothesis (H_o) is approximately 15.86 and it is significant at 1% level. The log-likelihood values for the PR model is 2343.5 and the NB is -1059.9, which justifies the view that modeling over-dispersed data through the NB model is better than the PR model. Consequently, the marginal effects of the NB regression are presented in Table 5.7 to determine the magnitude of impact of the estimated variables.

Three variables including education level, access to formal credit and formal savings account are not included in the final model. This is because the survey sample has few observations for these variables, hence cannot be used for any meaningful analysis and conclusions regarding household's decision to raise small ruminant livestock. However, all the remaining variables (household status gender, age, household size, non-farm income and extension access) from the PR model and four variables (age, household size, non-farm income and extension access) from the NB model are significant and can be described as determinants of sheep and goat production based on household heads' characteristics. From the NB, the coefficient of household status is negative and insignificant at 5% level. This suggests that the status of family members do not affect decision to own small ruminants in the family and as such, only one regression analysis is presented based on household head characteristics. Consequently, the socioeconomic and institutional factors that explain farmers' decision to raise sheep and goat in northern Ghana are discussed as follows.

Table 5.7 Marginal Effects of the Negative Binomial Regression of Household Head's Small Ruminant Livestock Production Decisions

	--------Negative Binomial Regression ----		
Variable	Marginal effect[1] (β)	SE of β	Z-test
Household status	-0.1007	0.0509	1.99

Non-farm inc.	3.4257**	1.5770	2.17
Age	0.1005**	0.0508	1.98
Gender	-2.307	2.1643	-1.07
Household size	0.4966***	0.0859	5.78
Extension access	11.302***	1.7282	6.54

*Note: [1] denotes (dy/dx) calculated at the mean of the explanatory variable; where y = animal count and x = explanatory variable; ***denotes significance at 1%; ** significant at 5%;* significant at 10%.*

First, the regression analysis supports the hypothesis that the probability of a household's decision to raise small ruminant is higher for households who generate non-farm income. The result suggests that households with non-farm incomes are more likely to manage one or more sheep, goat or both than households without nonfarm income sources. This result is consistent with Duku *et al.* (2011) who report that the decision to manage one or more sheep, goat or both is positively related to economic options available to that household. This is true because, the current study finds that 59% of households who do not own small ruminants report insufficient capital/money to purchase stock, veterinary drugs and other livestock inputs as prime factors for not engaging in small ruminant production.

In addition, the hypothesis that the probability of managing one or more sheep and goat in northern Ghana increases with age of farm household heads is not rejected by the data analysed. The result suggests that older household heads are more likely to manage one or more small ruminants than their younger household head counterparts. This result is consistent with the findings of Fakoya and Oluruntoba (2009) in Nigeria who reports that older farmers have higher likelihood of managing small ruminants. This is because such farmers tend to be more experienced in farming and are more likely to have better knowledge of livestock husbandry than younger ones.

The study also supports the hypothesis that the probability of managing sheep and goat in northern Ghana is higher for households with larger family size. The finding

suggests that farm households with larger family size are likely to venture into sheep and goat business because such households will have extra labour to manage the animals. This is true especially for northern Ghana where the animals are mostly kept on free range or semi-intensive systems. Under such system, children or adult family members are responsible for shepherding and tethering of livestock especially in cropping seasons to avoid injuries crops. The size of the family becomes more important in decision to keep sheep and goat due to competing demand of labour for both crop farming and caring for animals. In support of this finding, Inoni *et al.* (2007) report a significant positive relationship between farm household size and the flock size of sheep, goat or both raised by smallholder households in Nigeria.

Finally, the hypothesis that the probability of managing sheep, goat or both in northern Ghana is higher for household heads with access to extension service than those without access is not rejected by the surveyed data. The result suggests that household heads with access to extension service are more likely to own and manage more small ruminants than households without access to extension service. Oluwatayo and Oluwatayo (2012) in northern Nigeria also report a positive relationship between smallholder farmers‘ access to extension and the decision to own one or more sheep, goat or both. It is worth noting that the finding of this study could be partly explained by the current livestock intervention projects undertaken by the government (Livestock Development Project). Under the project, many smallholder farmers were given sheep and goat on credit-in-kind basis in addition to routine extension education on animal husbandry practices.

In general, the study suggests that in increasing order of magnitude, access to extension service (11.30) has the highest marginal effect on the probability of a farm household to raise small ruminant livestock. This is closely followed by non-farm income sources (4.43), household size (0.497) and lastly, age of household heads

(0.101). It can therefore be argued that improving farmers‘ access to agricultural institutions particularly extension services offers the highest likelihood (marginal effect) of a rural farm households‘ decision to own and raise more small ruminants in northern Ghana.

5.2.2 Determinants of the Choice of Small Ruminant Type

5.2.2.1 Multinomial Logistic Regression

The parameters of the Multinomial Logit (MNL) regression model used to determine ownership of particular small ruminant species (sheep, goat and joint sheep and goat) among small ruminant farm holders are presented in Table 5.8. There are two sets of parameters indicating two binary comparisons made among the three categories of the small ruminant livestock managed by farm families. In both cases (binary comparisons), the estimated coefficients are compared with the reference category of goat production. Goat ownership is chosen as the base category because it is the dominant small ruminant species managed in northern Ghana. The LR chisquare test of the model significance suggests 1% significance level. Two variables including agro-ecological zone and sheep risk perception are significant at 1% and 5% level, respectively in the _decision to raise sheep alone logit‘. However, all the variables in the _decision to raise joint-sheep and -goat‘ logit are significant at 10% level.

The suitability of the multinomial logit model is compared with binomial logistic regression (Table 5.9) used in previous studies to estimate farmers‘ choice of type of livestock type in small ruminant production. The LR test for the binary logistic is significant at 1% level (Table 5.9). In addition, the basic assumption for logistic regression model is performed (linktest command in stata) to test whether the conditional probabilities (residuals or predicted values) exhibit logistic distribution and

establish whether the model is appropriate for the data. The result of the linktest suggests that using the logit regression rather than the probit model for the data is justifiable.

The coefficient, 1.051 of the predicted values is significant at 1% which implies the model is correctly specified. However, the coefficient -0.127 of the square predicted values is insignificant which justifies that the conditional probabilities exhibit logistic function of the independent variables. Thus the probit model is rejected in favour of the logistic model (see UCLA, 2015).

Table 5.8 Multinomial Logit Results of Household Decision to Manage Small Ruminant Livestock Type [1]

Variable	-------Raise joint-sheep and goat--			---------Raise sheep alone -----		
	Coefficient (β)	RSE of β	Z-Test	Coefficient (β)	RSE Of β	Z-Test
AGZone (1=Sudan, 0=otherwise)	-0.587**	0.298	-1.97	-1.187***	0.437	-2.71
Gender (1=male, 0=female)	0.637*	0.384	1.66	0.211	0.532	0.40
RISP (1=sheep riskier, 0=otherwise)	-1.474***	0.369	-3.89	-1.263**	0.501	-2.52
BENP (1=sheep profitable, 0=otherwise)	-1.132**	0.549	-2.06	-0.864	0.745	-1.16
Constant	2.752***	0.861	3.20	2.282**	1.137	2.01
Goodness of Fit and Model Performance Statistics						
Number of Observations	249					
LR chi-square	37.81***					
Log-likelihood ratio	-225.07					
Pseudo R^2	0.078					

***denotes significance at 1%; ** significant at 5%;* significant at 10%. [1]Base outcome is ―raise goat alone‖

Table 5.9 Binary Logistic Results of Household Decision to Manage Particular Small Ruminant Livestock Type

Variable	----Raised joint-sheep and goat----		
	Coefficient (β)	RSE of β	Z-Test
AGZone (1=Sudan, 0=otherwise)	-0.238	0.266	-0.90
Gender (1=male, 0=female)	0.619*	0.358	1.73
RISP (1=sheep riskier, 0=otherwise)	-0.948***	0.302	-3.14
BENP (1=sheep profitable, 0=otherwise)	-0.740*	0.440	-1.68
Constant	1.189*	0.704	1.69

Goodness of Fit and Model Performance Statistics	
Number of Observations	249
LR chi-square	21.18***
Log-likelihood ratio	-162.00
Pseudo R^2	0.0614

***denotes significance at 1%; ** significant at 5%;* significant at 10%. [1]Base outcome is ―raise goat alone‖

The signs of all variables in the two MNL logits and the binary logistic model are the same. However, only risk perception is significant for both MNL and binary logistic models. Gender is significant in the binary logistic model which implies that gender is an important factor in farmers‘ decision to raise joint-sheep and –goat livestock. However, gender is significant only in one logit (raise joint-sheep and – goat) of the MNL regression. This suggests that gender is a determinant factor for farmer‘s decision to own joint-sheep and goat and not for decision to raise particular small ruminant species (i.e., sheep or goat alone). The significance pattern of profit perception is the same as that of gender. The significance of profit perception in logit of the binary logistic regression (raise joint-sheep and –goat) implies that farmers who perceived sheep production as riskier have a lower probability to raise both sheep and goat together compared with one species alone. The insignificant parameter of sheep profit perception in _raise sheep alone‘ logit of MNL regression, other hand, shows that not all farmers that are included in the decision to raise joint-sheep and –goat category in binary logistic model have a lower probability to raise both sheep and goat together. Similarly, agro-ecological zone is significant in logits of the multinomial regression model, but not in binary logistic regression. That is, agro-ecological zone is an important determinant of farmers‘ decision to raise joint-sheep and –goat compared with goat alone (base category) and decision to raise sheep alone versus goat alone. Such information is missing from the binary logistic model. These differences clearly demonstrate that the variation in the significance of variables across the three small ruminant ownership categories (i.e., joint-sheep and –goat, sheep alone and goat alone) is suppressed in the binary logistic model. Hence, the multinomial logistic model is used to explain farm households‘ decision to raise particular small ruminant species in

northern Ghana. The marginal effects of the variables from the MNL are presented in Table 5.10.

Table 5.10 Marginal Effects of the Multinomial of Households' Decision to Manage Particular Small Ruminant Livestock Type

Variable	----------Raise sheep alone------ Marginal effects[1]	RSE of β	Z-test	--------Raise joint sheep and goat------ Marginal effects[1]	RSE of β	z-test
AGzone	-0.066	0.066	-1.00	-0.095*	0.043	-2.20
Gender	0.144*	0.081	1.66	0.016	0.060	0.26
RISP	-0.246***	0.068	-3.61	-0.037*	0.050	0.73
BENP	-0.200*	0.096	-2.09	-0.009	0.070	-0.14

*Note: [1] denotes (dy/dx) calculated at the mean of the explanatory variable; where y = animal count and x = explanatory variable; ***denotes significance at 1%; ** significant at 5%;* significant at 10%.*

The coefficient of agro-ecological zone is negative and significant in both logits of the MNL models. The results suggest that the odds in favour of a farmer in Sudan savannah zone to own both sheep and goat in relation to goat alone is 0.56 (odds=e^{β}) times lower than the odds of a farmer in Guinea savannah to manage both sheep and goat compared with goat alone, all other factors held constant. The result implies farmers in Guinea savannah are more likely to own both sheep and goat animals together, compared with farmers in Sudan savannah agro-ecological zone. Perhaps, goat's ability to strive well in various climatic and vegetative conditions, including humid and drier conditions allows farmers in Guinea savannah to manage goat in addition to sheep livestock species (Wilson 1991). The data also indicates that the odds in favour of a farm household in Sudan savannah agro-ecological zone to raise sheep compared with goat alone is 0.31 (odds=e^{β}) times lower than the odds of a farm family in Guinea savannah to raise sheep alone compared with goat, all other factors held constant. This indicates that households in Sudan savannah agro-ecological zone are more inclined towards goat production compared with farm households in Guinea savannah zone. The data is consistent with Peacock (2005) who reports that households

in very arid environments of Ethiopia are increasingly relying on goat production as compared with other livestock including sheep due to the high frequency of droughts in the area.

The hypothesis that women are more inclined to managing goat than men is not supported by the surveyed data from the second logit of the MNL regression. However, the odds ratio 1.9 (odds=e^{β}) in the first logit (joint-sheep and -goat ownership) is significant at the 10% level. The result suggests that males compared with female farmers have a higher affinity to raise both sheep and goat compared with goat alone. In other words, women, unlike men are more likely to manage only goat than both sheep and goat animals. In support of this finding, Dossa *et al.* (2008) in southern Benin report that female farmers are more inclined to raising goat alone compared with other livestock species.

The surveyed data did not reject the assertion that the risk associated with each small ruminant livestock affects household's decision to manage such particular animal. The odds in favour of farm households with higher sheep risk attributes to rear joint-sheep and -goat compared with goat alone is 0.23 (odds=e^{β}) times lower in relation to farmers with lower sheep risk perception, all other factors held constant. The result indicates that farmers who perceived sheep production as riskier are more likely to own and raise joint-sheep and goat livestock. More so, the findings suggest that those farm households (with high sheep risk perception) are more likely to rear goat alone (odds ratio=0.28). It appears that the majority of the households prefer to manage goat livestock as a way of minimising risks associated with sheep production. Hence, this might explain the high goat population and spatial distribution across subSahara African countries. During in-depth interviews with the survey respondents, it is noted that sheep production is riskier due to the frequent missing nature (i.e., easily stolen or killed by

predators), high death rates and easy susceptibility to diseases and pests attacks. On the other hand, goat is more prolific in producing offspring, that is, twice or more kids per birth compared with one lamb per birth for sheep.

The coefficient of profit perception is significant for the first logit of the MNL regression analysis. The finding suggests that farm households with higher sheep benefit attributes are less likely to own and manage joint-sheep and -goat compared with goat alone (odds ratio = 0.32). Even though, the income return per unit sheep animal is higher than goat (Upton, 1985), the higher risk associated with sheep production and the fact that goat has higher fecundity appears to explain the rationale behind farm households‘ choice of raising goat alone compared with both animals.

Key findings from the determinants of small ruminant livestock production are summarised as follows. First, the majority of the small ruminant farmers is household heads rather than individual members. Hence, only data on household heads are used as in the Negative Binomial and the Multinomial logit models. Second, the Negative Binomial suggests that the main determinants of the farmer‘s decision to keep small ruminant livestock include that non-farm income (socioeconomic attributes), age and household size (demographic factors), and extension support (institutional variables) are significant determinants of small ruminant production (Negative Binomial model). On the other hand, the results from the multinomial logit also suggest that agroecological zone, risk attitude and income associated with small ruminant production are significant determinants of the likelihood that households will own and manage particular small ruminant species (i.e., sheep or goat).

5.3 Socio-economic Value of Small Ruminant Production

This section summaries the various costs and benefits from traditional small ruminant production system. The cost component accounts for both cash and non-cash costs for

rearing sheep and goat livestock. On the other hand, the benefits consist of gross value (non-market and market physical products) and non-market socioeconomic benefits of sheep and goat livestock.

5.3.1 Annual Costs

The traditional small ruminant production system depends on low-input demand where labour and land assume a negligible role (Turkson and Naandam, 2006). The animals are allowed to roam freely to scavenge for food and water without labour for shepherding. Where labour is required, children are reported to be responsible for small ruminant herding (Mahabile and Panin, 2005). Households with no or insufficient number of children tethered animals immediately around the homestead. Hiring of external labour purposely for sheep and goat herding is non-existent in the current study. Hence, estimating herding cost directly in monetary terms is difficult. Thus, smallholder farmers spend less effort on small ruminant husbandry and there is little or no purchase of external inputs except the capital invested in the animals. The study shows that not only are the total value of cash costs incurred for both sheep and goat production very small, but also the costs are not significant among the three northern regions (Table 5.11 and Table 5.12). For sheep production, farm households in Northern region spend Gh₵34.97 yearly on the purchase of external inputs for an average sheep size of 13 animals (Table 5.11). In Upper East and West regions, the annual cost of external purchased inputs is Gh₵45.9 and Gh₵30.36 per household, respectively. Likewise, farm households who raise goat livestock spend Gh₵32.7 for the purchase of external inputs in Northern region (Table 5.12). In addition, farmers in Upper East region incur Gh₵37.3 while farm families in Upper West region spend Gh₵28.51 on external inputs for goat livestock.

Table 5.11 Annual Cash and Non-cash Costs (Ghana Cedis) For Sheep Production per Household Holdings, by Three Regions of Northern Ghana

Component	Regions			
	Northern	**Upper East**	**Upper West**	**Overall**
Average stock	13[a]	11[a]	12[a]	12
Cash cost				
Veterinary service	15.03[a]	15.46[a]	19.38[a]	15.98
Medicine/drugs	6.67[a]	7.65[a]	3.61[a]	6.36
Fencing/housing	8.86[a]	14.04[a]	4.38[a]	9.46
Dipping	1.48[a]	2.77[a]	0.00[a]	1.56
Feed supplements	2.93[a]	5.45[a]	3.00[a]	3.66
Total per household	**34.97[a]**	**45.90[a]**	**30.36[a]**	**37.16**
Total per sheep	**2.70[a]**	**4.20[a]**	**2.50[a]**	**3.10**
Non-cash cost				
Lambs 0-12 months	54.84[a]	37.43[a]	21.00[a]	43.56
Ewes	70.83[a]	82.17[b]	130.67[c]	85.31
Rams	85.02[a]	88.24[b]	184.80[c]	104.53
Total per household	**210.69[a]**	**207.84[a]**	**336.47[a]**	**233.40**
Total per sheep	**16.2[a]**	**18.9[a]**	**28.0[a]**	**19.5**

Note: Means across the rows with different superscripts (a, b and c) are significantly different at p< 0.05 level on one-way ANOVA test of means. Exchange rate: US$1 is equivalent to GhȻ1.9

Table 5.12 Annual Cash and Non-cash Costs (Ghana Cedis) For Goat Production per Household Holdings, By Three Regions of Northern Ghana

Component	Regions			
	Northern	**Upper East**	**Upper West**	**Overall**
Average flock	13[a]	10[a]	12[a]	12
Cash cost				
Veterinary service	12.08[a]	16.02[a]	12.40[a]	13.2
Medicine/drugs	9.19[a]	6.35[a]	5.75[a]	7.51
Fencing/housing	4.59[a]	8.80[a]	8.24[a]	6.73
Dipping	1.70[a]	2.49[a]	0.93[a]	1.75
Feed supplements	6.11[a]	3.65[a]	1.54[a]	4.26
Total per household	**32.7[a]**	**37.31[a]**	**28.85[a]**	**33.12**
Total per animal	**2.52[a]**	**3.73[a]**	**2.4[a]**	**2.76**
Non-cash cost				
Kids 0-12 months	27.80[a]	13.85[a]	34.04[a]	25.25
Does	56.65[a]	61.47[a]	82.47[a]	64.46
Bucks	49.08[a]	55.71[a]	76.04[a]	57.54
Total per household	**133.53[a]**	**131.03[b]**	**192.55[c]**	**147.25**
Total per animal	**10.25[a]**	**13.10[b]**	**16.05[c]**	**12.27**

Note: Means across the rows with different superscripts (a, b and c) are significantly different at p< 0.05 level on one-way ANOVA test of means. Exchange rate: US$1 is equivalent to GhȻ1.9

The insignificant differences in the annual costs of external inputs per household among the three regions may be attributed to the traditional free range or extensive system of livestock production in northern Ghana. Even though, the mean costs are not significant among the regions, it appears that farm households in Upper East and

Northern regions spend more money on purchased inputs particularly veterinary services, feed supplements and drugs/medicine compared with farmers in Upper West region. As a result, farmers in Upper East (Gh₵131.03) and Northern regions (Gh₵133.53) incur less annual non-cash cost (monetary value) of animal theft and mortality compared with Upper West region (Gh₵192.55) for goat livestock. There is, therefore, some evidence to support the assertion that an improvement in basic animal health care and nutrition will lead to more efficient meat production of the traditional small ruminant system. Reasons for such losses in three regions are summarised in Table 5.13. These reasons are comparable with results from Karbo *et al.* (2007) in Upper East Region, Dei *et al.* (2010) in the Northern Region and Baah *et al.* (2012) in the Ashanti Region of Ghana.

Table 5.13 Reasons for Level of Non-Cash Costs in Sheep and Goat Production, By Three Regions of Northern of Ghana

	Proportions of Households Reporting:			
Reasons	**Northern**	**Upper East**	**Upper West**	**Overall**
Sheep production				
Diseases and pests attack	51.3	50.0	53.1	**51.3**
Starvation or hunger	3.5	2.0	3.1	**3.1**
Accidents (car, motorbike)	11.5	16.0	0.0	**10.8**
Predators (snake bites, etc)	6.2	8.0	15.6	**8.2**
Theft	24.8	22.0	28.1	**24.6**
Chewing of plastic materials	2.7	2.0	0.0	**2.1**
Goat production				
Diseases and pests attack	51.3	50.0	53.1	**51.3**
Starvation or hunger	3.5	2.0	3.1	**3.1**
Accidents (car, motorbike)	11.5	16.0	0.0	**10.8**
Predators (snake bites, etc)	6.2	8.0	15.6	**8.2**
Theft	24.8	22.0	28.1	**24.6**
Chewing of plastic materials	2.7	2.0	0.0	**2.1**

5.3.2 Gross Value of Sheep and Goat Livestock (Physical Products)

Illustrated in Table 5.14 and Table 5.15 are the gross values of sheep and goat, respectively among the three northern regions. The significant difference in gross value for sheep production among the three study areas is due to higher non-market products

in Upper East and market benefits in Northern region. Similarly, the difference in goat's gross value is attributed to higher meat produced in Northern region and non-market products in both Upper East and Upper West regions.

Table 5.14 Gross Value of Sheep Livestock (Gh₵) Per Household Holdings, By Three Regions of Northern Ghana

Component	Regions			
	Northern	Upper East	Upper West	Overall
Average sheep flock	13a	11a	12a	12
Physical products				
Non-marketed products Meat consumed at home	111.80 a	195.13b	56.40c	**124.49**
Manure	0.01a	0.01a	0.01a	**0.01**
Hide	7.51a	6.58a	7.57a	**7.22**
In-kind	29.54a	82.1b	9.36c	**39.73**
Sub-totals (A)	**148.86a**	**283.82b**	**73.34c**	**171.45**
Marketed products Meat	540.55a	346.02b	385.53c	**459.45**
Less non-cash cost (death/losses)	210.69a	207.84a	336.47a	**233.40**
Less cash cost	34.97a	45.90a	30.36a	**37.16**
Sub-totals (B)	**294.89a**	**92.28b**	**18.7c**	**188.89**
Gross Value (A+B)	**443.75a**	**376.10b**	**92.04c**	**360.34**

Note: Means across the rows with different superscripts (a, b and c) are significantly different at p< 0.05 level on one-way ANOVA test of means. Exchange rate: US$1 is equivalent to Gh₵1.9

Table 5.15 Gross Value of Goat Livestock (Gh₵) Per Household Holdings, By Three Regions of Northern Ghana

Component	Regions			
	Northern	Upper East	Upper West	Overall
Average goat flock	13a	10a	12a	**12**
Physical products				
Non-marketed products Meat consumed at home	69.14a	95.34b	70.42c	**72.30**
Manure	0.01	0.01	0.01	**0.01**
Hide	-	-	-	**-**
In-kind	21.61a	41.68a	32.61a	**30.05**
Sub-totals (A)	**90.76a**	**137.03b**	**103.04c**	**102.36**
Marketed products Meat	274.11a	168.91b	183.74c	**218.89**
Less non-cash cost (death/losses)	133.53a	131.03b	192.55c	**147.25**

Less cash costs	32.70[a]	37.31[a]	28.85[a]	**33.12**
Sub-totals (B)	**107.88[a]**	**0.57[b]**	**-37.66[c]**	**38.52**
Gross Value	**198.64[a]**	**137.60[b]**	**65.38[c]**	**140.88**

Note: Means across the rows with different superscripts (a, b and c) are significantly different at p< 0.05 level on one-way ANOVA test of means. Exchange rate: US$1 is equivalent to GhȻ1.9

For both sheep and goat livestock, the proportion of market products forms substantial 66.5% and 54.3%, respectively in Northern region (Figure 5.3 and Figure 5.4). This higher meat production in NR is partly due to the greater value of sheep animals sold and the increase in stock size through births (kids and lambs). However, such sheep and goat market contributions are lower for the two remaining regions. In fact, the market contribution of goat's products is negative (-57.6%) for households in Upper West regions due to high non-cash costs of mortality and theft in the region.

Figure 5.3 Contributions of Market and Non-Market Physical Products to Gross Value for Sheep Production

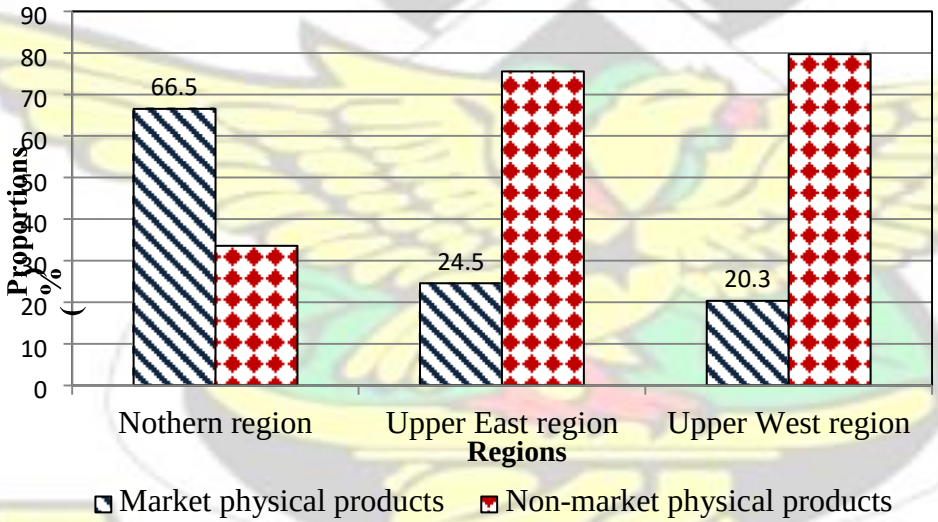
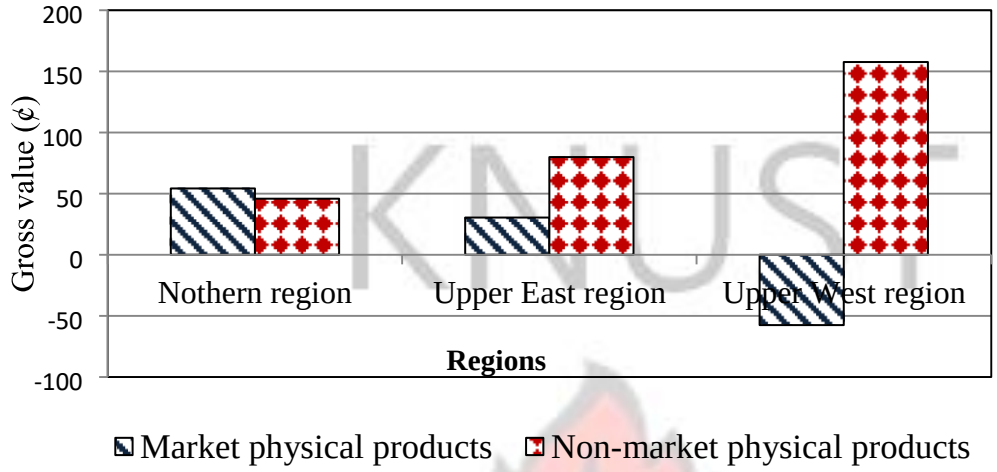


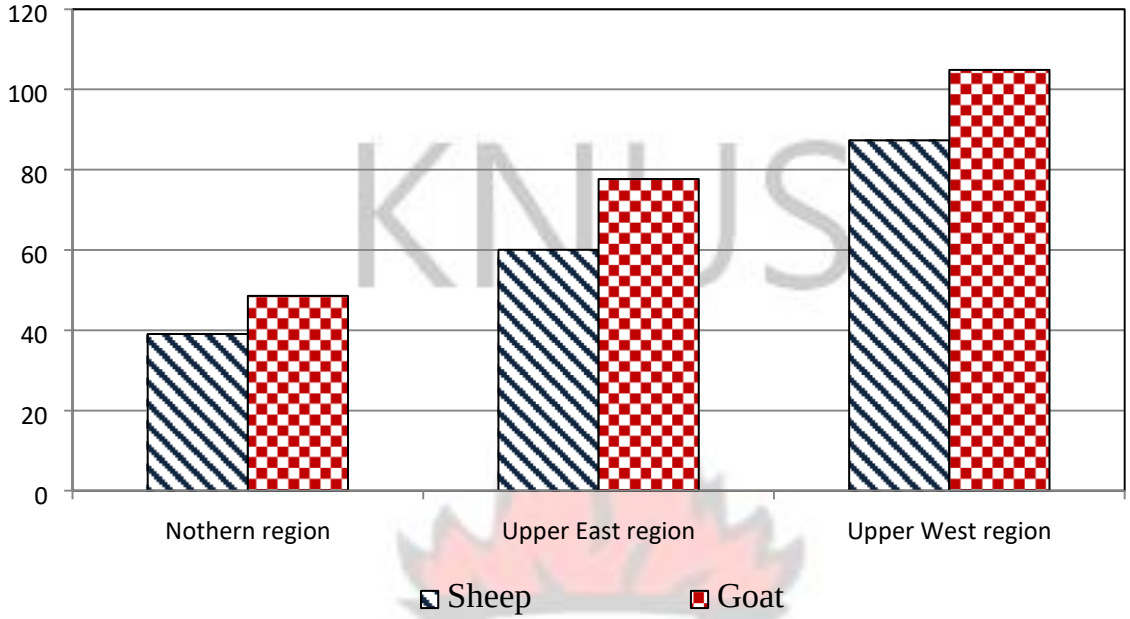
Figure 5.4 Contributions of Market and Non-Market Physical Products to Gross Value for Goat Production



Even though, sheep and goat sales rate are lower in both UER and UWR, the regions are compensated by higher values of sheep livestock given out in kind to improve social relationships, especially in UER. In addition, a higher value of both animals is slaughtered to improve household nutrition in UER and UWR compared with NR.

However, the data show that farmers in UWR and UER, respectively lost more than 104% and 77% of goat's gross value in the form of animal death and theft. With respect to sheep gross value, UWR lost 87% while UER lost 60%. On the other hand, less than 48% and 39% of the gross value from goat and sheep, respectively are lost in NR (Figure 5.5). Ayalew *et al.* (2003) reports similar findings in Ethiopia. Such a high loss rate can be attributed to the traditional free range system practiced by households in the study area.

Figure 5.5 Proportions of Sheep and Goat Gross Value Lost Due To Non-cash Cost of Mortality and Theft by Three Regions in Northern Ghana



The high relative contribution of non-market physical products to gross value in both UWR (i.e., 79.9% for sheep and 157.6% of goat) and UER (i.e., 75.5% for sheep and 79.9% goat) compared with NR (i.e., 33.5% for sheep and 45.7% goat) reveals the comparative importance of small ruminants towards household smallholder needs (shown in Figure 5.3 and Figure 5.4). The individual products are either consumed or transferred (in-kind) with a small fraction marketed especially in Upper West and East regions. Despite the insignificant contribution of manure to the total physical products (gross value), the evaluation provides a real practical methodology that can be adapted and applied to other large livestock, such as cattle where smallholder households frequently use manure as an alternative to inorganic fertilizer. In a study for Upper East Region of northern Ghana, Karbo *et al.* (1999) observe that sheep and goat manure is also appropriate for promoting early growth in millet and sorghum. Thus, strategies to improve small ruminant manure harvesting are desirable to increase crop production in northern Ghana.

5.3.3 Other Benefits of Sheep and Goat Livestock

Generally, smallholder farmers' access to formal credit is low (16% of households had credit access). In addition, saving with formal financial institutions is not enticing (29.3% of households had savings account) due to high transaction cost and inflation. Despite such low credit and savings patronage by households, there are few microfinance and rural bank institutions in some of the study areas offering credit at average interest rates of 20% per annum during the study period. Given that informal credit markets (finance) are highly variable in rural Africa (Ayalew *et al.*, 2003) and offers limited scope for direct comparison (Bosman *et al.*, 1996), the benefit from financing is estimated using the interest rates offered by micro-finance and rural bank institutions in the study areas. Thus, the benefits of sheep for financing B_f, (total outflow x interest rate) yield Gh₵90.82 in NR compared with Gh₵79.97 in UER and 59.89 in Upper West region. Similarly, the financing contributions of goat livestock are Gh₵37.48 in NR and Gh₵35.05 and Gh₵28.87, respectively in Upper East and Upper West regions (Table 5.16).

Further studies on informal insurance suggests that data on insurance premiums is scanty from literature, thus the proportion of 8% reported by (Karlan *et al.*, 2012) is adopted to be the benefit factor for insurance. The annual insurance benefit of sheep production ((average value of the flock-market sales) x benefit factor) is lower for NR (Gh₵55.70) compared with UER (Gh₵61.16) and UWR (Gh₵57.21) per household. Even though the insurance benefit for goat livestock among the three zones is not significant, higher values are reported for UER (Gh₵33.1) and UWR (Gh₵37.89) compared with NR (Gh₵32.19).

Table 5.16 Other Benefits of Sheep and Goat Livestock in cedis Per Household, By Three Regions of Northern Ghana

Component	Regions			
	Northern	Upper East	Upper West	Overall
Socio-economic products of Sheep production				
Insurance	55.70[a]	61.16[b]	57.21[c]	**57.21**
Financing	90.82[a]	79.97[b]	59.89[c]	**81.98**
Total (C)	**146.52[a]**	**141.13[b]**	**117.10[c]**	**139.19**
Socio-economic products of Goat production				
Insurance	32.42[a]	33.16[a]	37.89[a]	**36.92**
Financing	37.48[a]	35.05[a]	28.87[a]	**34.08**
Total (C)	**75.90[a]**	**68.21[a]**	**66.76[a]**	**71.00**

Note: Means across the rows with different superscripts (a, b and c) are significantly different at p< 0.05 level on one-way ANOVA test of means. Exchange rate: US$1 is equivalent to Gh₵1.9

The socio-economic products of sheep represent Gh₵146.52 in NR while Gh₵141.13 and Gh₵117.10 are reported for UER and UWR, respectively. The difference among the regions is significant and may be partly due to larger herd size per household and higher sales in Northern region. Similarly, the socio-economic benefit of goat production is higher for NR (75.90) before UER (68.21) and finally UWR (66.76).

5.3.4 Total Net Benefits of Sheep and Goat Livestock

The total net benefits for sheep and goat livestock consist of the total sum of nonmarket physical products, market products and socioeconomic products (Table 5.17 and Table 5.18). The sum of non-market physical and socioeconomic products constitutes the non-market component of the total benefit of sheep and goat production.

Table 5.17 Total Net Benefits of Sheep Livestock (Gh₵) per Household, By Three Regions of Northern Ghana

Component	Regions			
	Northern	Upper East	Upper West	Overall
Sheep Livestock				
Non-market physical products (A)	**148.86[a]**	**283.82[b]**	**73.34[c]**	**171.45**
Market product (meat)	540.55[a]	346.02[b]	385.53[c]	**459.45**

Less non-cash cost		210.69[a]	207.84[a]	336.47[a]	**233.40**
Less cash cost		34.97[a]	45.90[a]	30.36[a]	**37.16**
Total market product (meat)	**(B)**	**294.89[a]**	**92.28[b]**	**18.7[c]**	**188.89**
Socio-economic products	**(C)**	**146.52[a]**	**141.13[b]**	**117.10[c]**	**139.19**
Total Net Benefit (A+B+C)		**590.27[a]**	**517.23[b]**	**209.14[c]**	**499.53**
Capital (assets worth)		813.05	732.36	719.71	**772.50**
Return on capital (%)		72.60%	70.62%	29.05%	**64.66%**

Note: Means across the rows with different superscripts (a, b and c) are significantly different at p< 0.05 level on one-way ANOVA test of means. Exchange rate: US$1 is equivalent to GhȻ1.9

Table 5.18 Total Net Benefits of Goat livestock (GhȻ) per Household, By Three Regions of Northern Ghana

Component	**Regions**			
	Northern	**Upper East**	**Upper West**	**Overall**
Goat Livestock				
Non-market physical products (A)	**90.76[a]**	**137.03[b]**	**103.04[c]**	**102.36**
Market product (meat)	274.11[a]	168.91[b]	183.74[c]	**218.89**
Less non-cash cost	133.53[a]	131.03[b]	192.55[c]	**147.25**
Less cash cost	32.70[a]	37.31[a]	28.85[a]	**33.12**
Total market product (meat) (B)	**107.88[a]**	**0.57[b]**	**-37.66[c]**	**38.52**
Socio-economic products (C)	**75.90[a]**	**68.21[a]**	**66.76[a]**	**71.00**
Total Net Benefit (A+B+C)	**274.54[a]**	**205.81[b]**	**132.14[c]**	**211.88**
Capital (assets worth)	590.43	472.59	547.39	**545.17**
Return on capital (%)	46.50%	43.55%	24.14%	**38.86%**

Note: Means across the rows with different superscripts (a, b and c) are significantly different at p< 0.05 level on one-way ANOVA test of means. Exchange rate: US$1 is equivalent to GhȻ1.9

The data from both tables show a significant difference for the total net benefit of both animals among the three regions. The differences mainly came from a higher non-market contribution of sheep and goat for Upper East and West regions. Such non-market contribution is 51% in NR, 82.2% in UER and 91.1% in UWR for sheep production (Figure 5.6). Likewise, more than 60% of the total benefit of goat production is non-cash compared with a cash contribution of 39% in NR (Figure 5.7).

In Upper East region, the market contribution of goat livestock is about 1% while such contribution is negative in Upper West region. The implication is that smallholder households from both UWR and UER do not rely on goat sales to supplement household livelihood needs compared with Northern region.

Figure 5.6 Contributions of Sheep Market and Non-Market Benefits to Total Benefits, Three Regions of Northern Ghana

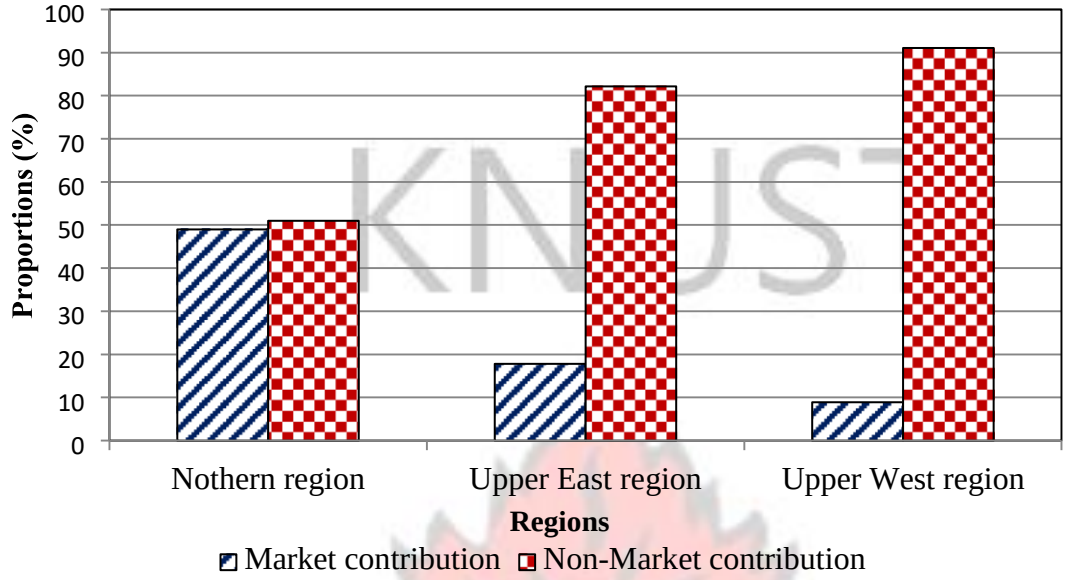
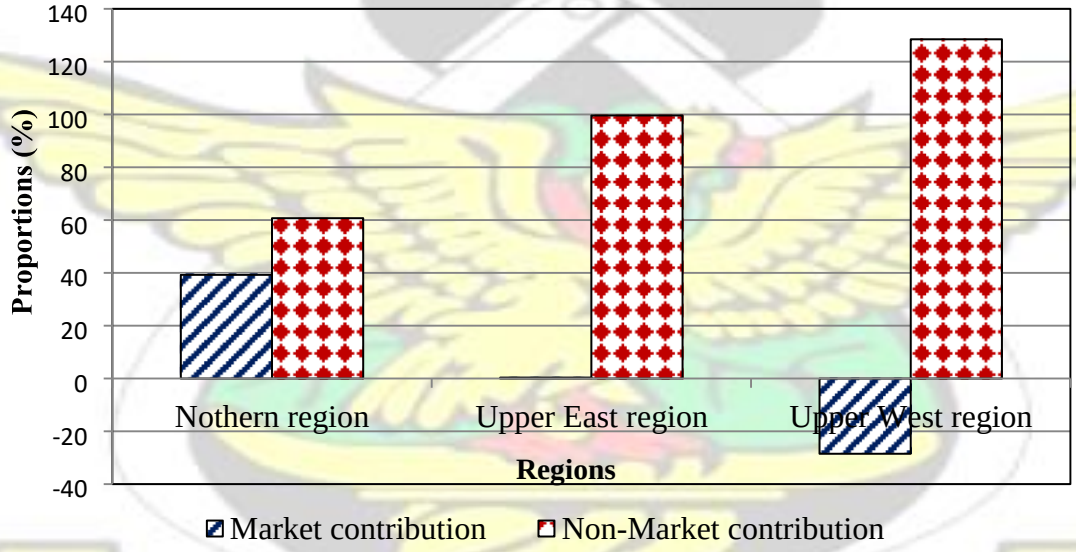


Figure 5.7 Contributions of Goat Market and Non-Market Benefits to Total Benefits, Three Regions of Northern Ghana



It can therefore be concluded that a greater portion of the benefits realized from the traditional small ruminant system is non-cash. This result compares well with Bosman *et al.* (1996b) who report that 80% of the total benefit realized from managing goat in Southwestern Nigeria is non-marketable. Ouma *et al.* (2003) also make a similar observation in Kenya where 77% of the total returns in managing cattle under the extensive system are non-cash. Other studies (see, for instance, Ayalew *et al.*, 2003; Moll, 2003; Scoones, 2003) across sub-Saharan Africa also report similar findings.

The significance of managing sheep and goat in smallholder households in market terms alone is limited because the revenue generated from annual market products per household is relatively smaller or negative. The high proportion of non-market functions of the animals in both Upper East and West regions compared with farm households in Northern region confirms the contribution of sheep and goat to the nutritional and food security needs of the poor and vulnerable households in rural communities. Nearly 90% to 80% of households in Upper East and West regions are extremely poor and additional 15% to 34% are food insecure compared with 70% poor and only 10% food-insecure in Northern region (Biederlack and Rivers, 2009; Mackay and Aryeetey, 2004). Such households from Upper East and West regions frequently depend on small ruminants to perform various non-market functions that represent an important livelihood strategy. For instance, gifts in the form of animals provide a critical risk-coping strategy in marginalized and rural communities. During times of hardship, smallholder farmers tend to benefit some economic relief from those family relations who previously received sheep, goat or both from farmers as gifts or part of share agreements (Dovie *et al.*, 2006). In addition, the smaller size of sheep, goat or both helps to improve poor households' nutrition since the animals can easily be slaughtered for home consumption (Lebbie, 2004). Moreover, such households manage food insecurity through the sale of animals when the need arises, especially during periods of drought and crop failure.

Generally, smallholder farmers in the traditional small ruminant system manage sheep, goat or both for non-market functions. Hence, such systems are less affected or even unaffected by market risks (Ouma *et al.*, 2003) since large parts of the returns are non-market. Given that smallholder farmers manage small ruminants to meet these needs, and that the products from the animals are often slaughtered at home or

transferred (gifted), economic value estimation by considering only expected revenue on market products may be misleading (Ayalew *et al.*, 2003). Consequently, projects to improve the traditional small ruminant production system should consider the actual production objectives. In other words, the cumulative benefits derived from the animals to smallholder farmers should be reckoned. In addition, such livestock technical projects should aim at improving the efficiency of managing small herds to reduce losses through mortality and theft instead of improving herd size holdings that are inconsistent with traditional production methods.

Figure 5.8 and Figure 5.9 further illustrate the importance of non-market components in the traditional small ruminant production system. The figures compare the total net benefit, revenue and costs with and without non-market contributions of sheep and goat production. The analysis depicts that when both market and nonmarket co-benefits of sheep and goat are considered, the aggregate of such returns results in above normal profits in Northern and Upper East regions and normal profit in Upper West region. According to Ouma *et al.* (2003), a firm will have normal profit if its total revenue exactly covers the total cost of production and such a firm will realized above-normal profit, when profit realized, is greater than cost of production. However, with the exclusion of non-market market contributions, goat production in Upper West region seems unprofitable and uncompetitive since the total return is negative (Figure 5.9).

Figure 5.8 Comparison of Sheep Economic Value, With and Without NonMarket Benefits, Three Regions of Northern Ghana

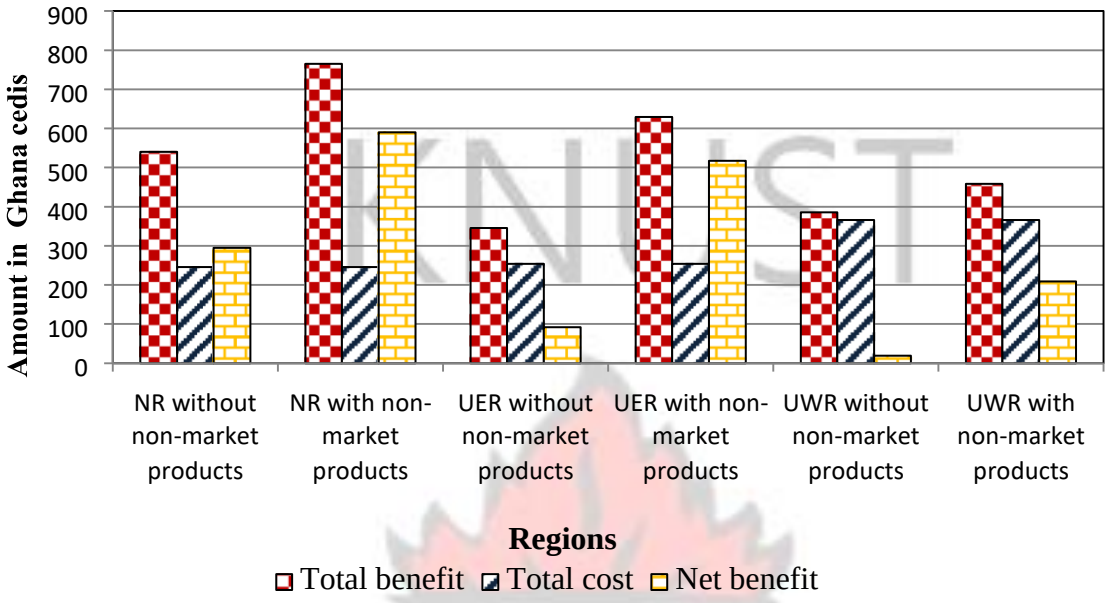
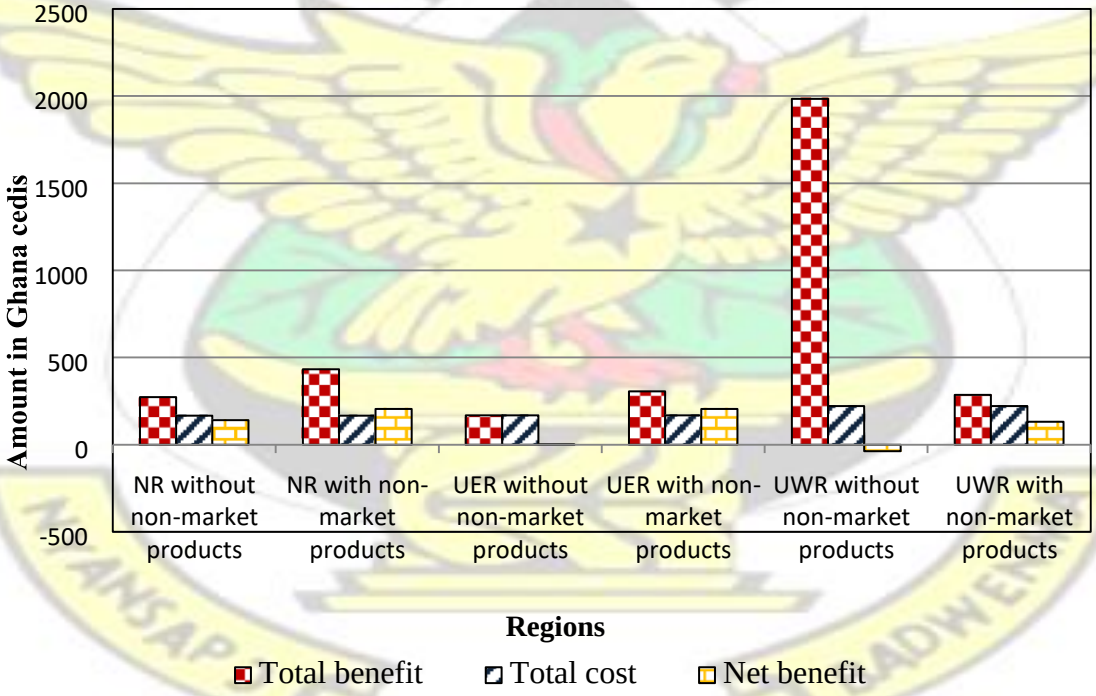


Figure 5.9 Comparison of Goat Economic Value, With and Without Non-Market Benefits, Three Regions of Northern Ghana



The analysis implies that sheep and goat production in Northern and Upper East regions and to some extent in Upper West region becomes more profitable and competitive when both market and non-market outputs are considered in the economic analysis than the case without non-market products. The logic extension is how competitive the

traditional small ruminant production is relative to other enterprises when both market and non-market benefits are considered. Hence, the role of such non-market benefits towards the sustenance of the traditional production system cannot be over-emphasised.

Profit alone is not enough to determine how efficiently the factors of production are utilized (Panin and Mahabile, 1997). The best criterion to determine input efficiency is to evaluate the returns per unit of input. From Table 5.17 and Table 5.18, it is indicated that the returns per capital invested in sheep production is high representing 72.6%, 70.6% and 29.05% in NR, UER and UWR, respectively. Similarly, the return on goat production is 46.5% in NR, 43.55% in UER and additional 24.14% in Upper West region. These returns exceed the average interest of 20% charged on loans by micro-finance and rural bank institutions in the study area. Even though, UWR has the least return on capital invested in goat production, that rate of return exceeds the bank's interest rate by more than 4.14 percentage points, which confirms Slingerland (2000) argument that investing in livestock production is better than saving in the bank.

5.4 Gender and Small Ruminant Production

5.4.1 Participation in Small Ruminant Management Practices

The level of male and female spouses' contribution to household small ruminant management practice is shown in Table 5.19. The result suggests that the participation of female partners in household small ruminant management activities is moderate (contribution index = 2.04). The result is comparable with Ayoade *et al.* (2009) who report that females occasionally participate in small ruminant management practice in Lafia area of Nasarawa State, Nigeria. Likewise, male spouses also rarely contribute (contribution index = 2.67) to small ruminant management practices in the household. The study supports the findings by Huelela (2010) that in sub-Sahara African countries,

women's contribution in managing household sheep and goat is not different from men's contribution.

Table 5.19 Contribution Index Result Showing Level of Male and Female Contribution to Household Small Ruminant Management Practices

	Female (Spouses)		Male (Husband)	
Management Practice	**Mean**	**Std**	**Mean**	**Std**
Herding/tethering	2.00	0.77	2.54	0.75
Feeding/providing fodder	2.76	0.47	2.63	0.65
Cleaning barns/kraal/pens	2.92	0.33	2.23	0.87
Provision of water	2.45	0.71	2.51	0.65
Caring for sick animals	2.02	0.81	2.92	0.35
Construction of barns/kraal/pens	1.61	0.70	2.95	0.23
Marketing/sales of animals	1.52	0.70	2.95	0.26
Castration of animals	1.14	0.38	2.75	0.27
Taking sick animals to veterinary	1.71	0.77	2.66	2.41
Discussions in extension visits	1.80	0.74	2.62	0.65
Fodder harvesting	2.56	0.67	2.60	0.67
Contribution index[1]	**2.04**	**0.10**	**2.67**	**0.23**
Cronbach's Alpha (α)[2]	**0.61**		**0.77**	

[1] *index calculated from a 3-point likert scale, 1 = never, 2 = occasionally and 3 = always. Mean score of each management practice is calculated and the total mean of all the practices divided by all the management practices to determine the contribution index. Indexes, > 2.9 = always contributed, 2 - 2.9 = occasionally contributed and 1 – 1.99 = never contributed.*

[2] *Cronbach alpha (α) used to test internal consistency. Coefficients less than 0.60 are poor (Gleim and Gleim, 2003)*

The survey also indicates that while female spouses always contribute (mean = 2.92) in the cleaning of barns/kraals/pens, male spouses occasionally (mean = 2.23) perform this management practice. The analysis is consistent with Javed *et al*. (2006) who report that the cleaning of barns/kraals/pens is ranked number one livestock activities that female spouses in a household participate. Management practices such as herding/tethering, feeding/providing fodder and water, and fodder harvesting are sometimes carried out by both men and women spouses in the household. However, women never contributed to the construction of barns/kraals/pens, marketing/sales of animals, castration, visits a veterinary clinic and discussions in extension visits.

Men on the other hand, are always involved in the construction of barns/kraals/pens, marketing/sales of animals and occasionally contribute to castration, visits to a veterinary clinic and discussions in extension visits. Aqeela *et al.* (2005), Farhana *et al.* (2011), and Luqman *et al.* (2006) support this finding, and the authors report that women participate in less physical livestock management practices such as feeding, providing water, cutting fodder, tethering/herding and cleaning of barns/kraals/pens while men are actively engaged in animal protection and marketing/sales. In a study from Zimbabwe, Mupawaenda *et al.* (2008) find that men contribution to household livestock management is mainly through herding and sale of animal products despite the fact that women always feed the animals. A report by FAO (2011) is comparable to this finding. Because of such gender division of labour, Mupawaenda *et al.* (2008) recommend that extension training and workshop include both men and women in the household. On the other hand, Yisehak (2008) in Ethiopia also report that even though both male and female spouses engage in livestock management activities, men tend to have access to training and technology because men in the household are often regarded as the head.

5.4.2 Participation in Small Ruminant Management Decisions

Overall, female spouses never contribute (index = 1.96) in decision-makings towards the management of household small ruminant of the sample surveyed (Table 5.20). However, the analysis shows that men always participate (participation index = 2.91) or are independent decision-makers regarding the management of household sheep and goat animals. Given that rural female spouses in Ghana have limited access to, and control of household productive resources, such females‘ participation in decision-makings in the allocation and usage of the productive resource is negligible (Awumbila, 2006). The study is also consistent with Mupawaenda *et al.* (2008) who

report that kinship of most sub-Sahara African countries such as in northern Ghana is the patriarchal society. Consequently, men are traditionally the household heads with control over production and are said to be the main decision-makers in the household. Similarly, the result supports the argument made by Yisehak (2008) who reports that women are normally in charge of feeding animals, cleaning barns, caring for weak animals, among others. However, men are the main decision makers in the production and marketing activities of the animals.

Table 5.20 Contribution Index Result Showing Level of Male and Female Participation in Household Small Ruminant Management Decisions

	Female (Spouses)		Male (Husband)	
Management decisions	**Mean**	**Std**	**Mean**	**Std**
Selecting animal type	1.96	0.79	2.84	0.46
Selecting small ruminant breed	1.84	0.77	2.83	0.47
Health care of animals	1.78	0.77	2.85	0.46
Sales/marketing of animals	1.97	0.78	2.93	0.30
Use of income or products from animals	2.20	0.80	2.94	0.26
Ownership of animals	1.99	0.81	2.96	0.23
Contribution index[1]	**1.96**	**-**	**2.91**	**--**
Cronbach's Alpha (α)[2]	**0.90**		**0.78**	

[1] *index calculated from a 3-point likert scale, 1 = never, 2 = occasionally and 3 = always contributed. Mean score of each management practice was calculated and the overall mean of all the practices divided by all the management practices to determine the contribution index. Indexes, > 2.9 = always contributed, 2 - 2.9 = occasionally contributed and 1 – 1.99 = never contributed.*

[2] *Cronbach alpha (α) used to test internal consistency. Coefficients less than 0.60 are poor (Gleim and Gleim, 2003)*

Interestingly, the study reveals that women occasionally participate (mean = 2.20) in decision-makings concerning the final use of income or products from the animals. This is a positive signal for improving household members' welfare since women in most rural communities are the custodians of household chores (nutrition, caring for children, among others).

5.4.3 Gender and Productivity in Small Ruminant Production

The production elasticities of the Cobb-Douglas production function for small ruminant farmers are presented in Table 5.21. The production function is first estimated for all the 249 farmers (pooled regression) including gender as a dummy variable. The other two regressions represent male and female-managed small ruminant farms. The estimates represent elasticities that explain the percentage change (increase or decrease) in output in response to a percentage change in input while other factors are held constant. Such inference is ideal for quantitative variables (Gujarati, 2004). Concerning qualitative factors (i.e., dummy variables), it shows how one category can lead to higher output than the other through the sign and significance of the variable (Cheng'ole *et al.*, 2003). Thus, a variable with a positive sign suggests the likelihood of increasing output with respect to the variable.

Table 5.21 Coefficients with Heteroskedasticity Corrected of the Cobb-Douglas Production by Various Small Ruminant Managers

Variable	**Pool** Coefficient β	SE(β)	**Male managers** Coefficient β	SE(β)	**Female managers** Coefficient β	SE(β)
Constant	4.354***	0.735	4.507***	0.677	5.658**	0.243
Gender	0.444***	0.157	-	-	-	-
Household size	0.454***	0.113	0.531***	0.125	0.211	0.269
Age	0.380**	0.181	0.296*	0.175	-0.214***	0.585
Extension access	0.325***	0.121	0.317**	0.131	0.510**	0.201
Marital status	-0.309**	0.150	0.109	0.110	-0.537*	0.401
Non-farm income	0.274**	0.116	0.197	0.125	0.489*	0.261
Diagnostics						
Number of observations		240		173		67
R-square	0.16		0.17		0.51	
Log likelihood	-520		-380		-135	

***denotes significance at 1%; ** significant at 5%;* significant at 10%.

The negative coefficient also indicates the likelihood of decreasing output with respect to the factor. Three variables, thus is, educational level, access to formal credit and cooperative association are not included in the final model. This is because the survey

sample has few observations for these variables, hence cannot be used for any meaningful analysis and conclusions.

From the pooled (all households) regression, the coefficient of gender is positive and significant at 5%. This confirms productivity differences in small ruminant production between male and female-managed farms (see for instance Marinda *et al.*, 2006; Njuki *et al.*, 2006; Quisumbing, 1996). Thus, the estimation of two regressions for both male and female-managed farms is justified since men and women are affected by different socio-economic and institutional factors in production.

Both the pooled and male-managers regression analyses support the hypothesis that the probability of increasing small ruminant productivity is higher for farmers (malemanagers) with larger household size. Household size in smallholder households represents the available labour for small ruminant production. As such, farmers with larger household size will have enough labour to carry out various small ruminant activities (running, herding, cleaning kraals and other husbandry activities) and thereby increasing productivity. Hence, this stresses the important role household labour plays in realising higher small ruminant productivity, especially in male farm households. However, the hypothesis is not supported in the female-managers' regression analysis. The coefficient of family size is not significant in the female's model and this implies that household size is not a determinant factor for small ruminant productivity in female households. In contrast, Oluwatayo and Oluwatayo (2012) report a significant negative relationship between female farmers and small ruminant productivity in Nigeria.

The parameter estimate for age is positive and significant in the pooled and malemanaged regression analyses. Therefore, the data confirms the assumption that general livestock production experience increases with age and as such, positively contributes to small ruminant productivity. The result is consistent with Fakoya and

Oloruntoba (2009) who report a positive relationship between a farmer‘s age and small ruminant herd size. Even though, age significantly influences female managers‘ farms, the magnitude of such influence is negative. This result is in support of Marinda *et al.* (2006) who report an inverse relationship between female farmers and maize productivity in Kenya. In another study in Kenya, Sulo *et al.* (2012) also report a negative relationship between the age of female farmers and adoption of improved agricultural technologies to increase productivity. It appears that younger female farmers tend to have the ability to readily understand and apply new technologies than older ones in the case of farming and raising livestock. However, the result contradicts the findings by Oluwatayo and Olwatayo (2012) who find a positive and significant relationship between the age of female farmers and small ruminant productivity in Nigeria.

All the three regression analyses support the hypothesis that increasing access to extension service improves small ruminant productivity in northern Ghana. This indicates that both male and female farmers who have access to extension service are guaranteed increase small ruminant productivity. Given that extension education provides training to farmers on improving livestock technology, farmers with regular access to extension education will have a significant increase in animal productivity (Elizabeth, 2006). Thus, the hypothesis that small ruminant farm families with access to extension education will have higher small ruminant productivity is not rejected by the study.

The estimate for non-farm income source is positive and significant in the pooled and female-managed regression models. However, it is insignificant in the malemanaged model. Extra income from off-farm employment is used to purchase external inputs or access to veterinary services and thereby increasing small ruminant productivity (Al-

Rimavi, 2002). A reason why non-farm income in male-manage farm is insignificant may be attributed to the fact that men who are pre-occupied by nonfarm income may have less time on their small ruminant farms.

5.5 Constraints to Small Ruminant Production

5.5.1 Constraints to Small Ruminant Production of the Sampled Survey Major constraints that limit small ruminant production in northern Ghana are presented in Table 5.22. The five most common constraints recognise for sheep production includes diseases and parasites (1st), feed shortage (2nd), high mortality of animals (3rd), theft or predators (4th), and high input cost (5th).

Table 5.22 Major Constraints to Managing Sheep and Goat in Northern Ghana

Constraints	Sheep			Goat		
	Frequency	Mean*	Rank	Frequency	Mean*	Rank
Feed shortage	151	3.30	2	215	3.15	3
Disease and parasites	152	3.66	1	216	3.44	1
Marketing problem	153	2.20	12	216	2.22	12
High input cost	153	2.92	5	216	2.80	7
Insufficient credit provision	151	2.90	6	215	2.80	7
Insufficient extension access	153	2.81	8	214	2.65	10
Insufficient water	153	2.18	13	215	2.23	13
Theft or predators	153	3.03	4	214	2.94	5
Housing problems	153	2.65	10	215	2.65	11
High veterinary costs	153	2.84	7	215	2.85	6
Insufficient technical knowledge	153	2.77	9	215	2.75	9
Destructive habits of animals	152	2.53	11	212	3.20	2
High mortality of animals		3.05	3	212	3.08	4

The higher the mean the greater the importance on the constraints, constraints were measured on a 4-point likert scale: 1 – Unimportant, 2 – Somehow important, 3 – Important and 4 – Very important.

For goat production, the destructive habits of goat are ranked second (2n) after disease and parasites (1st). Feed shortage is ranked third (3rd). High mortality of animals is ranked fourth (4th), and Theft or predators is fifth (5th). Various studies

(Baah *et al.*, 2012; Dossa *et al.*, 2007; Fakoya and Oloruntoba, 2009; Kabore *et al.*, 2011; Naadam and Mbilla, 2010; Saffu *et al.*, 2009; Turkson and Naandam, 2006) across sub-Sahara Africa have reported similar findings. These constraints partially or wholly determine the health and general welfare of the animals and may limit production or cause high mortality rates thereby reducing the overall economic benefits of the animals (Ademosun, 1992).

Besides the two most common constraints, that is, disease/parasites and feed shortage, most of the surveyed households report that pilfering of sheep is more rampant than goat due to the bad grazing habit of sheep. Sheep normally graze away from home hence exposing them to thefts, accidents, and predators. Goat is also acknowledged for grazing around homesteads and for their destructive nature. The grazing nature of goat permit a greater women population to manage small ruminants
(Karbo *et al.*, 2007) because women are normally custodians of household activities (Okali and Sumberg, 1984).

5.5.2 Factors Influencing Smallholders' Vulnerability to Production Constraints: Disease and Feed Shortage

The coefficients and odds ratio of the ordinal logit used to determine factors influencing small ruminant disease and feed constraints in the study area are presented in Table 5.23. It is shown that different economic attributes, institutional and production factors account for the probability of farm households experiencing disease and parasites threats, as well as feed problems. The coefficients of the explanatory variables can be interpreted as the change in the log odds associated with a unit change in the explanatory variable. That is a positive or negative coefficient of a variable increases or decreases the log odds, when other predictors are held constant. For instance, the coefficient of 0.018 for age in the disease constraint logit suggests that for a unit

increase in the youth (or moving from an adult to a youth), the log odds of the youth to experience disease constraint increase by a factor of 0.018, all other factors held constant.

Table 5.23 Odds Ratios Parameters, Standard Error and Z-Statistics of Diseases and Parasites as well as Feed Constraints for Households

	--Disease and parasites----			-----Feed shortage-------		
Variables	Coef (β)	Odds ratio	Std. Err	Coef (β)	Odds ratio	Std. Err
Age(youth vs. adult as base)	0.018	1.018**	0.009	0.005	1.005	0.009
Gender (female vs. male as base)	-0.034	0.967	0.307	0.304	1.355	0.416
Extension access (no vs. yes as base)	0.650	1.916**	0.614	0.082	1.065*	0.288
Agro-ecological zone (Guinea vs Sudan as base)	-0.037	0.964	0.276	-0.063	0.920	0.269
Non-farm income source (no vs. yes as base)	-0.113	0.893	0.254	-0.488	0.614**	0.168
Production system (extensive vs. semiintensive/intensive as base)	0.551	1.734**	0.601	-0.188	0.828	0.261
Herd size (medium vs. small size as base)	0.404	1.498	0.537	-0.145	0.865	0.280
Herd size3 (large vs. small size as base)	-0.582	0.191*	0.191	0.433	1.649**	0.216
Constant	-0.307	0.735	0.428	-0.465	0.627	0.351
Goodness of fit and model performance						
Number of observations		249			249	
LR chi-square		16.73**			9.72***	
Pseudo R^2		0.0526			0.0217	

****denotes significance at 1%; ** significant at 5%;* significant at 10%.*

However, it is easier to interpret coefficient estimates in odds ratio (e^{β}) rather than log odds (Krushna and Kant, 2005). The odds ratio compares the odds of a household experiencing high level of disease/parasites and feed problems with the odds of a household experiencing no or lower levels of disease parasitic infection and feed shortages. Thus, for a unit change in the predictor variables (i.e., socio-economic, institutional and production factors), the odds in favour of a household experiencing disease/parasites and feed constraints versus households without or with low levels of such constraints are the proportional odds times larger, given that the remaining factors are held constant.

From the analysis, the odds ratio of a farmer exposed to diseases and parasites is highest for access to extension education (1.916) followed production system (1.734), significant at 5% level. Age of farm household (1.018) is third before large herd size ownership (0.191) at 5% and 10% significant level, respectively (Table 5.21). The odds ratio of 1.916 suggests that the odds in favour of a household without extension access to experience diseases and parasites is 1.916 greater times the odds of a farmer with extension contact, all other factors held constant. The analysis indicates that households who never received extension education are more prone to diseases and parasites compared with households who have extension education access. The result concurs with reports (Mudukuti and Miller, 2002) that livestock extension education is required to control and prevent diseases and parasites in Zimbabwe. Given that rural livestock producers rely on extension advice to adopt new technologies including vaccination, diseases diagnosis and treatment, and to provide effective health care, ineffectual extension education remains a constraint to diseases and parasites management (Turkson and Amakye-Ansah, 2005). In a study for Nigeria, Adesehinwa, Okunola and Adewumi (2004) report that livestock farmers with extension contacts are less likely to be affected by diseases and parasites since information on best management practices and sources of inputs such as veterinary drugs are provided by extension agents. Therefore, the hypothesis that the probability of experiencing diseases/parasites is higher for households without extension access is supported by the survey data.

The data show that the odds in favour of farmers managing small ruminants on the free range/extensive system to be exposed to disease and parasites is 1.734 times greater than the odds in favour of those who manages sheep and goat on the intensive/semi-intensive system. The implication is that farmers who raise sheep and goat under the free range/extensive systems are more susceptible to diseases and parasites problems

compared with farmers who manage animals under the intensive/semi-intensive system. The finding is consistent with Terril (1985b) and Ademosun (1992) who report that sheep and goat on the free range systems are more prone to diseases and parasites due to poor housing, overcrowding, and poor ventilation that characterised such a production system. In addition, the data support the hypothesis that youthful household heads experience higher diseases and parasite constraints compared with households headed by adult farmers (odds ratio=1.018). However, the odds in favour of farm households with large herd size who experience higher levels of diseases and parasites challenges is 0.191 times lower compared with farm families who manage smaller herd size, all other factors are held constant. This implies that households with smaller herd sizes are more susceptible to diseases and parasites problems compared with households with larger herd sizes.

Compared with disease and parasite constraints, three variables including extension access, non-farm income, and large herd size significantly influence feed constraints among farm households from the survey data. The odds ratio estimates are highest for extension access before large herd size holding and finally non-farm income level. The data suggests that feed shortages are more prevalent in households without extension contacts compared with households who access extension training (odd ratio is 1.065). However, the odds ratio 0.614 suggests that the odds in favour of farm households with non-farm income level to experience feed shortages is 0.614 times lower than farmers who do not have alternative income aside farming, all other factors held constant. This result is consistent with Ndamukong (1989) who observed that livestock farmers who are also sustained by non-farm income source have limited time to engage in livestock husbandry activities such as conservation of feeds, among others. On the other hand, the odds ratio 1.649 indicates that the odds in favour of farm households with large

herds to experience feed shortage is 1.649 times greater than the odds in favour of farmers with small herd size, all other factors held constant. The implication is that farmers with large herd size are more susceptible to feed shortages compared with farmers with smaller herd size.

5.5.3 Feed Shortage

Grazing is reported as a major form of feed source for sheep and goat in the survey area. The most common grazing types include grazing around home settlements/communal lands, along roadsides and riversides, on-farm grazing and feeding on crop residues. From the surveyed households, about a quarter (24.8%) allows sheep and goat to graze around home settlements/communal lands while 23.4% utilise crop residues. In addition, 20.2% allows grazing along roadsides and 16% each manages their animals along riversides and on-farm grazing. Sheep and goat graze freely without control and in rare cases, such animals are provided with housing at night. Free grazing of animals is most frequently practiced in communities with abundant grazing land such as Sakom in Bawku West, Tiwii in Sissala West and Gbimsi and Tamplingu in the Mamprusi West districts. This finding is consistent with Naandam and Mbilla (2006) who report that about three-quarters (75%) of small ruminant farmers in the Upper East region of Ghana practice free grazing around home settlements/communal lands throughout the day while only 20% allow grazing during the day and provide accommodation at night. In more densely populated communities such as Nyarigabisi in Bolgatanga, Kanvilli and Vitting in Tamale, Tolon in Tolon district, and Kpongu in Wa East districts, free grazing is restricted and as such crop residues including maize bran, home-made brewers recipes (millet and sorgum), groundnut haulms and cowpea vines are used to feed the animals. A report by Karbo *et al.* (2007) supports this finding.

Even though, free grazing around homesteads is common for sheep and goat in northern Ghana, different feeding systems are practiced depending on wet or dry seasons for crop farming (Table 5.24). Free grazing or roaming is typically practice in the dry season when crop farming is absent. During rainy seasons when crop farming is intensified, the animals are either tethered around homesteads or on communal lands for feeding. In some cases, the cut-and-carry system of harvesting grasses is practiced. The demand for labour for both small ruminants and crop farming during the cropping season

Table 5.24 Percentage of Feed Management Practices for farmers during Dry and Wet Seasons in Northern Ghana

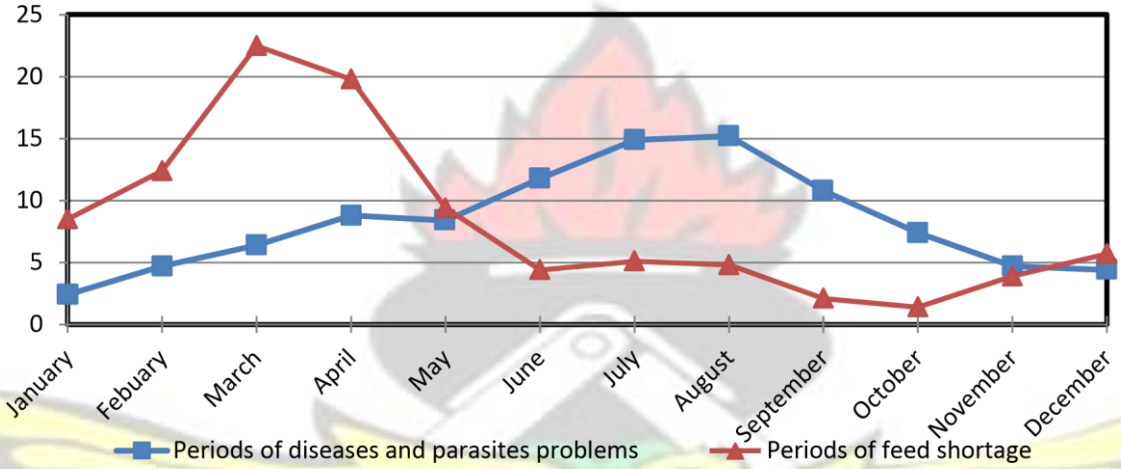
Feeding management	Sheep		Goat	
	Wet season(%)	Dry season(%)	Wet season(%)	Dry season(%)
Free grazing/roaming	15.1	71.1	20.2	75.8
Extensive grazing (shepherd)	7.2	22.8	6.6	17.5
Tethering of animals	66.4	1.3	61.0	1.9
Cut and carry/zero grazing	11.2	4.7	12.2	4.7
Total	**100**	**100**	**100**	**100**

is a challenge for households whose household size is smaller especially for the number of children. Upton (1985) also describes similar feeding systems in South West Nigeria.

Contrary to Upton‘s (1985) report that no supplementary feeding is carried out particularly during the dry season, the study reveals that only less than 20% of the sampled household do not practice feed supplementation. About 34% supplement sheep and goat feed with maize grain/bran, 30% salt/local mineral salts, 21% home- made brewer‘s recipes (millet or sorghum), 12% cultivate fodder leaves and 5% oil cakes/meals. Most of the respondents (55%) supplement all-year-round while 35% during the dry season and only 10% practice supplementation in the wet season.

Dry season feed shortages pose a great challenge to small ruminant farmers in northern Ghana (Turkson and Naandam, 2006). The quality and quantity of animal feeds (fodder, browse, and forage) are drastically low hence animal morbidity and mortality tend to rise during the long dry season. Months in which households experience severe feed shortage are presented in Figure 5.10.

Figure 5.10 Periods of Severe Feed Shortage and Diseases and Parasites Problems in Northern Ghana



Feed shortage for sheep and goat is most severe during the peak dry season that is, from January to March, and starts to decline from April through May to June. Turkson and Naandam (2006) in Northern region of Ghana report a similar result. Respondents attribute feed shortages to protection of grazing lands (17.6%), increase in animal size (16.2%), declining productivity of grazing lands (15.2%), increase human population (12.8%), insufficient labour (11.7%), crop farming on grazing lands (10.7%), residential developments (10.3%) and lastly drought (5.5%).

An improved feed technology based on all-year-round production using indigenous and high-yielding pasture as well as promotion of crop residues and cultivation of legume crops such as groundnuts can be used to reduce the seasonality of feed shortages in the study area (Turkson and Naadam, 2006). Studies on less expensive protein supplements from indigenous browse species such as *Gliricidia sepium* in the study

area is important (Husseini *et al.*, 2011). Indigenous browses' (*Gliricidia sepium*) leaves and twigs or a mixture of the two can be harvested and processed into meals full of protein and then fed to sheep and goat, especially during the dry seasons.

5.5.4 Diseases and Parasites

Major health problems that lead to high animal mortalities in the study area include diseases and parasites (1st), insufficient extension personnel (2nd), insufficient veterinary services (3rd), high cost of veterinary services (4th), and unavailability of drugs and medicines (5th) in rural areas. Other problems include insufficient feedstuff (6th), poor housing (7th), and lastly insufficient drinking water (8th). About 30% of the respondents indicate inviting or visiting veterinary agents when animals are sick while 18% use ethno-veterinary medicine (traditional medicine). Traditional medicine is an important aspect of animal health care management and such herbal treatment tends to augment formal veterinary services from the Ministry of Food and Agriculture (Karbo *et al.*, 2007). Majority of the respondents (80%) treat and vaccinate their animals against diseases and parasites. Vaccination is not routine except when there is a disease or parasite outbreak or they did so once a year. A little over half of the surveyed households (51%) source veterinary vaccines from veterinary offices in towns/villages. Input dealers in towns and villages as well as fellow farmers are all important sources of veterinary drugs to sheep and goat farmers in the study area. Sixty-four percent (64%) of the households indicate that veterinary service in the community is not affordable.

During an in-depth interview and discussion with respondents, the common diseases and parasites or symptoms of diseases report include nasal congestion, foot and mouth rot, tick infestation, pneumonia, diarrhoea, peeling/dropping of hair/fur and worms infestation. This result is similar to the observation make by Ockling (1987) on some

diseases and parasites of small ruminants in the Brong-Ahafo region of Ghana. Ademosun (1992) also reports that diseases such as *peste des petits ruminants* (PPR) and parasites including helminthiasis are the most prevalent conditions found in tropical Africa. Periods (seasons) in which diseases and parasites infestation are most prevalent is presented in Figure 5.10. Sheep and goat become susceptible to diseases and parasites infection at the start of the cropping season (April-May) when the first rains drop and fresh grasses start to sprout. Most respondents report July, August and September as the peak periods where sheep and goat suffer severe diseases and parasites attacks. The result concurs with Ockling (1987) who reports that worm infestation in sheep and goat is highest during the rainy seasons (April-September) and reduces gradually during the dry season. Ockling (1987) also observe that the few parasites infestations during the dry season are attributed to the high humidity in the only mornings.

Given that diseases and parasites are more prevalent during the wet seasons and in some parts of the day during the dry seasons, genetic improvement of local breeds (West African Dwarf sheep and goat) that have higher diseases and parasites resistance is desirable. Since the availability of extension services greatly influence a household‘s vulnerability to diseases and parasites attacks, educating households through extension programmes on good animal health husbandry practices is relevant.

In addition, veterinary service delivery in the area needs improvement and should be located in the farmers‘ communities to reduce the threats of diseases and parasites outbreaks.

5.5.5 Farmers’ Suggestions to Overcoming Small Ruminant Production Constraints

Smallholder small ruminant farmers in northern Ghana recommend provision of credit (24.7%), improved housing technology (13.7%), establishment of community

veterinary offices (11.6%), education on good husbandry practices (8.9%), provision of drugs (7.7%), and improved feed technology during the dry seasons (7.1%) as fundamental solutions to small ruminant production constraints in the study areas (Table 5.25). These results are comparable to Turkson and Naandam (2006) who report that livestock farmers in some part of the Northern region (Ghana) seek assistance in the form of drugs provision, credit, and improved breeds as key remedies to livestock production constraints. The relatively high incidence of diseases and parasites might have triggered the recommendations provided by farmers for various reasons.

Table 5.25 Farmers' Suggestions to Overcoming Small Ruminant Production Constraints in Northern Ghana

	Responses		Percent
Solutions	**Number**	**Percent**	**of cases**
Improved housing technology	46	13.7	23.4
Credit provision	83	24.7	42.1
Education on good husbandry management	30	8.9	15.2
Improved extension visits	22	3.6	6.10
Establishment of land for grazing during wet season	12	6.5	11.2
Improved feed technology during dry season	24	7.1	12.2
Availability of feed supplements	12	3.6	6.10
Provision of improved breeds	11	3.3	5.60
Provision of free drugs and medicines	26	7.7	13.20
Awareness creation of vaccination every quarterly	7	2.1	3.60
Free vaccination of animals	10	3.0	5.10
Establishment of veterinary offices in communities	39	11.6	19.80
Improve transportation to solve marketing problem	1	0.3	0.50
Subsides on veterinary drugs and services	8	2.4	4.10
Construction of dam to provide water for animals	5	1.5	2.50
Total	336*	100	170.6

**Respondents gave more than one solution in most cases hence the number of responses is greater than the sample size.*

First, an improved housing technology may serve to prevent diseases menace, theft and predation (Oladeji and Oyesola, 2012). Besides, such housing will facilitate the collection of manure to be applied on farms (Dei *et al.* 2006). In addition, the relationship between the nutritional status and health condition of the animals warranted the call for improved feeding technology during the dry seasons. According

to Ockling (1987) poorly nourished animals become more susceptible to parasitic diseases attack, hence Ockling (1987) recommends improved nutrition as a key _prophylactic' measure to prevent most disease cases in sheep and goat.

5.6 Chapter Summary

The chapter has presented and discussed the results of the study. A description of the demographic profile of farm households has been analysed and discussed. Empirical results on the decision to own small ruminants and the types (goat alone, sheep alone or both) have also been outlined. In the following section, the overall economic benefits of small ruminant accounting for both market and non-market functions were also estimated and discussed. In addition, discussions of results on gender and small ruminant production as well as constraints that limit production have been presented in this chapter. The next chapter summarised and concluded the study.

Policy implications, as well as suggestions for future studies have been considered.

CHAPTER 6

6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

The purpose of this study is to understand the socio-economic attributes of small ruminant livestock production and generate technical information appropriate for policy action on increasing small ruminant production in northern Ghana. Sheep and goat production in northern Ghana is dominated by the free range system characterised by low productivity and high mortality rate. Such a poor performance may directly or indirectly affect the general well-being of households who wholly or partially depend on sheep and goat production. Consequently, the need for intervention programmes with pragmatic policies to improve upon such low small ruminant performance is

relevant. Therefore, the main motivation for this study is to provide information that can contribute to a better understanding of the traditional livestock production systems and formulation of effective policies for increased productivity.

Data was collected using a multi-stage sampling procedure, from a sample of 300 households, during the months of October to December 2012 in the three regions of northern Ghana: Northern, Upper East and Upper West region. The study was subdivided into four different empirical analyses. A first component of the analysis was based on categorical data models (Negative Binomial and Multinomial logit) to assess socio-economic determinants of small ruminant production system. The result indicates about 66% of the farmers are domestic unit heads different from individual household members. The Negative Binomial regression shows no significant relationship between a farmer‘s household status and decision to own small ruminants hence, household heads are assumed to take production decisions which are consistent with decision-makings in northern Ghana. Using household heads‘ attributes, the result from the Negative Binomial regression indicates that the main determinant of small ruminant production includes non-farm income source, age, household size, and access to extension services. All the variables have significant positive effects on farm household head‘s decision to own small ruminants as hypothesized. The Multinomial logit model is used to analysed farmer‘s preference for small ruminant species owned (i.e, sheep alone, goat alone or both animals). The model reveals that agro-ecological zone, gender and farmers‘ risk as well as profit perception influence farmer‘s preference for particular small ruminant species. In particular, agro-ecological zone, gender, farmers‘ risk and profit perception have significant effects on farmer‘s preference to own joint-sheep and -goat livestock compared with owing goat alone.

Except for gender, the coefficients of all variables have negative effects on farmer's decision to own both sheep and goat compared with goat livestock. On the other hand, agro-ecological zone and risk perception significantly influence decision to raise sheep alone compared with goat alone. Both variables have a negative effect on the farmer's decision to manage sheep compared with goat livestock.

A second component of the empirical analysis employed replacement cost method (aggregate economic value) to estimate the total benefit of traditional free range system of small ruminant livestock accounting for both market and non-market cobenefits of small ruminants. The study reveals that the main benefits for raising small ruminant livestock are numerous and these include socio-cultural benefits (religious/faith-based cultural and non-faith-based cultural function), physical benefits (for sale or regular income source, hide and slaughter for consumption) and socioeconomic functions (non-cash savings against future expenses, insurance for urgent need of cash and for food risk management). The annual aggregate benefit per household from sheep and goat is lowest in the Upper West region and highest in the Northern region. The analysis shows that the annual aggregate benefit from sheep products is about Gh₵590.00 per household in Northern region, Gh₵517.23 in Upper East region and Gh₵209.00 in Upper West region. Over 51%, 80%, and 90% of these benefits in Northern, Upper East and Upper West regions, respectively are nonmarketable (non-cash). Similarly, more than 60% of the aggregate benefit of Gh₵274.50 from goat production in the Northern region is also non-marketable. In addition, the study illustrates that the non-market component of goat products represent 99% in Upper East region of the aggregate value of Gh₵205.50. For Upper West region, the non-market co-benefit was 128% (132.14, representing US$69.5) because the return on the market components is negative. In a similar analysis, the data show that

households in Northern, Upper East, and Upper West regions lost 39%, 60% and 87.3%, respectively, of sheep market products (meat) in the form of death and theft. In comparison, 48.5% of market value of goat livestock is lost in Northern region while 77.6% is lost in the Upper East and 104.8% in Upper West regions. Despite these higher production risks that characterised the traditional small ruminant production system, the rate of return on capital invested is higher for the three regions. For sheep production, the highest return is 72.6% in the Northern region followed by 70.62% in the Upper East region and lastly, 29.1% in the Upper West region. Similarly, Upper West region reports the lowest rate of return (24.1%) for goat production compared with 43.5% in Upper East and 46.5% in the Northern region.

In an analysis of gender and small ruminant production, a contribution index is calculated to determine the participation of both male- and female- spouses in household small ruminant management activities and decision-makings. In another analysis, a Cobb-Douglas production function is used to analysed small ruminant productivity of both male and female producers. The contribution index shows an index of 2.04 for female spouses while 2.67 is recorded for male spouses in undertaking small ruminant management activities in the household. The study finds that female spouses always contribute (2.92) to cleaning of barns/kraals/pens but not in management activities such as discussions in extension visits (1.80), taking sick animals to veterinary (1.71), construction of barns/kraals/pens (1.61) and castration of animals (1.14). Men, on the other hand, are always responsible for the construction of barns/kraals/pens (2.95), marketing/sales of animals (2.95) and caring for sick animals (2.92). Management activities such as herding/tethering, feeding/providing fodder and water, and fodder harvesting are sometimes carried by both men and woman's spouse in the house. In terms of management decision-makings, the contribution index of female

spouses is 1.96 compared with 2.91 for male spouse counterparts. Apart from decisions on the use of income or products from the animals, female spouses are limited in small ruminant management decision-making in the household. The CobbDouglas regression shows that the farmer specific and institutional characteristics that influence small ruminant productivity include gender, household size, age, non-farm income source and extension service access. There are significant productivity differences between male and female small ruminant farms. Marital status and nonfarm income source are significant determinants of female small ruminant productivity, but of no necessity for male farm managers. Household size, however, is a significant determinant of male small ruminant productivity, but not in female farm managers. Age of household head and extension contact are found to have a significant effect on the small ruminant productivity of both male- and female- managed farms. However, the effects of some these estimates are mixed depending on the gender of farm households. Whereas age positively contributes to the productivity of male farmers, its effect on female producers is negative.

Component four of the empirical analysis centers on analysing constraints that limit small ruminant production in northern Ghana. It uses ordinal logit to explain the effect of socio-economic and institutional factors that predisposes farmers to major small ruminant constraints. The analysis reveals that diseases and parasitic infection, theft, destructive habits of animals and feed shortage are the top four constraints that limit small ruminant production. Above all other constraints, the data show that parasitic disease infection and feed shortage are the two most important constraints that hinder small ruminant production in the study area. Consequently, the ordinal logit shows that disease and parasite, as well as feed constraints, are affected by farmer and nonfarmer characteristics such as extension service access, production system, non-farm income

source and herd size. Farmers with smaller herd size and inadequate access to extension service and who manage sheep and goat under the free range system are more likely to be affected by disease and parasites menace. Also, farmers with larger herd size but lacking access to extension services and who are sustained by non-farm income activity are more prone to feed shortages in northern Ghana. The key remedies proposed by smallholder farmers to manage livestock production constraints include provision of credit, improved housing technology, establishment of community veterinary offices, education on good husbandry practices, provision of drugs/medicines and improved feed technology during dry seasons.

6.2 Conclusions

The study has assessed socio-economic determinants of small ruminant production, estimated the total benefit derived from the traditional small ruminant production system, gender contributions and constraints to small ruminant production in northern Ghana. Generally, four main conclusions are presented as follows.

6.2.1 Determinants of Smallholder Small Ruminant Production Systems

The examination of farmer‘s decision to own small ruminant livestock reveals that the majority of the farmers are household heads. Further investigation using the Negative Binomial regression model reveals that a farmer‘s status in the household is not a precursor to own small ruminant. Hence, the study refutes prior suggestions that sheep and goat may be owned and managed as non-pooled household resources and as such, production and management decisions are also made independent of household head‘s decision consideration. Using the household head data, the analysis shows that small ruminant ownership is likely to increase in northern Ghana when older farmers with large household size have access to income-generating activities outside the farm. In addition, access to extension even though has few observations is also likely to fuel

ownership of sheep and goat livestock in the study area. This result has important implications for livestock projects to select farm households for small ruminant production. It indicates how important farmers and non-farmers‘ characteristics influence the decision to manage small ruminant livestock.

Further analysis of preference of farmers for small ruminant types suggests that male farmers in the Guinea savannah agro-ecological zone are more inclined to own joint-sheep and -goat livestock. However, smallholder farmers who perceive sheep production as riskier and profitable are less likely to raise both sheep and goat together. Perhaps, the reason why farmers who perceive higher profitability for sheep production but are less likely to own both sheep and goat could be linked to higher perceived risk to sheep production. In support of this claim, the analysis reveals that farmers in the Guinea savannah region and those with higher sheep risk perception are more likely to go into goat production compared with sheep livestock.

6.2.2 Overall Economic Value of Small Ruminant Livestock

The study reveals that the objectives (advantages) of raising sheep and goat under the traditional production systems are numerous and can be classified as market outputs (sales) and non-market co-products including insurance and financing role, display of status, home consumption, manure, and strengthening social relationships. Consequently, such systems cannot be valued by a single criterion such as production for sale alone (market products).

The estimated total economic value demonstrates that smallholder farmers raise both sheep and goat to play important non-market functions in the household. Even though, the proportion of non-market components of sheep and goat are higher in all three regions, it appears that the use of small ruminants for such non-market cobenefits is relatively dominant in the Upper East and West regions. This confirms the assertion

that small ruminants farming represent key coping strategy in the livelihood of the poor and food insecure in the Upper East and West regions compared with the Northern region. The overall implication of this analysis suggests the importance of the non-market co-products towards sustaining and improving the competitiveness of the traditional small ruminant production systems.

The higher mortality and theft rate of small ruminant livestock among the three regions reveal the higher production risk associated with the traditional livestock system which probably reinforces the fact that small ruminants in northern Ghana are raised in chiefly support of non-market functions. Farmers may maintain sheep and goat in production beyond the animal‘s prime or economically optimum maturity to satisfy these non-market outputs. The resulting effect is, the animals may become predisposed to high risks such mortality, morbidity and theft.

6.2.3 Gender and Small Ruminant Production

The results reveal that both male and female spouses in the household equally contribute to management activities of small ruminant livestock. Women are involved in less physical small ruminant activities such as cleaning barns/kraals/pens, such women on occasions engaged in herding/tethering, feeding, provision of water, caring for weak animals and fodder harvesting. Men, on the other hand, constantly contribute to physical activities such as construction of kraals/barns/pens, marketing of animals and caring for sick animals. Despite this share of responsibility between male and female spouses in the family, the study shows that men are the sole decision makers with regards to small ruminant management activities.

The regression analysis highlights important farmer characteristics (age, gender, marital status, non-farm income source and household size), and policy factors

(access to extension service) that contributed to small ruminant productivity. The Cobb-Douglas regression indicates that the gender of a farmer significantly influences small ruminant productivity and as such, male and female small ruminant farmers have different productivities which are affected by different socio-economic and institutional factors. While, marital status, non-farm income source, age and extension access have a significant influence on small ruminant productivity of female farmers, age, household size and extension access significantly impact the productivity of male farmers.

The findings explain that male- and female-spouses within the household play different roles in small ruminant production and management decision. It further affirms that sheep and goat productivity of male farmers is influenced by set factors different from female farm managers.

6.2.4 Constraints to Small Ruminant Production Systems

The general constraints to small ruminant production include disease and parasite incidences, theft, destructive habits of animals and feed shortage which depict typical characteristics of traditional small ruminant production systems. Disease and parasites, as well as feed constraints, are reported as the most important constraints. The ordinal logit show that the probability of experiencing disease and parasite constraints increases with insufficient access to extension service, type of production system and smaller herd sizes. Similarly, insufficient extension access, larger herd size and lack of non-farm income source are likely to expose farmer‘s to feed

shortages in the study area.

In a response to curb these constraints, farmers requested for credit provision to buy drugs/medicine, improved housing technology, veterinary offices in farming communities, education on good husbandry practices and improved feeding technology

during the lean season. The fact that farmers are heavily affected by diseases and parasites as well as feed shortages justifies the need for these recommendations and in most cases the recommendations are complementary to each other. For instance, the need for improved housing to eliminate the incidences of diseases and parasites will also require improved feeding technology to improve nutrition so as to reduce the vulnerability of the animals to disease and parasite infection.

6.3 Policy Recommendations

Based on the conclusions of the study, the following important recommendations are made for policy action in order to improve the smallholder small ruminant production systems in northern Ghana.

6.3.1 Determinants of Smallholder Small Ruminant Production Systems

The policy implication of this analysis is in the area of selecting farm households for small ruminant intervention programmes. The results show that socio-economic and institutional factors influence farm households‘ decision to participate in small ruminant production. Importantly, non-farm income source, age, household size and access to extension service increase the probability of farm families to own sheep and goat livestock. Given that smallholders‘ production objectives and needs associated with raising small ruminants are influenced by social, economic and policy factors, livestock administrators dealing with intervention programmes in northern Ghana should therefore prioritise farmers with these attributes for implementation of livestock sector initiatives. The implication is that intervention programmes to improve small ruminant production should not only focus on increasing extension service to farmers, but also pay attention to farmer‘s characteristics such as non-farm income sources. Programs that link farmers to other income generating activities aside farming is relevant to boost small ruminant production. Therefore, Governmental and Non-

governmental Organisations can support rural employment creation, especially in the informal sector such as weaving, basketry, carpentry among others in farming communities. This will not only help households to smoothen household consumption but will also increase investment in small ruminant livestock because farmer‘s may have extra income to buy more breeds, veterinary drugs/medicine, among others.

6.3.2 Overall Economic Value of Small Ruminant Livestock

Policies or recommendations that outline appropriate improvement measures for the traditional livestock production system deserves much attention. The study reveals that a greater portion of the aggregate benefit from the traditional small ruminant system is to satisfy important non-market co-products. As a result, the production system is plagued with high production risks of mortality and theft. These results make a convincing case for livestock policies that recognised the total benefits of small ruminants, including non-market products in smallholder households. Small ruminant off-take rates (markets) will increase if policies are devised to provide costeffective and economic alternatives that will substitute the non-market role of sheep and goat in smallholder livelihoods. Unless there are less expensive, feasible and attractive options, the current status quo of the traditional small ruminant production systems will remain a permanent feature in the farming system since the non-market functions of the animals are deeply rooted in rural livelihoods. One pragmatic but a long-term alternative that will lessen the non-market (socio-economic products) roles of sheep and goat is to actively incorporate smallholder farmers into formal financial and insurance markets. This will not only entice farmers to become marketableoriented producers, but will also help reduce the huge losses of small ruminants. This is so because the practice of holding onto mature animals while exposing them to diseases, vehicular accidents, and theft to serve these non-market functions will be avoided or at least minimized.

6.3.3 Gender and Small Ruminant Production

Another area that demands policy intervention to improve on the traditional livestock system is to strengthen the role of women in managing household small ruminants. The study shows that, though both male- and female- spouses in the family equally contribute to small ruminant management activities, the opinion of women are frequently not considered in management decision-makings. The result, therefore, makes a strong demand for livestock programmes that will encourage male spouses to allow their female partners to participate in small ruminant management decisionmakings. The Ministry of Food and Agriculture should play the leading role to promote this agenda. In this regard, livestock administrators can incorporate such an idea into livestock extension programmes. In other words, extension programmes should be designed to allow spouses of farm households to participate in extension visits and training. Furthermore, the significant influence of extension contact on the small ruminant productivity of both female and male farms warrants for an increase in resources to livestock extension services to improve on regular visits. Such visits will not only afford women farmers the opportunity to interact freely with extension agents, but will also ensure that they receive first-hand information on good animal husbandry practices.

6.3.4 Constraints to Small Ruminant Production Systems

Small ruminant key constraints such as disease and parasitic infections and feed shortages deserve much research-audience. Among proposed strategies that can be explored by livestock administrators are improved housing technologies with a raised perforated platform separating animals from direct contact with the ground. Such a housing technology has the tendency to reduce diseases and parasites menace such as foot rot, pneumonia, worm infestation, among others since animals are not in direct

contact with droppings and urine. Besides, the symbiotic relationship between crops and animal production is improved since the collection of manure for crop production becomes easier. In addition, the Government, through the Ministry of Food and Agriculture, can promote the setting up of veterinary offices in typical farming communities for animal health delivery services and education.

Livestock administrators to reduce the seasonality of feed shortages of animals can look into the possibility of improving feed technology, especially using indigenous and high-yielding pasture and cultivation of leguminous crops. Indigenous browse species such as *Gliricidia sepium* leaves and twigs or a mixture of both can be harvested and processed into meals fortified with proteins and fed to animals during the lean seasons. The feed technology will not only ensure the availability of feeds throughout the season, but will also lessen animals‘ susceptibility to diseases and parasitic infection. In addition, the conservation of crop residues such as rice husk, corn haulms, and legumes twigs can be promoted to ensure feed availability during lean seasons.

6.4 Suggestions for Future Research

- Further studies are required to examine the determinants of factors influencing non-market co-products of small ruminants in smallholder households. Such studies will be relevant for livestock administrators and policy analysts in devising alternative options that will cater for holding small ruminants for financing and insurance functions under the traditional livestock systems.
- Gender-specific research work such as assessing women‘s willingness and responsiveness to livestock extension packages should be the focus of future research attention. This will help in the development of tailor-made extension programmes that will be ideal for women livestock farmers.

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APPENDIX I: SURVEY QUESTIONNAIRE

QUESTIONNAIRE

ECONOMICS OF SMALL RUMINANT LIVESTOCK PRODUCTION IN NORTHERN GHANA

Region……..……

Name of District……...

Name of Town/Village/Community……..……

Location

- ☐ Urban
- ☐ Peri-urban
- ☐ Rural

Agro-ecological zone

- ☐ Guinea savannah
- ☐ Sudan savannah

Enumerator…….. Tel. No……

SECTION A: FARMER AND HOUSEHOLD BACKGROUND INFORMATION

1.1 Gender of farmer/respondent

☐ Male
☐ Female

1.2 Primary role in household

☐ Head
☐ Spouse
☐ Child
☐ Others (specify)_____

1.3 Number of individuals in the household

Number of female children less than 18 years_____
Number of male children less than 18 years_____
Number of adult females 18-65 years_____
Number of adult Males18-65 years_____
Number of adult females above 65 years_____
Number of adult males above 65 years_____

1.4 Please, specify your age_____

1.5 Marital status

☐ Single
☐ Married
☐ Divorced
☐ Widow
☐ Separated
☐ Other (Please specify)_____

1.6 Religious affiliation of farmer.

☐ Muslim
☐ Christian
☐ African traditional faith
☐ Other faith (specify)_____

1.7 Primary occupation of farmer?

☐ Full-time crop farmer
☐ Part-time crop farmer

1.8 Ethnic background of farmer.

☐ Dagomba
☐ Gonja
☐ Frafra
☐ Dagari
☐ Wala
☐ Sissala
☐ Others (specify)_____

1.9 What is the highest level of education you completed?

Education	**Tick appropriately**
None	☐
Primary	☐
JHS	☐
SHS/O‘ level	☐

Vocational/technical	☐
Training colleges (teacher, health, etc)	☐
Polytechnic	☐
University	☐
Others (specify)_____	☐

1.10 Besides crop farming and small ruminant productions, what other type of economic activity work do you do?

- ☐ Private own non-farm business
- ☐ Salaried/paid worker
- ☐ None
- ☐ Others (specify)_____

1.11 P lease indicate your total household income (in new Ghana cedis) earned during 2011 (i.e. from January to December 2011).

- ☐ Less than Gh¢1,000
- ☐ Gh¢1,001 – 5,000
- ☐ Gh¢5,001 – 10,000
- ☐ Gh¢10,001 – 15,000
- ☐ Gh¢15,001 – 20,000
- ☐ Gh¢20,001 – 25,000
- ☐ Above Gh¢ 25,001

SECTION B: FARM INFORMATION

2.1 How did you acquire your cultivated farmland?

- ☐ Own/Family
- ☐ Lease
- ☐ Purchase
- ☐ Free communal land
- ☐ Do not have access to land
- ☐ Other (specify)_____

2.2 What is your total cultivated farmland size?

- ☐ Hectares_____
- ☐ Acres_____

2.3 If applicable, what type of major crops do you grow? **Tick all that apply**

Crop types	**Tick all**
Cereal crops (specify)_____	☐
Tuber crops (specify)_____	☐
Legume crops (specify)_____	☐
Vegetables (specify)_____	☐
Tree crops (specify)_____	☐
Forage crops (specify)_____	☐
Other **(**specify) _____	☐

2.4 What do you normally do with the crop residue from your farm?

Activity	**Cereals**	**Legumes**	**Vegetables**	**Tree crops**
Leave it on the farm	☐	☐	☐	☐
Feed to animals	☐	☐	☐	☐

Burn them	☐	☐	☐	☐
Sell to other farmers	☐	☐	☐	☐
Fuel	☐	☐	☐	☐
Other (specify)	☐	☐	☐	☐

2.5 Please indicate the small ruminant Livestock type managed on your farm?

Small ruminant type	**Tick**
Sheep alone	☐
Goats alone	☐
Sheep and Goats combined	☐

2.6 Please rate the reasons for the choice of the small ruminant you manage. **Rank importance (1-Unimportant, 2-Neither important/unimportant, 3-Important, 4- Very important)**

Importance	**Sheep**				**Goats**			
	Un-important	**Neither imp/unimportant**	**important**	**Very important**	**Un-important**	**Neither imp/unimportant**	**Important**	**Very important**
High prolificacy	☐	☐	☐	☐	☐	☐	☐	☐
Low mortality rate	☐	☐	☐	☐	☐	☐	☐	☐
Disease resistance ability	☐	☐	☐	☐	☐	☐	☐	☐
Environmental adaptability	☐	☐	☐	☐	☐	☐	☐	☐
High profitability	☐	☐	☐	☐	☐	☐	☐	☐
Easier to market	☐	☐	☐	☐	☐	☐	☐	☐
Less expensive to start	☐	☐	☐	☐	☐	☐	☐	☐
Easier to manage/handle	☐	☐	☐	☐	☐	☐	☐	☐
Gift	☐	☐	☐	☐	☐	☐	☐	☐
Diversification of risk	☐	☐	☐	☐	☐	☐	☐	☐
Inheritance	☐	☐	☐	☐	☐	☐	☐	☐
It‘s a custom/tradition to keep them	☐	☐	☐	☐	☐	☐	☐	☐
I don‘t know	☐	☐	☐	☐	☐	☐	☐	☐
Other (specify)_____	☐	☐	☐	☐	☐	☐	☐	☐

2.7 Please specify if you raise other species of animal(s) in your farm

Animal type	**None**	**Male Numbers**	**Female Numbers**
Cattle	☐		
Horses	☐		
Donkeys	☐		
Poultry	☐		
Others (specify)	☐		

2.8 Please specify which production system reasonably describes your small ruminant Livestock production/management system

Production systems	**Sheep**	**Goats**	**Sheep and goats**
Free range (no shepherd)	☐	☐	☐
Extensive system (with shepherd)	☐	☐	☐
Semi-intensive system (tethering of animals)	☐	☐	☐

Zero grazing or cut and carry system	☐	☐	☐
Intensive system (commercial production)	☐	☐	☐
I don‘t know	☐	☐	☐

2.9 Please specify the number of sheep, and goats you manage on your farm

Animal type	**Number**
Sheep flock	
Female Lambs < 6 months	
Male lambs 6 – 12 months	
Ewes	
Rams (not castrates)	
Rams (castrates)	
Goat flock	
Female kids < 6 months	
Male kids 6-12 months	
Does	
Bucks	
Castrates	

2.10 Please rate **your opinion** by comparing sheep and goats on the following risk attributes. **Rate, 4- Very high, 3- High, 2- Low, and 1-Very low**

Risk attributes	**Sheep**				**Goats**			
	Very high	**High**	**Low**	**Very low**	**Very high**	**High**	**Low**	**Very low**
High death rate (mortality)	☐	☐	☐	☐	☐	☐	☐	☐
Easily missing/lost	☐	☐	☐	☐	☐	☐	☐	☐
Easily stolen	☐	☐	☐	☐	☐	☐	☐	☐
Easily lost weight	☐	☐	☐	☐	☐	☐	☐	☐
Destructive nature of animal	☐	☐	☐	☐	☐	☐	☐	☐

2.11 Please rate **your opinion** by comparing sheep and goats on the return (profitability) to the farmer. **Rate, 4- Very high, 3- High, 2- Low, 1-Very low**

Profitability	**Sheep**				**Goats**			
	Very high	**High**	**Low**	**Very low**	**Very high**	**High**	**Low**	**Very low**
Income return	☐	☐	☐	☐	☐	☐	☐	☐

SECTION C: ECONOMIC VALUE ESTIMATION

3.1 Please rate/rank the main benefits from managing small ruminants? **Rank importance (1-Unimportant, 2-Neither important/unimportant, 3-Important, 4- Very important)**

Classification of purpose	**Sheep**				**Goats**			
	Unimportant	**Neither imp/unimportant**	**important**	**Very important**	**Unimportant**	**Neither imp/unimportant**	**important**	**Very important**
Physical products	☐	☐	☐	☐	☐	☐	☐	☐
Meat (sales)	☐	☐	☐	☐	☐	☐	☐	☐
Meat (for home consumption)	☐	☐	☐	☐	☐	☐	☐	☐

Manure (for farm)	☐	☐	☐	☐	☐	☐	☐	☐
Skin (hide)	☐	☐	☐	☐	☐	☐	☐	☐
Socio-economic uses	☐	☐	☐	☐	☐	☐	☐	☐
Non cash-savings	☐	☐	☐	☐	☐	☐	☐	☐
Insurance (in urgent need of cash)	☐	☐	☐	☐	☐	☐	☐	☐
Food risk management (against crops, and other animals failures)	☐	☐	☐	☐	☐	☐	☐	☐
Socio-cultural uses	☐	☐	☐	☐	☐	☐	☐	☐
Gifts	☐	☐	☐	☐	☐	☐	☐	☐
Religious rituals or faith based rituals (Christmas, Islamic, traditional, etc)	☐	☐	☐	☐	☐	☐	☐	☐
Non-faith based cultural functions (funeral, dowry, etc)	☐	☐	☐	☐	☐	☐	☐	☐
Others (specify)_____	☐	☐	☐	☐	☐	☐	☐	☐

3.2. If applicable, how many small ruminants have you **sold and/or purchased** in the past 12 months?

Animals	**Sold**		**Purchase**	
	Number	**Unit price**	**Number**	**Unit price**
Sheep				
Ram				
Ewe				
Female Lamb				
Male lamb				
Castrates				
Goat				
Doe				
Buck				
Male kid				
Female kid				
Castrates				

3.3 If applicable please indicate the number of small ruminants **received as a gift or shared agreement from** friends, relatives, and family in the past **ONE** year.

Sheep	**Number**	**Goats**	**Number**
Ram		Doe	
Ewe		Buck	

Female Lamb		Male kid	
Male lamb		Female kid	
Castrates		Castrates	

3.4 If applicable, please indicate the number of ruminants **used as a gift, or shared agreement to** friends, relatives, and family in the past **ONE** year.

Sheep	**Number**	**Goats**	**Number**
Ram		Doe	
Ewe		Buck	
Female Lamb		Male kid	
Male lamb		Female kid	
Castrates		Castrates	

3.5 If applicable, please specify the number of your small ruminants that **died or got lost** during the past **ONE** year.

Structure	**Number**	**Death**	**Number**	**Lost**
Sheep flock		☐		☐
Lambs		☐		☐
Ewes		☐		☐
Rams		☐		☐
Castrates		☐		☐
Goat flock		☐		☐
Kids		☐		☐
Does		☐		☐
Bucks		☐		☐
Castrates		☐		☐

3.6 Please identify the reasons for the deaths or loss of small ruminants on your farm.

Reasons for death or lost	**Sheep**	**Goats**
Sickness (diseases and pest attacks)	☐	☐
Starvation or hunger (feed shortage)	☐	☐
Accidents (car, motorbike, etc)	☐	☐
Predators (snake, etc)	☐	☐
Theft (stolen by humans, etc)	☐	☐
Others (specify)_____	☐	☐

3.7 If applicable, please specify the number of small ruminants you **slaughtered for food, naming ceremony, marriage, and festival** in your home for the past **ONE** year.

Sheep	**Number**	**Reason**	**Goats**	**Number**	**Reason**
Ram			Doe		
Ewe			Buck		
Female Lamb			Male kid		
Male lamb			Female kid		
Castrates			Castrates		

3.8 Please indicate the amount of time spent on each activity by household member (hours per day).

Task	Husband	Wife	Children 6-9 years	Children 10-18 years	Hired labor	Others
Herding and/or tethering						
Feeding animals						
Cleaning barns						
Taking to drinking water source						
Caring of sick animals						
Fattening management						
Construction of barns						
Sales of animals						

3.9 Please indicate the cost incurred during the past **ONE** year (Jan-Dec, 2011) on the following sheep and goats management services or activities.

Cost component (Ghana Cedis)	Sheep	Goats
Veterinary service		
Medicine/ drug		
Housing		
Fencing		
Dipping		
Feed supplement		
Others (specify)		

SECTION D: GENDER AND PRODUCTION

4.1 Please indicate who is primarily responsible for managing the household small ruminant livestock

	Sheep	Goats
Adult Male (Husband)	☐	☐
Adult Female (Spouse)	☐	☐
Joint (Both husband and spouse)	☐	☐
Others (specify)	☐	☐

4.2 Please rate your contribution to the household small ruminant management? **Tick appropriately (1- Never contributed, 2- Rarely contributed, and 3-Always contribute**d).

Task	Female (Spouse)			Male (Husband)			Other (specify) _____ _____
	Never contributed	Occasionally contributed	Always contributed	Never contributed	Occasionally contributed	Always contributed	
Herding and/or tethering	☐	☐	☐	☐	☐	☐	☐
Feeding/providing fodder to animals	☐	☐	☐	☐	☐	☐	☐
Cleaning barns/pens	☐	☐	☐	☐	☐	☐	☐
Provision of drinking water	☐	☐	☐	☐	☐	☐	☐
Caring for sick animals	☐	☐	☐	☐	☐	☐	☐
Construction of livestock housing	☐	☐	☐	☐	☐	☐	☐

Marketing of animals	☐	☐	☐	☐	☐	☐	☐
Castration of animals	☐	☐	☐	☐	☐	☐	☐
Taking sick animal to veterinary	☐	☐	☐	☐	☐	☐	☐
Discussions in extension visits	☐	☐	☐	☐	☐	☐	☐
Fodder harvesting	☐	☐	☐	☐	☐	☐	☐
Others (specify)_____	☐	☐	☐	☐	☐	☐	☐

4.3 Please rate your participation in decision making regarding the following household small ruminant management task. **Tick appropriately (1- Never contributed, 2- Rarely contributed, and 3-Always contribute**d**).**

Task	**Female (Spouse)**			**Male (Husband)**		
	Never contributed	**Occasionally contributed**	**Always contributed**	**Never contributed**	**Occasionally contributed**	**Always contributed**
Selecting animal type (sheep or goat)	☐	☐	☐	☐	☐	☐
Type of small ruminant breed	☐	☐	☐	☐	☐	☐
Health care (culling, vaccination, visiting vet., etc)	☐	☐	☐	☐	☐	☐
Sale or marketing of animals	☐	☐	☐	☐	☐	☐
Use of income and/or products from animals	☐	☐	☐	☐	☐	☐
Ownership of animals	☐	☐	☐	☐	☐	☐
Others (specify)_____	☐	☐	☐	☐	☐	☐

SECTION E: PRODUCTION/MANAGEMENT CONSTRAINTS

5.1 Please rate the importance of the following constraints in the production/management of small ruminants on your farm (1-**Unimportant, 2-Neither important/unimportant, 3-Important and**
4 Very important) **Tick appropriately.**

Constraints	**Sheep**				**Goats**			
	Not important	**Neither important/ not important**	**Important**	**Very important**	**Not important**	**Neither important/not important**	**important**	**Very important**
Feed shortage	☐	☐	☐	☐	☐	☐	☐	☐
Disease and parasites	☐	☐	☐	☐	☐	☐	☐	☐
Inadequate Marketing services	☐	☐	☐	☐	☐	☐	☐	☐
High cost of inputs (feeds, drugs)	☐	☐	☐	☐	☐	☐	☐	☐
Lack of access to credit	☐	☐	☐	☐	☐	☐	☐	☐
Insufficient extension service	☐	☐	☐	☐	☐	☐	☐	☐
Water shortage	☐	☐	☐	☐	☐	☐	☐	☐
Theft/predators	☐	☐	☐	☐	☐	☐	☐	☐
Livestock housing problems	☐	☐	☐	☐	☐	☐	☐	☐

Lack of or high cost of veterinary drugs	☐	☐	☐	☐	☐	☐	☐	☐
Lack of technical knowledge on animal management practices	☐	☐	☐	☐	☐	☐	☐	☐
High mortality of young animals	☐	☐	☐	☐	☐	☐	☐	☐
Destructive habit of animals	☐	☐	☐	☐	☐	☐	☐	☐
Others(specify)_____	☐	☐	☐	☐	☐	☐	☐	☐

5.2 Feed Shortage

5.2.1 What are the major feed sources available to your small ruminants?

Sources	**Tick all that apply**
Grazing along riversides	☐
Grazing along roadsides	☐
Crop residues	☐
On- farm grazing	☐
Conserved feeds (dry/bundle browses, silage)	☐
Harvested browse/fodder trees/shrubs	☐
Grazing around settlements/communal lands	☐
Home left overs	☐
Concentrates	☐
Others (specify)	☐

5.2.2 If it applies, please specify the grazing system you practice during wet and dry seasons?

	Sheep		**Goats**	
Grazing system	**Dry season**	**Wet season**	**Dry season**	**Wet season**
Free grazing or free roaming animals	☐	☐	☐	☐
Extensive grazing (with shepherd)	☐	☐	☐	☐
Tethering grazing of animals	☐	☐	☐	☐
Cut and carry or zero grazing	☐	☐	☐	☐
Others (please specify)	☐	☐	☐	☐

5.2.3 If applicable, what type of feed supplements do you provide to your sheep, goat or both?

Feeds supplement type	**Sheep**	**Goat**
Do not provide supplements (**move to Q 5.2.3.3**)	☐	☐
Maize grain/brand	☐	☐
Oil cakes/ meals	☐	☐
Home-made brewers recipe (millet/sorghum brews, etc)	☐	☐
Salt or local mineral sources	☐	☐
Cultivated fodder leaves	☐	☐
Others (specify)	☐	☐

5.2.3.1 How often do you provide ☐ Daily sheep or goats with supplements? ☐ Once a week

- ☐ Whenever available
- ☐ Others (specify)_____

5.2.3.2 When do you usually offer sheep or goats supplements.

- ☐ Wet season only
- ☐ Dry season only
- ☐ All year round
- ☐ Others (specify)_____

5.2.3.3 Why don't you provide sheep and/or goat with supplement?

- ☐ Supplement are not available
- ☐ Supplement are expensive
- ☐ Unaware of importance of supplements
- ☐ Do not want to offer supplements
- ☐ Others (specify)_____

5.2.4 If applicable, please indicate the feed preservation method you practice.

- ☐ Do not practice feed preservation
- ☐ Sun-drying
- ☐ Tying into bundles and packing on sheds
- ☐ Hay
- ☐ Silage
- ☐ Other (specify)_____

5.2.4.1 If you do not practice feed conservation, please explain?

- ☐ I do not have skills or the experience
- ☐ There is a shortage of grass/fodder
- ☐ I do not have enough labor to harvest grass/fodder
- ☐ There is abundance of feeds all year round
- ☐ I do not have sufficient storage space
- ☐ Other (specify)_____

5.2.5 Please indicate the severity of feed shortage for sheep, goat or both production in the last year on your farm?

- ☐ Very low severity
- ☐ Low severity
- ☐ High severity
- ☐ Very high severity

5.2.6 If you experience severe feed shortage, what reasons account for the shortage? **Rank the reasons (1-Not important, 2-Neither important/not important, 3-Important and 4- Very important)**

Reasons	**Not important**	**Neither important /Not important**	**Important**	**Very important**
Declining productivity of grazing lands	☐	☐	☐	☐
Increase in size of animal production	☐	☐	☐	☐
Farmland cultivation on grazing land	☐	☐	☐	☐
Protection of grazing lands	☐	☐	☐	☐
Residential development on grazing lands	☐	☐	☐	☐
Drought	☐	☐	☐	☐
Increase in human population	☐	☐	☐	☐
Others_____ ___	☐	☐	☐	☐

5.2.7. Please indicate which months of the year you experience the most severe feed shortage for your small ruminant farm?

Month	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Tick all	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

5.3 Disease and Pest Conditions

5.3.1 Do you have veterinary services in your community?	☐ Yes ☐ No
5.3.2 Please describe the accessibility of the veterinary service in your community?	☐ Not accessible ☐ Neither accessible/Not accessible ☐ Accessible ☐ Very accessible
5.3.3 Please rate the affordability of the veterinary service in your community	☐ Not affordable ☐ Neither affordable/Not affordable ☐ Affordable ☐ Very affordable

5.3.4 If applicable, indicate the frequency of your veterinary service access.

Frequency	**Tick**
Only when needed	☐
Once a month	☐
Twice every month	☐
More than twice every month	☐
Once a year	☐
Twice a year	☐
Other frequency (specify)_____	☐

5.3.5 If applicable, why don't you access veterinary service? **Rank the reasons (1-Not important, 2Neither important/not important, 3-Important and 4- Very important)**

Reasons	**Unimportant**	**Neither imp/unimportant**	**Important**	**Very important**
Veterinary services are not accessible	☐	☐	☐	☐
Veterinary services are not important	☐	☐	☐	☐
No transport to carry animals to vet. station	☐	☐	☐	☐
Veterinary offices are far from my farm	☐	☐	☐	☐
Veterinary services are too expensive	☐	☐	☐	☐
Other (specify)_____	☐	☐	☐	☐

5.3.6 Please indicate the severity to which diseases and pest affected your sheep, goat or both during last year (Jan-Dec. 2011).

- ☐ Very low severity
- ☐ Low severity
- ☐ High severity
- ☐ Very high severity

5.3.7. Please indicate which months of last year (Jan-Dec, 2011) did you experience severe disease and pest attack for your small ruminant production?

Month	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Sheep	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Goats	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

5.3.8 What do you normally do when your animal get sick? **Tick all that apply**

- ☐ Treat with traditional (ethno-veterinary) medicine
- ☐ Sell animal immediately
- ☐ Slaughter animal immediately
- ☐ Visit/invite district veterinary officer
- ☐ Visit/invite local chemical input dealer
- ☐ Speak to or consult other farmer
- ☐ Others (specify)_____

5.3.9 If applicable, how often do you vaccinate your animal?

Frequency	**Tick one**
Never	☐
Once every year	☐
When there is a disease/pest outbreak	☐
When is recommended by veterinary officer	☐
When I get advice from other farmers	☐
Other (specify)_____	

5.3.10. What are the major sources of medicine and drugs for your small ruminants?

Sources	**Tick all that apply**
Other farmers	☐
Input dealers in village	☐
Input dealers in nearest town	☐
Animal traders from town	☐
Veterinary office in nearest town	☐
Other sources (specify)_____	☐

5.3.11. Rate the importance of the common problems associated with health and management of sheep and goats in your community? Rank (**1- Not important to 4- Very important**)

Problems	**Not important**	**Neither imp/not important**	**Important**	**Very important**
Disease and/or parasite problems	☐	☐	☐	☐
Lack of veterinary services	☐	☐	☐	☐
Insufficient drugs and medicines	☐	☐	☐	☐
Insufficient feeds	☐	☐	☐	☐

Lack of animal health professionals	☐	☐	☐	☐
Veterinary services not affordable	☐	☐	☐	☐
Lack of extension agents	☐	☐	☐	☐
Insufficient water source	☐	☐	☐	☐
Others (specify)	☐	☐	☐	☐

5.3.12. In your own opinion what solution do you propose to improve on sheep and/or goat production in your community?

_____

_____

SECTION F: ACCESS TO FINANCIAL INSTITUTIONS

6.1. Have you taken credit from any **formal institution** during the past three (3) years for your farming?

☐ Yes
☐ No

6.2 If you answered _yes' to question 6.1, in what form was the credit?

☐ Cash
☐ In-Kind
☐ Both cash and in-kind
☐ Other (specify)_____

6.3 Do you have a savings account with any **formal financial institutions?**

☐ Yes
☐ No

6.4 Do you belong to any livestock producer association or cooperative?

☐ Yes
☐ No

6.5 Do extension agents frequently visit your farm for a discussion on livestock production?

☐ Yes
☐ No

6.6 If yes to question 6.5, what kind of advice/information does the agent give you concerning rearing of sheep and/goats?

_____

_____

_____