SOCIO-ECONOMIC FACTORS THAT AFFECT LIVESTOCK NUMBERS: A CASE STUDY OF SMALLHOLDER CATTLE AND SHEEP FARMERS IN THE FREE STATE PROVINCE OF SOUTH AFRICA

by

FOLASADE TEMITOPE OGUNKOYA

(49811622)

Submitted in accordance with the requirements
for the degree of

MASTER OF SCIENCE

In the subject

AGRICULTURE

at the

University of South Africa

Supervisor: **Dr B. NKONKI-MANDLENI**
Co-supervisor**: Prof. F.D.K. Anim**

May 2014

DEDICATION

This dissertation is dedicated to my father James Aderibigbe Ogunkoya and my mother Philomena Abike Ogunkoya, for always keeping me on my toes to achieve more in life.

DECLARATION

I, Folasade Temitope Ogunkoya, declare that “SOCIO-ECONOMIC FACTORS THAT AFFECT LIVESTOCK NUMBERS: A CASE STUDY OF SMALLHOLDER CATTLE AND SHEEP FARMERS IN THE FREE STATE PROVINCE OF SOUTH AFRICA” is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

SIGNED DATE: 03 December 2014

.....

Name: Folasade Temitope Ogunkoya

Student number: 49811622

ACKNOWLEDGEMENTS

My sincere gratitude goes to Almighty God, the Alpha and Omega, for making it possible for me to complete this study.

My profound gratitude goes to my supervisors Dr Busisiwe Nkonki-Mandleni and Prof. F.D.K. Anim for their continual support, instructions and constructive criticism throughout the course of the study. I also thank the members of staff of the Department of Agriculture and Animal Health for their academic support.

I appreciate the help of the communities of smallholder farmers in the four districts (Xhariep, Lejweleputswa, Fezile Dabi and Thabo Mofutsanyana), who were interviewed as well as the Free State's Department of Agriculture together with the assistance of the extension officers. This study would not be possible without their cooperation.

I also express my deepest gratitude to my parents for their prayers, love, financial and moral support through the years of my study.

My unreserved appreciation goes to Mr Olukayode Balogun for his constant support and encouragement throughout the course of study.

Finally, I cannot but say a big thank you to my dearest siblings, Aderonke, Adetunji, Adefunke and Oluwafunmilayo, for their constant love, support and prayers.

ABSTRACT

The study was conducted across the four district municipalities in the Free State province of South Africa. The objective of the study was to determine socio-economic factors that affected livestock numbers among smallholder cattle and sheep farmers in the Free State province of South Africa. The research was qualitative and quantitative in nature. Proportionate random sampling method was used to collect data. The population comprised of smallholder cattle and sheep farmers that kept at least 30 livestock. Data between the 2008 and 2012 farming seasons were collected by administering well-structured questionnaires to 250 smallholder cattle and sheep farmers. Data collected were captured and analysed using the statistical package for social sciences (SPSS version 22 of 2013) to obtain frequency, cross-tabulation, descriptive statistics and ordinary least square (OLS) regression. Descriptive statistics results indicated that lack of camp systems, drought prevalence, increased feed costs, poor veterinary interventions, insufficient breeding stock, high cost of fuel and transportation, lack of equipment, diseases, stock theft and pilfering, and insufficient grazing land were the prevalent factors that affected cattle and sheep farming in the province.The OLS regression results indicated that the variables that significantly affected livestock numbers were district, household size, livestock numbers in 2008, planted pastures, grazing land condition, grazing land acquisition, service, advice / training, veterinary services, purchase of dosing products and sales per year. The results also indicated that the majority (96.8%) of the smallholder cattle and sheep farmers would like to increase their livestock numbers.

It was therefore recommended that extension and veterinary services should be strengthened in the study area. In addition, it was recommended that smallholder livestock farmers should be encouraged to plant pastures to reduce pressure on the natural veld and make forage available throughout the year. Lastly, as a recommendation, government should provide subsidies with distribution policies that will ensure that all smallholder livestock farmers can benefit.

Keywords: Socio-economic factors, ordinary least square, cattle and sheep, smallholder cattle and sheep farmers, Free State province.

TABLE OF CONTENTS

page

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

ANOVA	Analysis of Variance
BPP	Bovine Pleuro-Pneumonia
CH4	Methane
DEFRA	Department for Environment Food and Rural Affairs
ECF	East Coast fever
FAO	Food and Agricultural Organization
FMD	Foot and Mouth Disease
GDP	Gross Domestic Product
GHG	Greenhouse gases
IFAD	International Fund for Agricultural Development
IPCC	Intergovernmental Panel on Climate Change
LID	Livestock in Development
LU	Livestock Unit
NDA	National Department of Agriculture
OLS	Ordinary Least Square
SPSS	Statistical Package of Social Sciences
UN	United Nations
UNECA	United Nations Economic Commission for Africa

CHAPTER 1

1.1 INTRODUCTION

Livestock can be described as all domesticated animals, especially sheep, goats, cattle and pigs, intentionally reared in an agricultural setting for food, fibre or breeding purposes (Ntshepe, 2011). Livestock systems occupy about 30 percent of the planet's dry land surface area (Steinfeld *et al*., 2006a*).* According to Nouman *et al*. (2014), livestock has the biggest land-use activity globally, which is expected to double by 2020 with an annual increase of 2.7 percent in meat production and 3.2 percent in milk production. Livestock production in developed countries is highly efficient due to the limited availability of resources, especially land, which are better utilized with more attention given to animal ethics, environmental impact, product traceability and consumer satisfaction (Steinfeld, 2004). Livestock farming plays an important role in the agricultural sector for most countries. Livestock provide high-quality animal-source foods in conjunction with a myriad of associated economic and social benefits to communities worldwide (Capper, 2013). Imai (2003) believes that livestock farming plays an important role in helping households to cope with negative shocks, because livestock provide diversification of income sources as farmers can easily sell their livestock to get cash.

Livestock production is the key to food security for many farmers in most developing countries, and an increase in livestock production is invariably associated with an increase in livestock numbers (Salem and Smith, 2008). Livestock farming has great potential to alleviate household food insecurity and poverty in communal areas of the world, including South Africa (Musemwa *et al*., 2008). Livestock may be used as a form of insurance against crop loss in poor weather (Seo *et al*., 2008). Livestock production contributes to food security both directly and indirectly, and plays a crucial role in the livelihoods of almost one billion of the world's poorest people (Smith *et al*., 2013a). Important products and by-products derived from livestock farming include meat, milk, eggs, manure, feathers, hides and skins, fibre and wool. Keeping livestock is an important risk-reduction strategy for vulnerable communities, and livestock are important providers of nutrients and traction for growing crops in smallholder systems (Thornton, 2010).

Livestock provide major support to the livelihoods of many rural dwellers in Africa where milk, meat and blood are important dietary components (Mariara, 2009). Livestock can also be used to deliver vital nutrients needed to supplement the nutritional status of household members and secure their most fundamental livelihood asset and human capital as a means of alleviating poverty (Randolph *et al*., 2007). According to Seré (2009), keeping livestock is not only a pathway out of poverty for the rural poor but also a means of spreading their risk and increasing their assets and resilience in order to cope with climate, market and diseases shocks.

Livestock also contribute to the food supply by providing manure in contributing to land preparation, providing ready cash to buy planting materials or fertilizer, or to hire labour for planting, weeding, or harvesting and converting low-value materials that are inedible or unpalatable for human consumption into milk, meat and eggs. However, livestock decreases food supply by competing with people for food, especially grains; currently livestock supply 13 percent of energy to the world's diet but consume half of the world's production of grain (Smith *et al*., 2013b; Scholtz *et al*., 2013).

As noted by Ouma *et al*. (2004), the benefits of livestock in a livestock production system outweigh costs when non-market parameters are considered. The rate of return on livestock capital investment is higher than that obtainable from cash, in a form of savings that can be invested in formal or non-formal financial institutions. These benefits of livestock keeping are of special importance in developing countries, where financial markets function poorly and opportunities for risk management through formal insurance are generally absent (Moll *et al*., 2001). Apart from the financial benefits derived from livestock farming, Fafchamps *et al*. (1998) reveal that farmers may invest in livestock as part of a tribal custom or tradition, or use livestock as an investment device in the absence of access to banking.

Reflecting on the social importance of livestock, they are considered a common means of demonstrating wealth, strengthening relationships through bride price payments and for slaughter at funerals, child-naming ceremonies or other social/religious events to honour the person or god concerned. Livestock are also

used in settling local disputes, whereby fines are paid with certain numbers of livestock (Ouma, 2003). According to Morton (2007), livestock production, especially on a small scale, is critical for many of the poor in the developing world, often contributing to multiple livelihood objectives and offering a pathway out of poverty through its impact on their nutrition and health. Livestock kept or produced in smallholder farming systems are an important component of the agricultural economy in the developing countries of the world; large numbers of poor people currently depend and will continue to depend on this system for survival (McDermott *et al*., 1999).

The small-scale livestock farmers, sometimes referred to as smallholder farmers, are mainly categorized by the livestock numbers, land size and household inputs. Smallholder farmers in developing countries have multiple goals for their livestock enterprises. Apart from cash benefits, livestock are closely linked to the social and cultural lives of smallholder farmers, for whom animal ownership ensures varying degrees of household economic stability (Lubungu *et al*., 2012).

Schultze *et al*. (2007) believe that cattle are the best instrument for finance for smallholder farmers and that they are the best option for large and flexible cash reserves; they also maintain the food security of the smallholder farmers by providing emergency finance. In South Africa, cattle production is the most important livestock sub-sector as it contributes about 25–30 percent to the total agricultural output per annum. Cattle farming meet multiple objectives such as provision of draught power, manure and cash sales, among other socio-economic functions desired by poor farmers. Livestock are also the main sources of meat, dairy products, fibre and manure (Musemwa *et al.*, 2008). According to Umrani (2000), livestock contributes to the production of organic fertilizer and fuel; dung from livestock can be used to supply household energy.

McManus *et al*. (2011) observed that ambient temperature is the factor that has the largest direct effect on livestock production. Most livestock perform at their best at temperatures between 4^{o}C and 24^{o}C, and the temperature usually rises above this comfort zone in the tropics and sub-tropics. According to the study, climate affects livestock production through its impact on pasture, forage crop quality and

production, changes in distribution of livestock diseases, disease vectors and parasites. Changes in climate patterns have altered the patterns of disease in animals, as a result of change in the emergence of new parasites and syndromes and the prevalence of existing diseases, putting greater pressure on livestock production and survival (McManus *et al*., 2011).

Roger (2008) defines diseases in livestock as a state of disturbance of the health status of an animal. It can be caused by any factors that alter this status. Examples of diseases include foot-rot, gastrointestinal parasitism, hypocalcaemia and pregnancy toxaemia. According to the study, diseases in livestock can be specific, shared with other species, or zoonotic, i.e. transmissible between animals and humans. Diseases left uncontrolled can reduce livestock numbers drastically. On the other hand, Smith *et al*. (2013b) believe that livestock disease can impact on food security when transmitted to humans, as these diseases may limit productivity by hindering people's ability to produce food themselves or work to earn income to purchase food.

According to Salem and Smith (2008), breeding is an area of concern in improving livestock farming; however, cross-breeding of livestock to produce desirable traits for disease resistance requires better nutrition, which is provided by a higher intake and supply of good-quality forage. However, livestock development may imply an increase in the demand for forage crops, and this can be detrimental to grain production, thus raising grain security concerns (*Smith et al.*, 2013a). Thomas and Rangnekar (2004) further state that the available land for livestock grazing has been reduced due to pressure for more cropping areas and infrastructural development.

Blignaut *et al*. (2009) believe that in South Africa, as in many other African countries, the agricultural sector (of which livestock production is a part) plays a very important role in the national economy. Over 70 percent of the resource-poor farmers in South Africa live in harsh agro-ecological zones unsuitable for growing crops, and they are thereby forced to focus on livestock farming as a means of livelihood (Mapiye *et al*., 2009).

The livestock sector is currently experiencing an expansion due to increasing demand for livestock products and population growth. This expansion of livestock sectors presents both challenges and opportunities for rural households in emerging economies. For example, Thomas and Rangnekar (2004) reveal that livestock farming encounters negative factors such as problems with housing and control of resources; access to credit and microfinance to purchase necessary inputs such as feed, supplements and drugs; and readily available and relevant knowledge. A study by the United Nations (2011) indicates that climate change is having a negative effect on livestock production and has already led to a decline in the availability of surface-water resources, a requirement for livestock farming. Grassland pastures will also change to shrub land due to this decline, which will definitely have a negative impact on livestock farming.

Frequent droughts are also taking a toll on the condition and numbers of livestock, usually the breeding herd. A localized, limited supply of water leads to overgrazing and trampling by cattle, with a serious negative environmental impact (Marinara, 2009). This is similar to the case of livestock production in the tropics, where lack of available feed for livestock production is said to have resulted from overgrazing and poor-quality and reduced forage from natural veld during the dry season (Abdulrazak *et al*., 1997). Munyai (2012), in a study in the Limpopo province of South Africa, indicates that the most important constraints on livestock production are overstocking rates, feed and herbage shortage during winter, loss of livestock due to extreme drought, poor grazing-land management, uncontrolled breeding, stock theft and snares.

1.2. Motivation and problem statement

Food security has become a global issue. Demand for food, fuel and fibre will increase by 70 percent by the year 2050 (FAO, 2009). Several studies agree that increase in the demand for livestock production and products, driven largely by human population growth, income growth and urbanization, will continue for the next three to four decades (Capper, 2013; Thornton, 2010; Smith *et al.*, 2013b). In the future, due to the anticipated increase in human population, most of which has been projected to take place in developing countries, livestock production will increasingly be affected by competition for natural resources (particularly land and water),

competition for food and feed and the need to operate in a carbon-constrained economy (Thornton, 2010).

Livestock farming has great potential to alleviate household food insecurity and poverty in most of the world's communities. The role that smallholder livestock farmers play in livestock production is a very crucial one. According to Smith *et al*. (2013b), smallholder livestock keepers rely mostly on food that is not available to people (grass, fodder, residues and waste) to feed their livestock. In this way they reduce the threat posed by livestock to food security. Smallholder livestock keepers represent around 20 percent of the world's population and farm most of the agricultural land in the tropics. Projected increases in future demand for livestock in developing countries provide unique opportunities to use sustainable intensification of livestock systems as an instrument for reducing poverty and improving stewardship of the environment (McDermott *et al*., 1999). With the envisaged increase in human population by 2050, livestock are considered part of the solution to ensuring global food security.

In South Africa, agriculture, which includes livestock farming, plays an important role in the natural economy of the country. According to Meissner *et al.* (2013), livestock provides sustenance for most metropolitan and rural communities. Seventy per cent of the agricultural land in South Africa can be used by livestock, and game species are found in all the provinces. The Free State has the third-highest number of cattle and sheep compared with the other eight provinces (Table 1.1). Agriculture dominates the Free State landscape, with cultivated land covering 32,000 square kilometres; natural veld as well as grazing covers 87,000 square kilometres of the province. Livestock products contribute 30 percent of the agricultural income of the province. The province produces about 18 percent of South Africa's red meat and agriculture is central to its economy (South African Government information, 2012). For these reasons, it would be important and interesting to study the factors that affect livestock numbers and examine how smallholder livestock farmers in the Free State can reduce their vulnerability to factors affecting the livestock farming.

Table 1.1: Cattle and sheep estimates by province (August 2011 and November 2011)

Province	Cattle		Sheep	
	Aug 11	Nov 11	Aug 11	Nov 11
Western Cape	560 000	558 000	2 806 000	2 716 000
Northern Cape	509 000	517 000	6 045 000	6 055 000
Free State	2 279 000	2 348 000	4 753 000	4 880 000
Eastern Cape	3 137 000	3 221 000	7 084 000	7 302 000
KwaZulu-Natal	2 645 000	2 759 000	772 000	760 000
Mpumalanga	1 476 000	1 478 000	1 748 000	1 765 000
Limpopo	1 073 000	1 077 000	263 000	262 000
Gauteng	256 000	261 000	104 000	104 000
North-West	1 752 000	1 800 000	729 000	706 000

Source: Department of Agriculture, Forestry and Fisheries (February, 2012).

1.3 Aim of the study

The study aimed at determining socio-economic factors that affect smallholder cattle and sheep numbers in the Free State province of South Africa, in order to provide a clear understanding of the problems that prevailed in the area of study.

1.4 Specific objectives

The specific objectives of the research are to:

(i) determine the socio-economic and demographic characteristics of smallholder cattle and sheep farmers in the Free State province;
(ii) investigate the prevalent factors affecting smallholder cattle and sheep farming in the Free State.
(iii) determine the socio- economic factors that affect smallholder cattle and sheep numbers in the Free State province;
(iv) make recommendations on how smallholder cattle and sheep farmers can reduce their vulnerability to the socio-economic factors that affect cattle and sheep farming.

1.5 Limitations of the study

This study was limited by factors such as personal bias by the respondent during interviews. Many of the questions in the questionnaire relate to the farmers' perceptions, and there is the possibility of them being biased. Some questions also required reference to records; respondents who did not keep or could not find records could have given a biased response. Some respondents were sceptical about revealing accurate figures relating to livestock numbers; this was avoided by emphasizing the confidentiality of information during the interviews. Some of the questions dealt with the issues with the extension services in the area; as most of the extension officers interviewed were in charge of the various towns visited, farmers exercised caution in their choice of words. Most of the respondents felt more comfortable responding to questions in their local languages; for this reason some information may have been left out or wrongly interpreted into English. Where farmers were visited in their homes, interviews were sometimes interrupted by domestic issues, prolonging the length of the interview.

1.6 Outline of the study

Chapter 1 provides background on livestock farming. It provides the motivation for the study and the research objectives. It also gives the limitations and outline of the study.

Chapter 2 provides a review of the literature that identifies issues related to the factors affecting livestock farming at both global and local levels.

Chapter 3 presents a brief overview of the study area. It also includes a detailed discussion of the method used for data collection and analysis.

Chapter 4 determines the factors that affect livestock numbers in smallholder cattle and sheep farming. It also uses descriptive statistics to investigate the most prevalent factors affecting cattle and sheep farming. Further inferential statistics is provided to determine the socio-economic factors that affect cattle and sheep numbers.

Chapter 5 summarizes, concludes and makes recommendations based on the findings of the study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews livestock farming and its importance in socio-economic development globally, in African countries and in South Africa. The importance is viewed in terms of its contribution to the gross domestic product (GDP), food security and the rural poor. This chapter also focuses on the challenges affecting livestock production and the effects of the changing ecosystem on livestock production. The role of extension services in livestock production and management is also reviewed. Furthermore, this chapter reviews smallholder livestock production, livestock production systems, veld management and livestock grazing systems.

2.2 Livestock and socio-economic development

Livestock is globally the mainstay of the agricultural community. It provides 50 percent of the value of agricultural output globally and one-third of the value in developing countries (Nouman *et al*., 2014). In many African countries as well as in South Africa, many rural households earn a living from livestock farming and consider keeping livestock as a store of wealth (Mandleni and Anim, 2012). Livestock makes a multifaceted contribution to the social and economic development of the rural masses. However, livestock farming is an important component of the agricultural economy, especially in most developing countries (McDermott *et al*., 1999). Several factors have contributed both positively and negatively to changes in livestock numbers. Some of these factors are economic growth and increased incomes (Steinfeld et al., 2006a); increase in demand for livestock products arising from rapid growth in human population and urbanization (Delgado *et al.*, 1999; Thornton, 2010); developments in breeding, nutrition and animal health (Thornton, 2010); rapid technology invasion (Nouman *et al*., 2014; Rae, 2008); changing food preferences (FAO, 2009); changes in climatic conditions (Mandleni, 2011) and genetic improvements (Adkinson and Adkinson, 2013). Mwangi (2013) adds that socio-economic and environmental factors such as population growth, urbanization and economic development, changing livestock market demands, impacts of climate variability and science and technology trends have contributed to the changes in

livestock numbers. According to Ilea (2009), global livestock production is expected to double by 2050, growing faster than any other agricultural sub-sector.

Over the last six decades, livestock production has increased substantially across the globe; this increase in production has been driven mostly by animal science and technology, as well as by scientific and technological development in the areas of breeding, nutrition and animal health. People who live in highly industrialized countries derive more than 40 percent of their dietary protein intake from livestock (Steinfield *et al*., 2006a). It is projected that people who live in the rapidly emerging economies and developing countries will demand better animal-based foods in the future (Smith *et al.*, 2013a). Thornton (2010) is of the opinion that the future demand for livestock products, especially in developed countries, could be heavily moderated by socio-economic factors such as human health and changing socio-cultural competition between food and feed production for land use. Increasing industrialization of livestock production may also lead to increasing concerns about air and water pollution.

Considering the importance of livestock systems for food security, and their potential to impact on poverty, livelihood, health and nutrition as well as the environment, the livestock sector still receives limited attention in the global agriculture and food debate. According to Smith *et al.* (2013b), livestock production is an indispensable part of the solution to global food security; a reasonable amount of the world's food supply comes from systems of which livestock are an important part. Livestock production is an important contributor to sustainable food security for many nations, particularly in low-income areas, and marginal habitats that are not suitable for crop production (Godber and Wall, 2014). Warburton *et al*. (2011) state that smallholder farmers and livestock keepers are at the heart of world food production, producing more than half of the world's food; they feed an estimated 70 percent of the global population and cultivate most of the world's varieties of food crops and livestock.

The livestock sector accounts for over 40 percent of the global GDP and one-third of the global protein requirement; it forms a component of the livelihoods of about 70 percent of the world's more than one billion rural poor, who survive on less than US $1.25 per day (LID, 1999; UN, 2009).

Livestock systems are a significant global asset, occupying 45 percent of the earth's surface. Livestock contribute about 17 percent of the food energy and about 33 percent of the protein we consume (Seré, 2009). The economic importance of livestock production to agriculture and economic development as a whole cannot therefore be overemphasized. Livestock production accounts for 90 percent of the agricultural GDP in Mongolia and 80 percent in Sudan (FAO, 2009). According to PapaChristoforou and Markou (2006), livestock production in Cyprus accounts for about 42 percent of the value of total agricultural production. He notes that the increase in livestock production was as a result of the gradual transformation from low to high input production systems, which came about in an effort to improve productivity to meet increasing demand, reduce production risk associated with frequent droughts, decrease pressure on the environment from overgrazing and lower production costs. In the US, the livestock sector has developed and intensified according to strict production systems that emphasize efficiency rather than cultural, social, economic and environmental aspects. As a result this has posed sustainability problems that are difficult to resolve (Hinrich and Welsh, 2003).

Nouman *et al*. (2014) reveal that livestock production in Pakistan has increased contributing to the growth of the agricultural economy. The livestock sector contributes significantly to the health and economy of the rural communities and the whole nation of Pakistan; the sector makes an important contribution to the GDP and overall export earnings of the nation. According to Umrani (2000), the livestock sector of Pakistan contributed 9 percent to the GDP, 37 percent to the agricultural sector and formed about 5.3 percent of the overall export earnings of the country in 1998. Livestock was also responsible for the supply of 16 percent of total household energy in the form of dung. Apart from the contribution of livestock to Pakistan's national economy, Umrani (2000) also states that the majority of livestock belong to landless or small farmers who keep livestock under the extensive farming system. According to UzmaAmbreen *et al*. (2013), most of the natural exports of Pakistan come from the livestock sector; however, demand for livestock products is increasing as a result of population growth, economic development and urbanization. The study further state that livestock provide security against crop failure for the majority of the rural poor in the country.

Wilson (2007) reveals that the livestock sector contributes about 16 percent of the GDP of the Laos People's Democratic Republic; about 90 percent of all households in the country keep one or more species of livestock on a low-input system, which accounts for low levels of production in the country; while in India the livestock population occupies one-third of Asia's agricultural land area (Chhabra *et al*., 2013). According to Meena and Singh (2013), India's livestock sector has grown at an annual rate of 7 percent, which is more than double the growth of the agriculture sector. Meena and Singh further state that the livestock sector plays a multi-faceted role in the socio-economic development of rural households, and contributes about 4.2 percent to the GDP and 25.6 percent to the agricultural GDP in the country. Kumar *et al.* (2007) reveal that livestock is the prime source of livelihood for about 85 percent of the rural population in the north-eastern region of India, as dependence on livestock as an alternative source of income is very significant for the majority of the rural population. According to the study, several factors such as availability of labour, occupation, farm size, availability of irrigation and access to information sources determine a household's decision to rear livestock.

Rae (2008) states that in China, the revolution in the livestock sector resulted from rapid economic growth and development. He further states that backyard and part-time farming are the most common types of livestock farming in China, and that smallholder livestock farmers make up about 99 percent of all the livestock operations, producing most of the livestock products in the country. Ali (2006) adds that the growth of the livestock sector in China has been increasing consistently when compared to the growth in the crop sector. The sector contributes about 25 percent to the gross value of agricultural output, with great potential to provide nutritional security in terms of calories, protein and fats.

For the majority of the rural households that depend heavily on agriculture as a major source of livelihood in sub-Saharan Africa, livestock (especially cattle production) play an important role in agricultural development as well as in the economic and socio-cultural traditions of the people (Ngigi, 2005). According to Cardoso (2012), livestock production and performance has decreased within the last three decades in sub-Saharan Africa; production has failed to keep up with the increasing population; low productivity has been attributed to economic and

environmental consequences; and upgrading livestock management skills in the region has become necessary in order to bring about substantial increases in livestock yield for human consumption.

Livestock farming is mainly the primary source of livelihood for most of Namibia's population. About 75 percent of the land area is used for extensive livestock ranching; however, most of the marketed livestock in the country are produced by the commercial sector, with very little marketed livestock originating from the communal sector (Lange *et al.*, 1998). In Botswana, Barnes (2008) notes that livestock, especially extensive cattle-keeping on natural rangeland, dominates the agricultural sector. Most of the livestock in Botswana are found on communal land; 60 percent of the land is used for traditional livestock keeping, while commercial livestock farmers occupy only about 10 percent.

In South Africa, livestock production contributes significantly to food security and conservation of biodiversity. Livestock are produced throughout the provinces of South Africa, including the Free State, in different numbers, species and breeds, depending on the grazing, environment and production systems. Most of the agricultural land in South Africa is used by livestock, with a higher concentration in the higher rainfall regions of the east. The extensive system of livestock farming is the one most commonly practised across all the provinces. Both rural and urban societies keep livestock, with urban dwellers often having access to grazing land known as commonage, made available by town municipalities. However, livestock numbers across the provinces vary according to grazing land availability, the environment and the production systems (Meissner, 2013; Scholtz *et al*., 2013).

2.3 General overview of constraints of livestock farming / production

Livestock farming has been faced with many negative factors in various countries globally. According to Mupawenda (2009), livestock production is affected by several social, economic, biological, political and management factors. The problem of drought is one the factors affecting livestock farming. Wreford and Adger (2010) examined the effect of drought and heat wave on livestock farming in the UK, indicating that the effect of drought may not be felt immediately in the year it occurs. Farmers may sell more stock, resulting in increased production, in the year in which

drought occurs, but in the subsequent years, production may decrease as farmers rebuild their herds. The recovery from the drought conditions has resulted in fewer numbers slaughtered, as farmers rebuild their herds. Another study conducted in the UK by Benton *et al*. (2012) indicates severe weather conditions such as drought, rainfall, flooding and windstorms as factors affecting cattle and sheep farming. Flooding and windstorms lead to severe damage to livestock. For example, a loss of over £400 million to flooding was recorded in 2005, with acres of grazing land put off use for up to a year. Cows were back indoors on full winter rations because acres of grazing land were flooded. Drought in 2010 caused a reduction of between 25–40 percent in silage yield; quality and quantity of second-cut hay reduced by up to 50 percent; and some farmers were forced to sell most of their herds due to lack of feed for winter. Also, due to heat and drought, a low yield and quality of crops was recorded, and heat stress caused pre-shearing in sheep as well as reduction in forage so supplementary feed was required. There was also a decrease in grass silage and low replacement of forage, and farmers were forced to cull cows to market earlier as a result of increases in feeding costs (Benton *et al*., 2012).

IFAD (2009b) reveals that climate change has an effect on livestock farming and it will be harder on the poor people in developing countries. This is due to their dependence on natural resources and agriculture for their survival. Similarly, a study conducted by the Food and Agriculture Organization (FAO, 2008), also reveals that changes in climate patterns will result in food insecurity; resource-poor developing countries that cannot meet their food requirements through market access will be worst affected.

Morgan and Wall (2009) believe that livestock tend to suffer from increasing production losses as a result of diseases caused by parasites, and that insufficient attention has been paid to mechanisms that could mitigate such increases, and how they can best be exploited. In addition, the degree of damage caused by livestock parasites is strongly correlated with the abundance of the macro parasites. The study indicates that increases in ambient temperature as a result of global warming might be expected to have profound effects on the abundance of parasite populations through higher rates of development and release of infective stages. Wuebbles and Hayhoe (2004) show that warmer temperatures in the US Midwest

due to climate change mean more heat stroke cases in livestock, as well as reduced appetite and productivity, which eventually leads to a decline in weight gain and milk production. In the US, pre-term delivering, poor birth weight of offspring and pregnancy complications were indicated in cattle and sheep, due to stress in the maternal environment. Factors such as undernourishment, exposure of pregnant females to hyperthermic environments, grazing during pregnancy and nutrient restrictions were recorded as being responsible (Vonnahme, 2012).

Wolfe *et al*. (2008) in a study in the northern US, whose agriculture economy is dominated by dairy milk production and high-value horticultural crops, indicate that many crops will have yield losses associated with increased frequency of high-temperature stress, an inadequate winter chill period for optimum fruiting in spring, and increased pressure from invasive weeds, insects and diseases due to increased atmospheric carbon dioxide. This could also indirectly affect livestock and dairy industries by affecting the availability and price of crops used for animal feed. Livestock are also affected by summer heat stress, which has long-term effects on both milk production and birthing rates as dairy cows prefer cool temperatures. The study however mentioned some adaptive measures such as reducing overcrowding, minimising time in hot holding areas, maximizing shade, new building designs, construction and installation of thermostat-controlled air conditioning systems, modification of feeding schedules and feed rations.

A study conducted in Brazil by Schultze *et al*. (2007) shows heat stress as a major factor in livestock production, especially cattle and sheep farming. Heat stress causes a series of alterations in the animals, affecting acid/base balance, hormone-regulating metabolism and immune response, and thereby feed intake. To enable animals to cope in hot climates, it was suggested that farmers stock breeds with traits such as a large skin area to live weight ratio, shielded eyelids, pigmented skin and eye lids to lessen susceptibility to eye cancer, white body cover or light colour and the ability to walk long distances, adjust to low water intake, endure harsh treatment, and resist ticks and other pests. According to Wilson (2007), the livestock sector in Laos People's Democratic Republic is facing several constraints such as low levels of investment in view of the importance of the sector, inadequate extension services with poorly trained staff, limited knowledge among farmers of

modern production techniques, high mortality rates resulting from poor nutrition and diseases, poor reproductive rates and lack of enforcement of polices.

In Kenya, where livestock farming at subsistence level is the major component of the economy, there are indications that change in patterns of land use from nomadic pastoralism to sedentary pastoralism and in some cases pure cultivation have an adverse effect on livestock farming. The change in patterns of land use was due to unprecedented population growth, excessive cropping systems and overgrazing. Relatively harsh environments infested with tsetse flies and ticks, in addition to frequent drought, were also noted to have affected cattle and sheep production negatively. Frequent outbreaks of diseases such as foot and mouth disease (FMD), Typanosomosis, Anaplasmosis, Lumpy skin diseases, malignant catarrh, Contagious Bovine Pluero-Pneumonia (BPP), East Coast fever (ECF) and Helminthiosis were said to have resulted into a number of deaths. However the study noted that disease control efforts are not impressive (Nyariki *et al*., 2009).

Banda *et al*. (2012) show that the extent to which livestock farmers in Malawi, especially those most involved in dairy production, are influenced by various challenges is determined by the farmers' access to animal health, breeding and financial services. Some of the challenges faced by the farmers include poor feeding, as most farmers keep the livestock in pen throughout the year, poor housing, poor health management practices, and poor breeding and health services, which in turn result into low productivity.

In a study in Ethiopia, Tibbo (2002) indicates feed shortages, livestock disease, low genetic potential of indigenous livestock, lack of marketing infrastructure and water shortages as the factors affecting cattle and sheep farming in the area. Hailemariam *et al.* (2013), in a study of traditional sheep production in southern Ethopia, state that disease and parasites and lack of proper water and feed resources, followed by lack of extension support, are the major constraints facing sheep farming in the area. According to Hailemariam *et al*. (2013), uncontrolled breeding is common in the area as mating occurs everywhere at the time of feeding. Still in southern Ethiopia, Tolera and Abebe (2007) reveal that lack of feed and water during the dry season and drought are the main constraint affecting livestock production. Shortage of rain and

frequently recurring drought and bush and range land encroachment by poisonous and undesirable plant species in the area are major causes of reduced forage production, which in turn contributes to a high mortality rate. Prolonged dry seasons and drought, outbreaks of disease (e.g. foot and mouth disease, black leg, and anthrax), infestation by parasites (e.g. ticks and mange mites) and predators (especially hyena) also have a significant effect on the health and productivity of the livestock in the area.

In Namibia, where the rural economy depends heavily on extensive ranching activities, Lange *et al*. (1998), reveal that livestock farmers are faced with increasing pressure from the extremely dry and erratic climate, poor economic conditions and land degradation. Reid *et al*. (2008) estimate a drop in carrying capacity of about 15 percent in grazing land. Smallholder farmers experience a range shift and a greater decrease of between 20 percent and 50 percent in a worst-case scenario. A study in Cameroon, whose economy is predominantly agrarian, indicates that cost of production increases as farmers attempt to compensate for unfavourable weather conditions (Molua, 2002).

In South Africa, one of the major issues of concern is climate change, according to a study conducted by Dobell *et al*. (2008) on analysis of climate risk for crops in 12 food-insecure regions – of which southern Africa is one – indicated that southern Africa will likely suffer negative impacts on several crops that are important to food security and livestock feed by 2030. Another study conducted by Turpie *et al*. (2002) predicts changes in the terrestrial ecosystem, of which livestock is a part, may result in loss of habitat and the extinction of certain species. The study also predicts that the economic impact of climate change will be felt throughout the primary sector, mainly in terms of changes in production that will affect the value added to national income as well as people's livelihoods within the livestock sector.

2.4 Livestock and the environment

2.4.1 Livestock as an emitter of greenhouse gas

In as much as livestock are important they have, however, wide range of undesirable direct environmental impacts upon the quality of air and water, nutrient leaching, soil

erosion and biodiversity (Capper, 2013). According to Meissner *et al.* (2013), the major environmental impact of livestock is land degradation, air pollution, water pollution and sometimes biodiversity conservation where production systems are not well managed. However, the rapidly increasing demand for livestock products also exerts pressure on the environment. There has been much speculation around the impact of increasing livestock production on the environment as global livestock demand increases to meet the increasing population demands. Much attention has been paid to greenhouse gas (GHG) emissions due to their effect on global warming and climate change. In industrialized countries, the GHG emissions from the energy sectors are much greater than the GHG emissions from agriculture (Scholtz *et al*., 2013).

Global livestock production accounts for about 18 percent of the GHG emissions (Seré, 2009). Most emissions come from industrialized countries practising factory farming systems, while the least come from family farms in developing countries. The feeding patterns of livestock are the major contributors to this GHG emission. Methane (CH_4), the most potent greenhouse gas, is produced by the rumination and belching of hoofed, cud-chewing livestock such as cattle, sheep and goats. Methane emissions per ruminant livestock in poor countries tend to be relatively high because of the poor diets that reduce the efficiency with which they convert their feed into milk and meat. Globally, about 80 million tons of methane is produced annually through this process of rumination and belching (Patra, 2012). The enteric methane emission by these ruminant livestock represents a loss of 2 percent to 12 percent of gross energy feeds and contributes to the global greenhouse effect. According to Gill (1999), livestock contribute directly to about 9 percent of the global anthropogenic GHG emissions and about 3 percent of UK emissions. These estimates of emission from livestock activities are subject to uncertainty, because generic coefficients applicable to all livestock are commonly used without taking into consideration the variations that exist in different production systems (Scollan *et al*., 2010).

More efficient management of grazing land and use of manure and improved livestock production efficiency through better breeding are ways of reducing GHG emission from the livestock sector by decreasing the numbers of livestock required per unit (Gill, 1999). It is estimated that the mitigation potential of improved feeding

alone in the tropical systems was found to be around 7 percent of the global mitigation of agriculture (Smith *et al*., 2013a). It is obvious that in considering mitigation options, a 10 percent reduction in GHG emission by the energy sector would be far more effective than a 10 percent reduction in contribution by agriculture (Scholtz *et al*., 2013).

2.4.2 Livestock and water use

The nature of global water security has been severely affected by climate change; this is evident in changes in rainfall patterns and increased frequency and severity of flood and drought (IFAD, 2009b). However, water resources have become increasingly scarce at global level and are expected to be severe in areas where the amount of rainfall will decrease due to climate change (Amede *et al*., 2011). This raises a serious concern and calls for a more efficient use and management of water resources in livestock production, as livestock can barely survive without water.

Water requirements and their impact on the environment for livestock production vary across different production systems. According to Smith *et al*. *(*2013a), the livestock sector makes use of one-third of the total agricultural water use and livestock grazing and feed production accounts for 90 percent of this water use (Herrero *et al.*, 2013). The largest volume of water usage is in the mixed arid farming systems, followed by pastoral arid systems (Silvestri *et al*., 2012). Livestock water use varies considerably within and among production systems and countries. Although 20–50 litres per tropical livestock per day is consumed depending on the species, breed and other prevalent conditions, this is not the only thing that requires water; water is also required for feed production and processing by-products (IFAD, 2009a). In fact Peden *et al.* (2009) indicate that transpiration of water in livestock feed production accounts for most of the water consumed by livestock; it is said to be 50 to 100 times more than the amount they drink.

Livestock owners are also often seen as a potential danger to water resources in two ways: firstly they could take possession of water points for the use of their own livestock and secondly they could destroy local vegetation and cause soil degradation as they herd livestock to water points (IFAD, 2009a). Improper

management of manure and waste products from livestock could also contaminate water resources.

Capitalizing on rain-fed agriculture may play a major role in reducing the competition for scarce water resources. Practising a mixed crop-livestock system may also be a better and more complementing way of utilizing water resources, as livestock can then make use of by-products from crops and a portion of non-processed water to convert fibrous matter into useful animal products with higher value, thereby contributing to increased water productivity (Alemayehu, 2012). Amede *et al*. (2011) refer to this rain-fed water management as an integrated strategy that enables crop-livestock systems to systematically capture, store and efficiently use water and nutrient resources on farms and watersheds in a sustainable way for both agricultural and domestic purposes.

2.4.3 Livestock and land use

Livestock is one of the main land users. This is because of the nature of pastoral production, which usually requires a very large expanse of land and efficient management (Herrero *et al*., 2013; Nyariki *et al*., 2009). According to Seré (2009), livestock systems occupy 45 percent of the earth's surface. This is not surprising as 70 percent of the agricultural land in South Africa is utilized by livestock (Meissner *et al*., 2013); 75 percent of land in Namibia is used for extensive livestock ranching (Lange et al, 1998); and beef cattle production alone occupies 75 million hectares in Northern Australia (Macleod *et al*., 2004). However, livestock production is generally assumed to be adversely affected by land degradation, which eventually reflects on the economic performance (Macleod *et al*., 2004). Poor management of livestock grazing and activities is evident in overstocking beyond the lands' carrying capacities, which exposes pastureland to erosion and loss of vegetation as a result of overgrazing. Trampling and constant veld fires are also said to have contributed to land degradation. Macleod *et al*. (2004) examined the productivity of livestock under different grazing regimes; they found that changes in land conditions had both positive and negative effects on livestock production, depending on the stocking rates and levels of feed utilization used. The link between land condition, livestock and economic outcomes was determined using a combination of experimental data and simulating models. It was established that as land conditions deteriorate,

reduction in livestock numbers is warranted; and that extreme cases of poor land conditions with high livestock numbers result in poor livestock performance, with poor market value and hence low profitability.

2.4.4 Livestock and climate change

Although livestock production is also believed to contribute to climate change, climate change also has significant impacts on the ecosystem and global livestock production. Most changes in climatic conditions such as temperature and rainfall have resulted in extreme natural occurrences such as drought, floods and windstorms. These are believed to affect the productivity and overall performance of livestock in terms of susceptibility to diseases, milk production, birth rate, growth rate and feed and water availability. These changes in climate may occur due to natural processes, external forces or persistent anthropogenic changes in the composition of the atmosphere or in land use. Several studies have shown that the agricultural sector, of which the livestock sector is a part, is one of the most exposed to climate change, since agricultural productivity depends on climate. The International Panel on Climate Change (IPCC, 2007) also confirms the real existence of climate change. It is predicted that the effects of climate change will become worse and the poorest people will be the worst affected and yet it is the poor that rely wholly on livestock for livelihoods and wealth. The increase in global average surface temperature may be between 1.8^{o}C and 4.0^{o}C, with an increase of 1.5^{o}C to 2.5^{o}C by 2100, when plant and livestock species could face the risk of extinction. The Food and Agriculture Organization (FAO, 2008), predicts a similar temperature rise from 1^{o}C to 2.5^{o}C by 2050.

The study conducted by IFAD (2009a) on livestock and climate change indicates that the negative impacts of climate change will be harder on poor people in developing countries because of their dependence on natural resources and agriculture, especially livestock farming, for their survival. Similarly, a study conducted by the Food and Agriculture Organization (FAO, 2008), reveals that changes in climate pattern will result in food insecurity, and resource-poor developing countries that cannot meet their food requirements through market access will be the worst affected.

Pittock (2003) predicts that in the next 50 to 100 years, Australia will be vulnerable to changes in temperature and precipitation because it already has extensive arid and semi-arid areas, relatively high rainfall variability from year to year, and existing pressures on water supply in many areas. This will invariably affect livestock farming, directly or indirectly. A study conducted on climate change in Malaysia by Murad *et al.* (2010) indicates that Malaysia ranks as the 26th largest GHG emitter in the world. The agricultural sector has experienced challenges, as it has never had a comparative advantage in the production of food; the study cites the example of cattle and sheep farming, which has suffered from a lack of grazing land as a result of the hot and humid climate, which in turn results in reduced food intake by animals.

In Africa, many countries are more prone to climate change and variation due to generally low adaptive capacity, high rates of poverty and lack of safety measures (Slingo *et al.*, 2005). South Africa, being one of the top 20 GHG emitters globally due to its reliance on coal for electricity, is particularly vulnerable to climate change due to its low and uneven distribution of rainfall (IPCC, 2001). A study on the effects on climate on South Africa by the United Nations (2011) indicates that South Africa's coastal regions will warm by around 1–2^{o}C and 3–4^{o}C by 2050 and 2100 respectively. There are also likely to be further significant changes in rainfall pattern coupled with increased evaporation that will affect water availability, which is an important requirement for livestock production.

There are also predictions about high levels of extinction of many crop species (United Nations, 2011). This will probably result in a reduction in the quantity and quality of forage available for livestock consumption. Additionally, climate change has already led to a decline in the availability of surface water resources. Maize production, an important component of livestock feed and a source of livelihood for many rural South Africans, is said to have decreased under climate change, thereby forcing a shift to more drought-tolerant crops such as sorghum. Grassland pastures are anticipated to change to shrub land and this will definitely have a negative impact on livestock production. According to Blignaut *et al.* (2009), every 1 percent decline in rainfall is likely to drop maize and wheat production by 1.1percent and 0.5 percent respectively.

As the climate is changing, livestock producers will have to adapt their production systems to cope with the changes. Adaptation includes all conditions that help people and ecosystems minimize their vulnerability to the adverse impacts of climate change and reduce the cost of disaster (IFAD, 2009a). Adapting to climate change will require substantial changes in the production and technology systems, which may in turn affect productivity. This is essentially in grassland systems, which often undergo fragile growth and where some of the world's poorest people depend solely on livestock for their livelihoods (Smith *et al*., 2013a). Seo *et al*. (2008) expect livestock farmers to adapt to climate change by reducing or increasing livestock operations or by selecting livestock species that are more tolerant to reduce their vulnerability to the new climate conditions. Adaptation techniques may also require modification of the managerial and policy aspects of livestock production (Silvestri *et al*., 2012). Adaptation techniques in livestock production may also include; provision of shade, modification of feeding schedules and introduction of breeds that perform better under any anticipated climate conditions (Smith *et al*., 2013a; Silvestri *et al*., 2012). Grassland management, which includes control of erosion, controlled grazing, making strategic watering points available for livestock, and different forms of water-harvesting structures, is also an adaptation strategy to minimize the effects of climate change and variability on livestock production (UNECA, 2011). However, whichever adaptation technique is used, farmers must first be aware of the changes in the climate conditions and how these affect them. This calls for thorough education and training in the subject.

2.5 Role of agricultural extension in livestock farming

Extension is an adult and out-of-classroom system of education. Agricultural extension is faced with the task of providing practical knowledge and disseminating useful information and skills related to agriculture. It must also address the current needs of the farmers, especially in rural communities, in a systematic and participatory manner (i.e. allowing for feedback), with the objective of improving their production, income and overall standard of living. Extension is essentially education-based and aims to bring about positive behavioural changes among farmers. Extension education plays a very vital role both in rural community progress and as part of a strategy of agricultural research and development. Agricultural extension officers serve as a link between the researchers and the farmers. Research

institutions focus on the technical aspects of inventing new and useful technologies, while extension concentrates on the acceptance, adoption and implementation of those technologies by farmers. Agricultural extension services can be provided by the public or private sectors. The public sector, which is the focus in this study, includes agricultural research institutes, ministries and departments of agriculture. Whether or not extension education has been effective in fulfilling all its obligations over the years remains an issue of debate.

In the past, extension services were taken to the farmers, especially smallholder farmers, whether in groups or individually through the training-and-visit approach; but in recent times, and with the new agricultural policies, extension services are provided to farmers only upon request, using a demand-driven approach. The demand-driven approach assumes that farmers who are eager for agricultural advice will ask for it, unlike the training-and-visit approach that imposes learning on the farmers without them seeing the need for it (Moyo, 2010).

Success of the extension services depends on how farmers are able to adopt and their willingness to accept any recommended innovations. It also depends on whether farmers are able to respond positively to new ideas, and lastly on how well-educated they are on how best to apply the new ideas (Anaeto *et al*., 2012).

The scope of extension can be classified into three basic concepts, which are:

I. The concept that views extension as an educational process. This concept is further divided into four different phases, namely knowing the rural and urban community phase; the programme planning and development phase; the implementation or execution of programme phase; and the evaluation or executed programme phase.

II. The concept of extension as education / change. This concept implies that extension brings about changes in the behaviour, attitudes and skills of the farmers in a systematic and planned way. It utilizes the basic principles of learning in extension education.

III. The concept of extension as salesmanship. This concept holds that extension sells its ideas and knowledge to farmers so they can grow and improve their standard of living (Anaeto *et al*., 2012).

The role of extension services includes bridging gap by linking agricultural development institutions with the farmers; formulation of policies; linking farmers with service providers and credit facilities; providing timely information on new agricultural technologies and making sure that that farmers adopt it; provision of educational and advisory services to farmers; and rural community development. In general, extension services continue to remain relevant in rural development as they assist farmers to identify their own problems, provide solutions and at the same time encourage them to take action (Ahmad, 2007; Anaeto *et al*., 2012).

Socio-economic status sometimes plays a role in farmers' receptiveness to agricultural extension services; better-educated farmers are more likely to receive new innovations better than illiterates, and wealthy farmers more than asset-poor ones (Mogues *et al*., 2009). Extension services have failed to work in many agricultural systems; farmers sometimes do not see the need to try something new, in some instances they lack the relevant knowledge and resources required to adopt new technologies. Extension services may fail due to lack of subsidies on the innovations, which makes it difficult to convince farmers; lack of capacity to provide services to farmers in terms of staff and resources; and the adoption of services by only "better-off" farmers (Mogues *et al*., 2009).

2.6 Smallholder livestock production

There is no specific and generally accepted definition of smallholder livestock production in terms of the number of livestock kept or what generally causes a livestock farmer to be referred to as smallholder. Fan *et al*. (2013) define the term "smallholder" in isolation, as a diverse set of households and individuals who face various constraints in their ability to undertake potentially profitable activities in the agricultural sector. The term "smallholder" is also sometimes used to mean small-scale, subsistence or resource-poor, depending on the context. This category of farmers manages about 80 percent out of the estimated 500 million small farms in the world and provides over 80 percent of the food consumed in the greatest part of

the developing countries. However the productivity of the smallholder varies and depends on a well-functioning ecosystem (IFAD, 2013).

Globally, smallholder livestock systems play a very important role in supporting rural livelihoods. In smallholder systems, livestock fulfil many functions in addition to producing meat, milk and eggs, including the provision of fertilizer, fuel, draught power and transport; a means of savings and investment; a buffer against crop failure; and diverse cultural and religious roles (FAO, 2009). In sub-Saharan Africa and South Asia, smallholder livestock farmers contribute more than 80 percent of the global livestock production, using foods that are not palatable to humans (i.e. grass, fodder and waste) for their livestock production (Smith *et al*., 2013b). Smallholder livestock systems can be characterized based on the type of input used for production, source of input used, density of livestock, market orientation and the relative contribution of the livestock produced to agricultural and household income (McDermott *et al*., 1999). For most smallholder farmers, providing food for their household is a greater priority than profit maximization. According to Lubungu *et al*. (2012), livestock are closely linked to the social and cultural lives of smallholder farmers, for whom animal ownership is to ensure varying degrees of economic stability. Most smallholder farmers rely on family labour to carry out their farming activities, and this helps them to reduce the cost of production.

Smallholder farming systems in developing countries are influenced by ecological, demographical and socio-economic factors. A major characteristic of this system is that it derives most of its inputs from the household and uses the output to meet household's subsistence needs, and in some cases sells some of the outputs to meet non-subsistence needs (McDermott *et al*., 1999).

Some of the constraints affecting productivity of the smallholder systems identified in the literature include: poor nutrition, weak institutional support, high transaction costs, poor flow of information, small size of land, poor livestock input and output markets, limited access to productivity-enhancing technology, standards of disease management, environmental challenges (climate change) and lack of access to education that could help develop and improve on their production systems (Fan *et al*., 2013; IFAD, 2013; McDermott *et al*., 1999; Smith *et al*., 2013a; Thornton, 2010) .

According to the FAO (2009), many smallholder livestock farmers operate just at the lower end of production, where a small additional input leads to a substantial increase in productivity. This means that if smallholder farmers are able to overcome the challenges facing them, with their sound collective experience and indigenous knowledge of local conditions they may form part of practical solutions that can help to move sustainable agricultural production forward.

2.7 Livestock production systems

Livestock production systems vary across countries and farms, depending on, among other things, the production environment, the agro-ecological zone, the prevailing environment and the purpose of production. According to Steinfeld *et al*. (2006a) most livestock production systems result from evolution that has occurred over time in response to an increasing demand for livestock products. Seré *et al*. (1995) classify livestock production systems as follows:

I. Solely Livestock Systems (L): Livestock systems in which over 90 percent of dry matter fed to animals come from rangelands, pastures, annual forages and purchased feeds, and less than 10 percent of the total value of production comes from non-livestock farming activities.

II. Landless Livestock Production Systems (LL): This is a livestock system in which less than 10 percent of the dry matter fed to animals is farm-produced and in which annual average stocking rates are above ten livestock units (LU) per hectare of agricultural land. The LL system is further classified into:

- Landless monogastric system (LLM): in this system, the value of production of pig / poultry enterprises is higher than that of ruminant enterprises.

- Landless ruminant systems (LLR): in this system the value of the production of ruminant enterprises is higher than that of pig and / or poultry enterprises.

III. Grassland-based Systems (GL): this is a type of solely livestock system in which over 10 percent of the dry matter fed to animals is farm-produced and in which annual average stocking rates are less than ten livestock unit per hectare of agricultural land.

IV. Mixed Farming Systems (M): in this system over 10 percent of the dry matter fed to animals comes from crop by-products and stubble, or more than 10 percent of the total value of production comes from non-livestock farming activities. This system is also further classified into

- Rain-fed Mixed Farming Systems (MR): a subset of the mixed systems in which more than 90 percent of the value of non-livestock farm production comes from rain-fed land use.

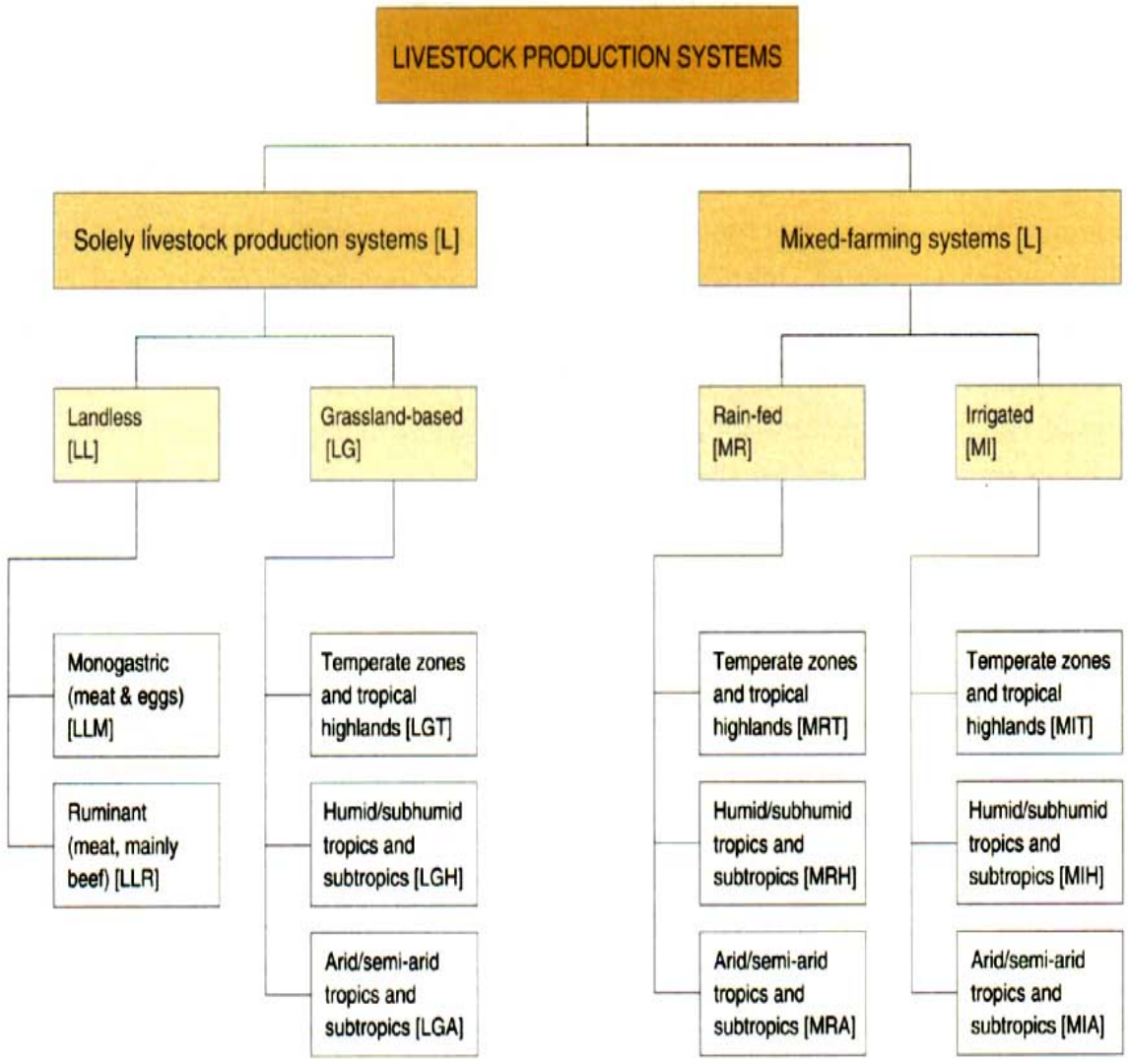
- Irrigated Mixed Farming Systems (MI): a subset of the mixed systems in which more than 10 percent of the value of non-livestock farm production comes from irrigated land use.

De Han *et al*. (1997), using the stocking rate per unit / hectare and percentage of feed produced on farms, similarly classified the livestock systems into three, namely grazing, mixed and landless systems. The grazing livestock system is the same as what Seré *et al*., (1995) refer to as solely livestock system in their classification; this means that the two can be used interchangeably.

The grazing or solely livestock systems cover the largest area and occupy about 26 percent of the earth's surface, yet they are characterized by low productivity when compared with other livestock systems. The grazing livestock system is mostly practised in more marginal areas that are unsuitable for crop production (Steinfeld *et al*., 2006a).The landless systems are mostly practised in areas with high population density and purchasing power, particularly in East Asia, Europe and North America (Steinfeld *et al*., 2006a), while the mixed livestock systems are mostly prevalent in areas that are more favoured in terms of soil and climate (Steinfeld *et al.,* 2006a).

For ruminant (e.g. cattle and sheep) livestock production, the mixed livestock system is most commonly practiced system in Asia and Africa, while the grazing (solely) livestock system is most common in Latin America. The monogastric livestock production (e.g. pigs and poultry), in the landless system predominates in Latin America while the mixed livestock system predominates in Asia (Gill, 1999).

The mixed livestock systems may be considered the best; they are relatively environmentally friendly, allowing for diversified use of land that ensures the financial security of farms and minimizes cost (Ryschawy *et al*., 2012). Figure 2.1 shows the classification of the world livestock production systems as described by Steinfeld and Maki-Hokkonen (1995).



.

Figure 2.1: World livestock production systems. Source: Steinfeld and Maki-okkonen,1995.

2.8 Veld management and livestock production

Veld management implies the management of natural vegetation for specific objectives related to the different forms of land use (Trollope *et al*., 1990). Assessment of veld condition is essential for the formulation of a good veld management programme (Trollope *et al*., 1990). Veld condition is assessed in terms of its ability to support a sustainable livestock production at a recommended stocking rate (Todd *et al*., 2009). Veld in good condition usually comprises different plant species with different growth forms that maintain a good cover in times of drought, as well as supporting the recommended stocking rate for the vegetation type. Todd *et al*. (2009) emphasize that veld management is essential in order to maintain long-term rangeland productivity while maximizing the output, and to ensure a consistent forage supply for livestock.

The South African veld has been in bad condition and is dominated by unpalatable vegetation. This is most likely the result of environmental conditions, overutilization of the resource due to overestimating grazing capacity, or simply lack of knowledge by the farmer, which is sometimes aggravated by poor advice (Meissner *et al*., 2013). According to Van de Pol and Jordaan (2008), 60 percent of the veld in South Africa is bad, 30 percent is intermediate and only 10 percent is in good condition. Veld management systems were therefore developed on the basis of rotational grazing in order to eliminate selective grazing.

Van de Pol and Jordaan (2008) identified four veld management systems as:

I. High-production grazing (HPG): this system involves light utilization of veld. It aims to utilize only palatable species of grasses which are lightly defoliated, so that the production of palatable species is stimulated while production of unpalatable species is forced to fade off gradually. Livestock perform better under this system, since only highly nutritious and palatable grasses are lightly utilized.

II. Controlled selective grazing (CSG): this system ensures the moderate utilization of palatable grass species, while unpalatable species are not used at all. Palatable species are also stimulated and unpalatable species fade off and eventually die out. The system is very similar to HPG in practice.

III. High-utilization grazing (HUG): this system of veld management is also sometimes referred to as non-selective grazing. All available species are utilized under this system; animals are compelled to utilize species they would normally ignore, as a camp is grazed until all grasses including the unpalatable species are utilized. This system allows for better production and maintenance of veld condition.

IV. Short rotational grazing (SRG): this is a multi-camp system which ensures that palatable species are utilized only once during a grazing period; animals are not allowed to re-graze during the same growing period. Although this system requires large capital input in terms of fencing and water circulation, grasses remain in a constantly stimulated condition, especially where several camps are available.

2.9 Grazing systems in livestock production

Grazing systems refer to the manner in which camps are alternatively grazed and rested. There are three basic forms of grazing system, as indicated by Todd *et al*. (2009):

I. Continuous grazing: this is a method of grazing in which livestock have continuous access to the same area of vegetation. This system is not economically viable most of the time, as it requires low stocking rates if animals are to perform at their best and if veld condition is to be maintained. This is because even at low stocking rates, animals are still likely to concentrate on grazing certain areas, thereby still causing veld deterioration. For example, animals are likely to graze more in areas close to the watering points than other areas. According to McCosker (2000), at stocking rates under the continuous grazing system, the grazing area is prone to drought and erosion; this leads to fluctuating livestock performance due to variations in the quality and quantity of the vegetation. On the other hand, McCosker (2000) indicated that lower stocking rates lead to under-grazing in patches and overgrazing in other areas, which may lead to woody shrubs and overuse of fire.

II. Rotational grazing: this type of grazing system allows for alternating periods of rest after animals have grazed on a particular vegetation area. This is to allow for regrowth. According to Van de Pol (2008), grazing intensity and frequency are influenced by alternating grazing and resting periods, thereby allowing for continuous selective grazing, which in turn leads to better management of veld condition and animal production.

III. Multi-camp systems: this system allows for a high stocking rate but only for a short period of time (usually less than two weeks). When livestock are introduced into a vegetation area, usually in small camps, because of the high stocking rates animals are forced to graze both palatable and unpalatable species of grasses. After being completely grazed, camps are rested for a period of at least a year. This system reverses land degradation and increases palatable species.

.

2.10 General overview of livestock production in South Africa

The agricultural land in South Africa is livestock-based and just as in many countries of the world, livestock production is essential to food security in South Africa. Livestock is produced in all nine provinces of South Africa, with high large and small stock concentrations in the south-east with higher rainfall areas. Livestock are found in varying numbers, breeds and species and in different production systems (Meissner *et al*., 2013). Different species of livestock found across the country include cattle, sheep, goats, horses, donkeys, pigs, chicken, geese, turkeys, pigeons and rabbits. Cattle production, followed by sheep and goat production, are the most important livestock sub-sectors in South Africa and contribute about 25–30 percent of the total agricultural output per annum (Musemwa *et al*., 2008). The smallholder livestock sector accounts for 41 percent of beef cattle, 12 percent of sheep and 67 percent of goat production. Smallholder livestock production occupies approximately 52 percent of the total cattle production, 72 percent of goat production and 17 percent of sheep production (Palmer and Ainslie, 2006). Livestock production in South Africa has also increased owing to the growth in population and improved incomes, hence the growth in demand for livestock-based products and food (Meissner *et al*., 2013).

Livestock is owned by both rural and urban societies and forms an integral and indispensable part of the social life and sustenance of poor communities, who consider livestock to be a valuable asset and a store of wealth that can be converted into cash in hard times. The commercial livestock sector production accounts for 75 percent of the natural agricultural output and occupies 52 percent of the farming land, while smallholder livestock production occupies about 17 percent of the total farming area in South Africa (Palmer and Ainslie, 2006).

Smallholder and commercial livestock producers vary in terms of their production systems, objectives and property rights; the smallholder sector has a significantly higher human population per unit area than the commercial sector, and better access to basic infrastructures such as roads, fences, water provision, water supply and equipment, when compared to the commercial sector. Production systems in the smallholder sector still suffer from limited technology and external inputs when compared to the commercial sector. For most smallholders the major reasons for keeping livestock include draught power, milk, dung, meat, cash income, capital storage and some socio-cultural functions.

2.11 Chapter summary

The review of literature in this chapter reveals that livestock contribute significantly to the agricultural development of most countries, especially in the developing countries. Livestock are the key to food security for many farmers in most developing countries. They are owned by people in both rural and urban societies and form an integral and indispensable part of the social life and sustenance of poor communities. Generally, livestock contribute to the food supply by providing manure to improve soil fertility; providing ready cash to buy planting materials or fertilizer or to hire labour for planting, weeding, or harvesting; and converting low-value materials that are inedible or unpalatable for humans into milk, meat and eggs.

Several factors have contributed both positively and negatively to the changes in demand and supply of livestock products. These factors include economic growth, increase in human population, evolution in science and technology, rural-urban migration, changes in the ecosystem, changes in climatic conditions and changes in human feeding patterns. To ensure food security in the future with the projected

increase in human population, the livestock production system must continue to improve and grow at an increased rate if the future demand is to be met.

The literature also focuses on the challenges affecting livestock production. It reveals that smallholder livestock farmers face several challenges as they try to improve their standard of living, in terms of the sustainability and management of their livestock production. Problems they encounter include frequent drought, lack of equipment; poor forage quality as a result of extended periods of drought; overstocking that in turn leads to overgrazing and land degradation, uncontrolled breeding due to poor education and poor management systems of farmers, limited water supply and limited access to credit.

If livestock farmers are to increase their livestock numbers and enhance their production, certain management practices must be put in place. The literature reveals that good extension services, proper veld management practices and well-planned grazing systems can help farmers reduce their vulnerability to some of the challenges affecting them.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The chapter presents and summarizes all the variables used for data analysis in tabular form. The research approaches used in the study are described. The chapter also covers the study area describing the total percentage of land it occupies in the total South Africa's land area. Climate of the study area as well as the contribution of the agricultural sector of the area to the South Africa's agro- economy is also explained. Research design, sampling procedure and data collection are introduced in this chapter. Lastly, the chapter presents econometric model, data analysis and summary.

3.2 Study area

The study was carried out in the Free State, which is the third-largest of the nine provinces in South Africa. The Free State covers 129,825 square kilometres in the heart of South Africa. The province is wedged between the Vaal River in the north and the Orange River in the south, with the Kingdom of Lesotho resting in the hollow of its bean-like shape. The province occupies 10.6 percent of South Africa's total land area (South African Government, 2012). The Free State borders more districts of Lesotho and more provinces of South Africa than any other province. The province consists of four district municipalities, which in turn consist of 19 local municipalities and one metropolitan municipality. The municipalities are indicated in Figure 3.1.

The total population of the four district municipalities at mid-2013 is 2,753,200, which is 5.2 percent of the South African population. The province has the second-smallest population and lowest population density of the nine provinces in South Africa (Statistics South Africa, 2013). The Free State is high-lying, with almost all its land being 1,000 metres above sea level.

3.2.1 Climate of the Free State

The Free State has a pleasant climate which allows a thriving agricultural industry. The province experiences a continental climate, characterized by warm to hot summers when most rain falls. Usually, the annual rainfall ranges between 600mm and 750mm in the east to less than 300mm in the west. It can be very cold in the winter, with heavy frost over most of the province. The average winter temperature is 7.7^{o}C and average summer temperature is 23^{o}C. Snow is often recorded on the eastern mountains and occasionally over the rest of the region (South African Government information, 2012).

3.2.2 Agriculture in the Free State

The province occupies 10.6 percent of all South African land. Agriculture dominates the Free State landscape, with cultivated land covering 32,000 square kilometres and natural veld and grazing covering 87,000 square kilometres of the province. The province contributes significantly to food security in South Africa and it is sometimes referred to as “the country’s breadbasket”. Animal products contribute 30 percent of the agricultural income of the province. About 90 percent of the province is under cultivation for crop production. Some of the most widely cultivated crops are maize, sorghum, potatoes, dry beans, vegetables, wheat, sunflowers and fruits, especially cherries. It produces about 40 percent of South Africa’s total maize crop, 50 percent of wheat, 80 percent of sorghum, 33 percent of potatoes, 18 percent of red meat, 30 percent of groundnuts, 15 percent of wool and about 90 percent of the country’s cherries. This makes agriculture central to the economy of the province (South African Government information, 2012).

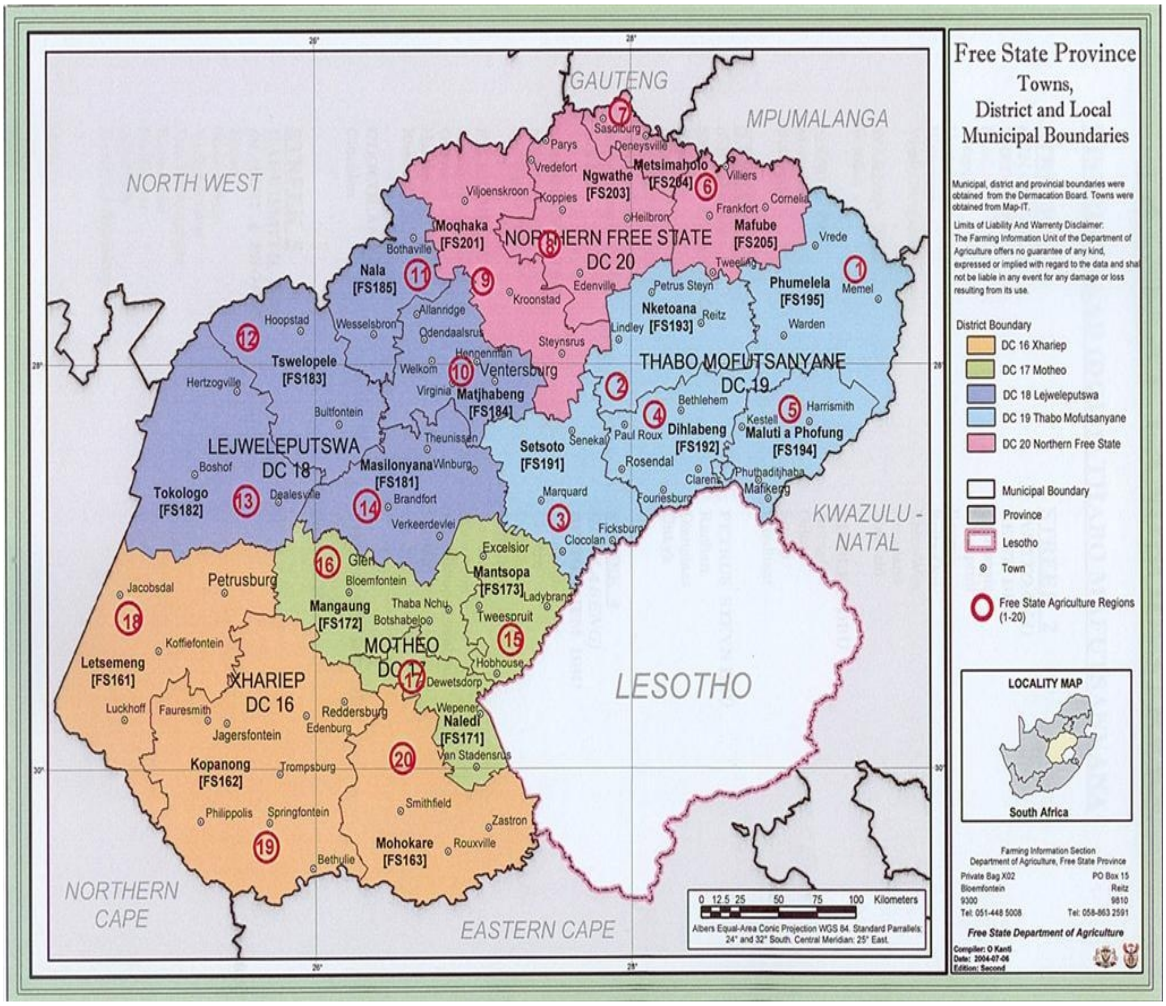


Figure 3.1: Map of study area. Source: www.vslandbou.co.za; (accessed on 17 February, 2014)

3.3 Research design

The research was designed to be both qualitative and quantitative in nature. A total number of 250 smallholder cattle and sheep farmers were selected from the four district municipalities in the Free State province. The sample size drawn from each of the four district municipalities was proportionate to the entire population size of the smallholder cattle and sheep farmers in each district municipality. The data used in this study were both primary and secondary data. Primary data were obtained in the form of interviews with the smallholder cattle and sheep farmers through the use of well-structured questionnaire. Secondary data were obtained from existing data in published books, journals, articles and the internet in order to set a basis for comparison for the primary data obtained.

3.4 Sampling procedure

The sampling technique used in this study was Proportionate Stratified Random Sampling. A complete list of all smallholder cattle and sheep farmers with at least 30 animals was requested from the Department of Agriculture in all the four district municipalities in the Free State. The identified farmers formed groups that were interviewed. From the list obtained from the Department of Agriculture, towns with a reasonable number of smallholder cattle and sheep farmers were identified and randomly selected across the 19 local municipalities. The selected towns were then divided into four sub-groups, with towns under each of the four district municipalities representing a sub-group. Frankfort, Sasolburg, Parys and Kroonstad formed the subgroup for Fezile Dabi district municipality; Ventersburg, Odendaalsrus, Verkeerdevlei, Boshof and Dealesville for Lejweleputswa district municipality; Warden, Tseng, Mangaung, Monontsha, Kestel, Makwane, Fouriesburg and Lindley for Thabo Mofutsanyana district municipality; and Smithfield, Zastron, Bethulie and Petrusburg formed the sub-group in the Xhariep district municipality. The sample size of each sub-group was proportionate to the population size of the sub-group when viewed against the entire population of smallholder cattle and sheep farmers in the province (65 out of 78 smallholder cattle and sheep farmers were sampled in Xhariep district municipality, 41 out of 50 in Lejweleputswa district municipality, 35 out of 42 in Fezile Dabi district municipality and 109 out of 130 in Thabo Mofutsanyana district municipality). This means that each of the four district municipalities had the same sampling fraction, and the selected towns in local municipalities under each of the four district municipalities represented a sub-group. Proportionate samples were chosen from each sub-group to complete the questionnaire. The sampling procedure is illustrated by figure 3.2.

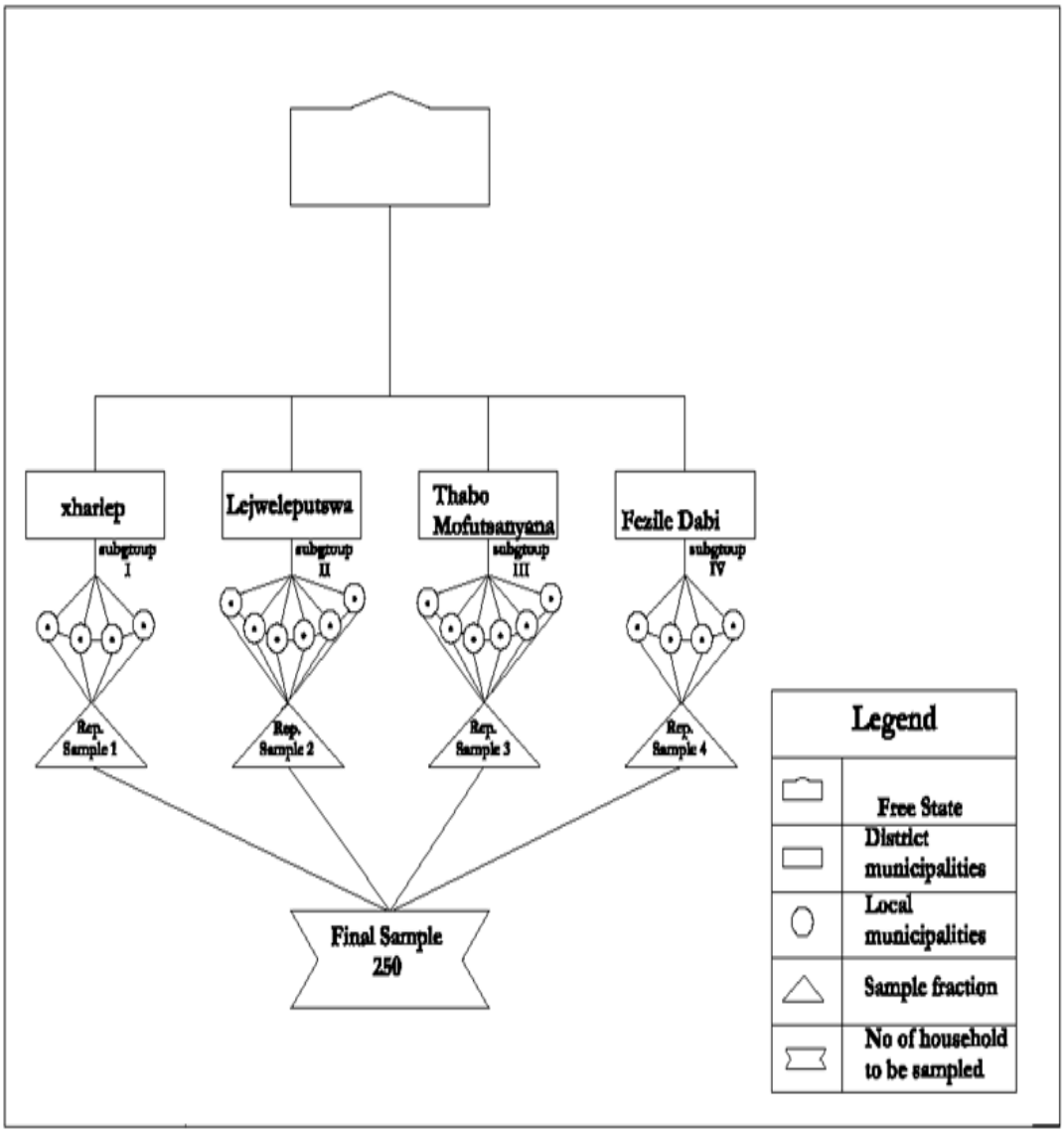


Figure 3.2: Diagram showing the sampling procedure

3.5 Data collection

Permission to collect data was obtained from the heads of the rural households, and suitable times and venues were arranged with the farmers. Data were collected with the use of a well-structured questionnaire which was written in English. The questionnaire used simple sentences to make it respondent-friendly, while local concepts were used for easy interpretation. The topics covered relevant information about socio-economic and demographic characteristics, land characteristics, problems encountered in livestock production and livestock productivity.

The questionnaire had already been tested on 15 household heads to ensure that the questions would be well understood. Face-to-face interviews were conducted with 250 household heads, male or female, in their homes or on the farms. In homes where the household head was absent, the interview was conducted with the oldest individual at home who was 18 years old and above. Questions that seemed difficult to the respondents were explained in their local language (Sesotho) while the interviews were being conducted, with the help of local extension officers from the department of agriculture. The time limit for each interview was kept at 30 minutes. This interview length was intended to obtain a clear opinion and appropriate details from the respondents. Personal observations of the study area were also carried out to confirm some of the answers provided by the respondents.

3.6 Econometric model used for data analysis

An Ordinary Least Square (OLS) multiple regression analysis was used to determine the socio-economic factors that affected livestock numbers in the Free State. This is a mathematical modelling approach that can be used to describe the relationship between a dependent variable and several independent variables (Maree, 2012). Ordinary least square regression is one of the major techniques used to analyse data, and forms the basis of many other techniques (Rutherford, 2001). Ordinary least square regression is particularly powerful as it is relatively easy to check model assumptions such as linearity, variance and the effect of outliers (Hutcheson and Sofroniou, 1999).

3.7 The model specification

The OLS regression model specification was used investigate the socio-economic factors that affected livestock numbers. The dependent variable, livestock numbers was continuous. Ordinary Least Squares linear multiple regression model was used to model a continuous dependent variable which is livestock numbers. In this respect, the OLS estimates were: linear, unbiased, with minimum variance, consistent and normally distributed (Gujarati, 2003). The OLS model is expressed as (Gujarati, 2003):

$$Y_i = \beta_0 + \beta_i X_i + \varepsilon_i \quad (1)$$

Where Y_i is the livestock numbers, β_i are parameters estimated, β_0 is a constant and X_i are the socio-economic factors which affected livestock numbers as specified in Table 3.1. The Ordinary Least Squares principle states that the sum of the squares of the deviation for all values of population Y_i and sample $\hat{Y}_i$, is to be a minimum. i.e.

$$\Sigma^{n}_{i=1}(Y_i - \hat{Y}_i)^2 \quad (2)$$

Where n is the number of data points composing the sample.
If Y is considered to be dependent upon more than one variable, then,

$$Y_j = \propto + \beta_1 X_{1j} + \beta_2 X_{2j} + \beta_3 X_{3j} + \cdots + \beta_{in} X_{mj} + \in_j \quad (3)$$

Or, more succinctly,

$$Y_j = \propto + \sum_{i=1}^{m} \beta_j X_{ij}\, \beta_1 X_{1j} + \in_j \quad (4)$$

3.8 The model estimation

The sample regression equation, containing the statistics used to estimate the population parameters when there are *m* independent variables, would be

$$\hat{Y}_j = a + b_1 X_{1j} + b_2 X_{2j} + b_3 X_{3j} + \cdots + b_{in} X_{mj} \quad (5)$$

$$\hat{Y}_j = a + \sum_{i=1}^{m} b_i X_{ij} \quad (6)$$

From equation (6), *b* can be determined as:

$$b = \frac{\sum xy}{\sum x^2} = \frac{\sum (X_i - \bar{X})(Y_i - \bar{Y})}{\sum (X_i - \bar{X})^2} = \frac{\sum X_i Y_i - \frac{(\sum X_i)(\sum Y_i)}{n}}{\sum X_i^2 - \frac{(\sum X_i)^2}{n}}$$

Then,

$$\bar{Y} = \propto + \beta\bar{X}$$

And

$$\propto = \bar{Y} - \beta\bar{X}$$

The best estimate of the population α is the sample statistic

$$a = \bar{Y} - b\bar{X}$$

The assumptions of linearity, normality, homoscedasticity and independent of error were considered, to ensure validity of the model. Autocorrelation and multicollinearity was checked by the Durbin-Watson statistic which was greater than 1but less than2. The Statistical Package for Social Sciences (SPSS) version 22.0 of 2013 was used to analyse the OLS model and the parameter estimates provided include: Regression coefficient β, constant, standard error, R^2, adjusted R^2, Residual analysis, Durbin-Watson, and t-values.

Table 3.1 describes and summaries all the independent variables used in the model in a tabular form. The expected effects of each of the independent variable were also indicated.

Table 3.1: Variable labels and their expected effects

ID	Independent variables Xi	Variable description	Expected sign
1	X_1	District municipality 1 = Fezile Dabi, 2= Lejweleputswa 3 = Thabo Mofutsanyana, 4 = Xhariep	Positive
2	X_2	Household size 1 = 0 - 5; 2 = 6 -10; 3 = above 10	Positive
3	X_3	Gender 1 = male; 2 = female	Positive
4	X_4	Age (Years) 1 = 18 – 27; 2 = 28 – 37; 3 = 38 – 47; 4 = 348 -57; 5 = >58	Positive
5	X_5	Level of education 1= Pre-school; 2 = Std1;3 =Std 6= Std10; 5 = Higher; 6 =none	Negative
6	X_6	Years of experience in farming 1 = 1 - 3 yrs; 2 = 4 - 6 yrs; 3 =7 - 9yrs; 4 = 10 - 13 yrs; 5 = 14 - 16 yrs; 6 =>16yrs	Positive
7	X_7	Household income (rands) 1 = <R60 000; 2 = R60 000 - R120 000; 3 = R120 001 - R180 000; 4= R180 001 - R240 000; 5 = R240 001 – R300 000; 6 = above 300 000	Negative
8	X_8	Livestock numbers in 2008 1 = Below 50; 2 = 50 – 100; 3 = 101 – 150; 4 = 151 – 200; 5 = 201 – 250; 6 = 251 – 300; 7 = 301 – 350; 8 = 351 – 400; 9 = Above 400	Positive
9	X_9	Farm ownership 1 = Individual company; 2=Family members; 3 = Farmers' group; 4 = Cooperative; 5 = Private; 6 = Trust; 7 = Traditional heads	Positive
10	X_{10}	Camp system 1 = Yes; 2 = No	Positive
11	X_{11}	Natural veld / grazing 1 = Yes; 2 = No	Positive
12	X_{12}	Planted pasture 1 = Yes; 2 = No	Positive

N (list wise) = 250

Table 3.1: Variable labels and their expected effects (continued)

ID	Independent Variables (X_i)	Variable description	Expected sign
1	X_{13}	Present grazing land condition 1 = Deteriorating - very poor condition/little grass; 2 = Deteriorating - poor condition but some grass. 3 = Fair -reasonable amount of grass; 4 = Good -plenty grass; 5 = Very good –improving	Positive
2	X_{14}	Grazing land acquisition 1 = Easy; 2 = Very easy; 3 = Difficult; 4 =Very difficult; 5 = Don't know.	Negative
3	X_{15}	Do you encounter any problem with getting service / advice/ training? 1 = yes; 2 = No	Negative
4	X_{16}	Problems with getting veterinary services 1 = yes; 2 = No	Negative
5	X_{17}	Do you encounter any problem with transportation? 1 = Yes; 2 = No	Negative
6	X_{18}	Do you encounter any problem with vaccination and inoculation? 1 = Yes; 2 = No	Negative
7	X_{19}	Do you encounter any problem with purchase of dosing products? 1 = Yes; 2 = No	Negative
8	X_{20}	Major objective of keeping livestock 1 = Major source of income; 2 = Self-consumption; 3 = Local status, success as a farmer wealth; 4 = Lobola	Positive
9	X_{21}	Sales per year (2008) (2012) 1 = below R100 000; 2 = R101 000 – R200 000; 3 = R201 000 – R300 000; 4 = R301 000 – R400 000; 5 = Above R400 000	Positive

N (list wise) = 250

3.9 Data analysis

Data obtained was coded and captured using Statistical Package for Social Science (SPSS version 22.0 of 2013) computer programme. Variables that were the most representative of the prevailing conditions in the study area were selected for the analysis. Because the data collected was qualitative and quantitative in nature, it was subjected to descriptive statistics, presented in the form of tables. Analysis of Variance (ANOVA) was used as a preliminary analysis to compare the means for the two groups, i.e. cattle and sheep farmers' characteristics are listed as Xs in the econometric model. Ordinary Least Square regression analysis was used to determine the socio-economic factors that affected livestock numbers.

3.10 Chapter summary

This chapter explains the area where the study was conducted. It also describes the research design, sampling procedure and the way in which data was collected and analysed. The socio-economic and demographic characteristics of the farmers were determined using descriptive statistics. Descriptive statistics was also used to determine the prevalent factors affecting smallholder cattle and sheep farming in the Free State. Ordinary least square regression model was used to determine the socio-economic factors that affected livestock numbers in the Free State. Variables and results of the study are presented in Chapter 4.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

The main aim of this the study was to determine the socio-economic factors that affected livestock numbers. The specific objectives were to determine the socio-economic and demographic characteristics of smallholder cattle and sheep farmers in the Free State province using descriptive statistics. They were also to investigate the factors that most influenced cattle and sheep farming using descriptive statistics and lastly, to determine the factors that affected livestock numbers using inferential statistic (OLS regression model).

Variables of descriptive statistics (dependent and independent variables) are presented in Tables 4.1 and 4.2. The tables provide mean values, standard deviation and variance of the variables that were later used in the OLS regression model. Since the same group of farmers were interviewed to collect information about the socio-economic factors that affected smallholder cattle and sheep farming in year 2008 and 2012, the mean values, standard deviation and variance of all the independent variables remained the same for both years. Tables 4.3 and 4.4 present cross-tabulation of the livestock numbers according to districts in the years 2008 and 2012 respectively. Table 4.5 presents information about the demographic characteristics of the farmers in order to describe and quantify certain characteristics of the farmers such as; district, household size, gender, age, marital status, level of education, years of experience, household income, farm ownership and major occupation. Table 4.6 presents the descriptive statistics (percentage, mean, standard deviation and variance) of the factors affecting cattle and sheep numbers while Tables 4.7 and 4.8 present the results of the OLS regression model in the years 2008 and 2012 respectively.

Table 4.1: Descriptive statistics of variables used (2008)

Variable	Mean	Standard deviation	Variance
Dependent variable:			
Y = Livestock numbers (2008)	1.84	1.431	2.047
Independent variables:			
District municipality (X_1) 1 = Fezile Dabi, 2= Lejweleputswa 3 = Thabo Mofutsanyana, 4 = Xhariep	2.82	0.977	0.954
Household size (X_2) 1 = 0 - 5; 2 = 6 -10; 3 = above 10	1.25	0.471	0.221
Gender (X_3) 1 = male; 2 = female	1.12	0.330	0.109
Age (Years) (X_4) 1 = 18 – 27; 2 = 28 – 37; 3 = 38 – 47; 4 = 348 -57; 5 = >58	4.16	0.907	0.823
Level of education (X_5) 1= Pre-school; 2 = Std1;3 =Std 6= Std10; 5 = Higher; 6 =none	3.74	1.254	1.573
Years of experience (X_6) 1 = 1 - 3 yrs; 2 = 4 - 6 yrs; 3 =7 - 9yrs; 4 = 10 - 13 yrs; 5 = 14 - 16 yrs; 6 =>16yrs	4.16	1.416	2.004
Household income (rands) (X_7) 1 = <R60 000; 2 = R60 000 - R120 000; 3 = R120 001 - R180 000; 4= R180 001 - R240 000; 5 = R240 001 – R300 000; 6 = above 300 000	1.26	0.639	0.408
Farm ownership (X_8) 1 = Individual company; 2 = Family members; 3 =Farmers' group; 4 = Cooperative; 5 = Private; 6 = Trust; 7 = Traditional heads	3.86	1.903	3.620
Camp system (X_9) 1 = Yes; 2 = No	1.43	0.496	0.246
Natural veld / grazing (X_{10}) 1 = Yes; 2 = No	1.00	0.063	0.004
Planted pasture (X_{11}) 1 = Yes; 2 = No	1.84	0.364	0.132
Present grazing land condition (X_{12}) 1 = Deteriorating -very poor condition/Little grass; 2 = Deteriorating -poor condition but some grass; 3 = Fair -reasonable amount of grass; 4 = Good -plenty grass; 5 = Very good –improving	1.72	1.113	1.239

N (list wise) = 250

Table 4.1: Descriptive statistics of variables used (2008) (continued)

Variable	Mean	Standard Deviation	Variance
Dependent variable:			
Y = Livestock numbers (2008)	1.84	1.431	2.047
Independent variables:			
Grazing land acquisition (X_{13}) 1 = Easily; 2 = Very easy; 3 = Difficult; 4 =Very difficult; 5 = Don't know.	3.51	0.932	0.869
Do you encounter any problem with getting service advice and training (X_{14}) 1 = yes; 2 = No	1.53	0.500	0.250
problem with getting veterinary services (X_{15}) 1 = yes; 2 = No	1.54	0.499	0.249
Do you encounter any problem with transportation (X_{16}) 1 = Yes; 2 = No	1.33	0.472	0.233
Do you encounter any problem with vaccination and inoculation (X_{17}) 1 = Yes; 2 = No	1.41	0.493	0.243
Do you encounter any problem with purchase of dosing products (X_{18}) 1 = Yes; 2 = No	1.33	0.472	0.223
Major objective of keeping livestock (X_{19}) 1 = Major source of income; 2= Self-consumption; 3= Local status, success as a farmer wealth; 4 = Lobola	1.19	0.574	0.330
Sales per year (2008) (X_{20}) 1 = below R100 000; 2= R101 000 – R200 000; 3 =R201 000 – R300 000; 4 =R301 000 – R400 000; 5 = Above R400 000	1.15	0.579	0.335

N (list wise) = 250

Table 4.2: Descriptive statistics of variables used (2012)

Variable	Mean	Standard Deviation	Variance
Dependent variable:			
Y = Livestock numbers (2012)	2.42	1.979	3.915
Independent variables:			
District municipality (X_1) 1 = Fezile Dabi; 2=Lejweleputswa 3 = Thabo Mofutsanyana, 4 = Xhariep	2.82	0.977	0.954
Household size (X_2) 1 = 0 - 5; 2 = 6 -10; 3 = above 10	1.25	0.471	0.221
Gender (X_3) 1 = male; 2 = female	1.12	0.330	0.109
Age (years) (X_4) 1 = 18 – 27; 2 = 28 – 37; 3 = 38 – 47; 4 = 348 -57; 5 = >58	4.16	0.907	0.823
Level of education (X_5) 1= Pre-school; 2 = Std1;3 =Std 6= Std10; 5 = Higher; 6 =none	3.74	1.254	1.573
Years of experience in farming (X_6) 1 = 1 - 3 yrs; 2 = 4 - 6 yrs; 3 =7 – 9 yrs; 4 = 10 - 13 yrs; 5 = 14 - 16 yrs; 6 = above 16yrs	4.16	1.416	2.004
Household income (rands) (X_7) 1 = <R60 000; 2 = R60 000 - R120 000; 3 = R120 001 - R180 000; 4= R180 001 - R240 000; 5 = R240 001 – R300 000; 6 = above 300 000	1.26	0.639	0.408
Livestock numbers in 2008 (X_8) 1 = Below 50; 2 = 50 – 100; 3 = 101 – 150; 4 = 151 – 200; 5 = 201 – 250; 6 = 251 – 300; 7 = 301 – 350; 8 = 351 – 400; 9 = Above 400	1.84	1.431	2.047
Farm ownership (X_9) 1 = Individual company; 2 = Family members; 3 =Farmers' group; 4 = Cooperative; 5 = Private; 6 = Trust; 7 = Traditional heads	3.86	1.903	3.620
Camp system (X_{10}) 1 = Yes; 2 = No	1.43	0.496	0.246
Natural veld / grazing (X_{11}) 1 = Yes; 2 = No	1.00	0.063	0.004
Planted pasture (X_{12}) 1 = Yes; 2 = No	1.84	0.364	0.132

N (list wise) = 250

Table 4.2: Descriptive statistics of variables used (2012) (continued)

Variable	Mean	Standard Deviation	Variance
Dependent variable:			
Y = Livestock numbers (2012)	2.42	1.979	3.915
Independent variables:			
Present grazing land condition (X_{13}) 1 = Deteriorating - very poor condition/Little grass; 2 = Deteriorating - poor condition but some grass; 3=Fair - reasonable amount of grass; 4 = Good - plenty grass; 5 = Very good -improving	1.72	1.113	1.239
Grazing land acquisition (X_{14}) 1 = Easily; 2 = Very easy; 3 = Difficult; 4 =Very difficult; 5 = Don't know.	3.51	0.932	0.869
Do you encounter problem with getting service advice and training (X_{15}) 1 = yes; 2 = No	1.53	0.500	0.250
Problem with getting veterinary services (X_{16}) 1 = yes; 2 = No	1.54	0.499	0.249
Do you encounter any problem with transportation (X_{17}) 1 = Yes; 2 = No	1.33	0.472	0.233
Do you encounter any problem with vaccination and inoculation (X_{18}) 1 = Yes; 2 = No	1.41	0.493	0.243
Do you encounter any problem with purchase of dosing products (X_{19}) 1 = Yes; 2 = No	1.33	0.472	0.223
Major objective of keeping livestock (X_{20}) 1 = Major source of income; 2= Self-consumption; 3= Local status, success as a farmer wealth; 4 = Lobola	1.19	0.574	0.330
Sales per year (2012) (X_{21}) 1 = below R100 000; 2= R101 000 – R200 000; 3 =R201 000 – R300 000; 4 =R301 000 – R400 000; 5 = Above R400 000	1.18	0.505	0.255

N (list wise) = 250

4.2 Cross-tabulation of cattle and sheep numbers according to districts

A cross-tabulation of the total number of cattle and sheep kept by the smallholder cattle and sheep farmers in the four districts in 2008 and 2012 was performed, to establish a basis for comparison and to determine cattle and sheep numbers for the years 2008 and 2012. The analysis was based on the information provided in the questionnaire during interviews. The cattle and sheep numbers were categorized into five categories, namely below 100 cattle and sheep per year; 100–200 cattle and sheep per year; 201–300 cattle and sheep per year; 301–400 cattle and sheep per year; and more than 400 cattle and sheep per year.

Tables 4.3 and 4.4 present the numbers of cattle and sheep kept by the smallholder farmers in the four district municipalities of the Free State. In the Fezile Dabi district municipality 35 smallholder cattle and sheep farmers were interviewed. Of the farmers interviewed, 28 kept below 100 cattle and sheep in 2008, five (5) farmers kept between 100 and 200 cattle and sheep and only two (2) farmers kept between 201 and 300 cattle and sheep in 2008. No farmer kept between 301 and 400 cattle and sheep or more than 400 cattle and sheep in 2008. However, in 2012, 22 out of the 35 smallholder cattle and sheep interviewed kept below 100 cattle and sheep whereas 10 farmers kept between 100 and 200 cattle and sheep. One (1) farmer each kept between 201 and 300 and between 301 and 400 cattle and sheep respectively. Also, only one (1) farmer kept more than 400 cattle and sheep in 2012.

In Lejweleputswa district municipality with 41 smallholder cattle and sheep farmers interviewed, 33 kept below 100 cattle and sheep in 2008 and only 8 farmers kept between 100 and 200 cattle and sheep in the same year. There was no farmer who kept between 201 and 300, 301 and 400 and more than 400 cattle and sheep respectively, in 2008. In 2012, however, 26 out of the 41 smallholder cattle and sheep farmers kept below 100 cattle and sheep. Also in 2012, 11 of the 41 farmers interviewed kept between 100 and 200 cattle and sheep, whereas two (2) farmers each kept both between 201 and 300 cattle and sheep and between 301 and 400 cattle and sheep respectively. No farmer in the district kept more than 400 cattle and sheep in 2012.

In Thabo Mofutsanyana district municipality, the total number of smallholder cattle and sheep farmers interviewed was 109 and 93 kept below 100 cattle and sheep in 2008 while eight (8) of the farmers kept between 100 and 200 cattle and sheep in the same year. At least two (2) of the farmers kept between 201 and 300 cattle and sheep, five (5) of the farmers kept between 301 and 400 cattle and sheep and only one (1) farmer kept more than 400 cattle and sheep in 2008. Also, in 2012, 76 out of the 109 smallholder cattle and sheep farmers interviewed in the district municipality kept below 100 cattle and sheep, 20 of the farmers kept between 100 and 200 cattle and sheep, whereas five (5) of the farmers kept between 201 and 300 cattle and sheep. Also, two (2) of the 109 farmers interviewed kept between 301 and 400 cattle and sheep and only six (6) farmers kept more than 400 cattle and sheep.

The total number of smallholder cattle and sheep farmers interviewed in Xhariep district municipality was 65. In 2008, majority (53) of the farmers kept below 100 cattle and sheep. Eight (8) farmers kept between 100 and 200 cattle and sheep. At least 2 of the farmers kept between 201 and 300 cattle and sheep, and only one (1) farmer kept between 301 and 400 and more than 400 cattle and sheep respectively. In 2012, out of the 65 smallholder cattle and sheep farmers interviewed 54 farmers kept below 100 cattle and sheep. Between 100 and 200 cattle and sheep were kept by five (5) of the farmers, two (2) of the farmers kept between 201 and 300 cattle and sheep, none of the 65 farmers interviewed in Xhariep district municipality kept between 301 and 400 cattle and sheep in 2012. There were only four (4) farmers that kept more than 400 cattle and sheep.

Farmers who kept below 100 cattle and sheep had an average total of 207 in 2008 and 178 in 2012. This indicated that the average total of farmers who kept below 100 cattle and sheep in 2012 decreased by 29. Furthermore, the average total of farmers who kept between 100 and 200 cattle and sheep increased by 17 in year 2012. Also, the average total of farmers who kept between 201 and 300 cattle and sheep increased from six (6) to ten (10) in 2012. Again in 2008, an average of six (6) farmers kept between 301 and 400 cattle and sheep and a reduction by just one (1) farmer was indicated in 2012. The average total of farmers who kept more than 400 cattle and sheep increased from two (2) 2008 to 11 farmers in 2012. Although more

farmers kept between 301 and 400 cattle and sheep in 2008, it can therefore be concluded that farmers kept more numbers of cattle and sheep in 2012 than in 2008.

Table 4.3: Cross tabulation of livestock numbers according to districts (2008)

	Districts				
Cattle and sheep Numbers (2008)	**Fezile Dabi** $N_1 = 35$	**Lejweleputswa** $N_2 = 41$	**Thabo Mofutsanyana** $N_3 = 109$	**Xhariep** $N_4 = 65$	**Total** N =250
< 100	28	33	93	53	207
100 – 200	5	8	8	8	29
201 –300	2	0	2	2	6
301 – 400	0	0	1	1	6
>400	0	0	1	1	2

N = 250

Table 4.4: Cross tabulation of livestock numbers according to districts (2012)

	Districts				
Cattle and sheep Numbers (2012)	**Fezile Dabi** $N_1 = 35$	**Lejweleputswa** $N_2 = 41$	**Thabo Mofutsanyana** $N_3 = 109$	**Xhariep** $N_4 = 65$	**Total** N =250
< 100	22	26	76	54	178
100 – 200	10	11	20	5	46
201 –300	1	2	5	2	10
301 – 400	1	2	2	0	5
>400	1	0	6	4	11

N = 250

4.3 Demographic characteristics of respondents

Table 4.5 displays the demographic characteristics of the respondents. It can be deduced from the table that the majority population of the respondents comprised of adult smallholder cattle and sheep farmers between the ages of 38 and 57, with educational level of up to standard six. Most of the farmers (77.2 %) practiced farming on a full time basis, indicating that they would have adequate time to supervise their farms and farming activities. Only 12 percent of the farms were owned by individual farmers while most of the farms were owned in groups or by a Trust. Other farms were owned by family members, cooperatives, private companies and traditional heads. This implied that farmers did not have complete control over their farms.

According to Table 4.5, only 14 percent of the farmers are located in Fezile Dabi district municipality of the province. A small percentage (16.4%) was located in Lejweleputswa district municipality. A larger percentage of the farmers were located in Thabo Mofutsanyana district municipality whereas only 26 percent were located in Xhariep district municipality. This indicated that the majority of the smallholder cattle and sheep farmers were located in Thabo Mofutsanyana district municipality of the Free State province.

As reflected in Table 4.5, majority (76%) of the respondents had up to five occupants per household, 22 percent of them had between six and ten occupants per household. Only about 1.6 percent of the respondents had more than ten occupants per household. This showed that some of the household members were likely to provide family labour for farm activities. Successful herd management for maximum profit requires family labour from certain members of household (Majekodunmi, 2011).

The results in Table 4.5 also indicate that majority (87.6%) of the respondents were male farmers while only 12.4 percent were female farmers. The implication was that smallholder cattle and sheep farming were more popular among male than females. Females are still expected to cook and perform house chore duties while males are expected to do jobs that require lots of energy such as certain farm operations involved in herd management (Moyo, 2010).

Table 4.5 also indicates that larger percentages (80.8%) of the respondents were married while the remaining 19.2 percent were single, divorced or widowed. This implied that most of the farmers were stable in their places of residence and had access to more family labour.

As reflected in Table 4.5, lower percentage of the respondents had between 1 and six years of experience in cattle and sheep farming. The majority (47.2%) of the respondents had between seven and twelve years of experience while about 38.8 percent had more than 12 years of experience in cattle and sheep farming. The implication is that majority of the respondents had substantial years of experience in cattle and sheep farming. Although Table 4.7 reflects that years of experience of the respondents had a positive effect on livestock numbers, it did not significantly affect livestock numbers.

Table 4.5: Demographic characteristics of respondents

Variable	Frequency	Percentage
District municipality		
Fezile Dabi	35	14.00
Lejweleputswa	41	16.40
Thabo Mofutsanyana	109	43.60
Xhariep	65	26.00
Total	**250**	**100.00**
Household size		
0 – 5	191	76.00
6 -10	55	22.00
> 10	4	1.60
Total	**250**	**100.00**
Gender		
Male	219	87.60
Female	31	12.40
Total	**250**	**100.00**
Age (Years)		
<37	12	4.80
38 – 57	127	50.80
>58	111	44.40
Total	**250**	**100.00**
Marital status		
Single	16	6.40
Married	202	80.80
Divorced	5	2.00
Widowed	27	10.80
Total	**250**	**100.00**
Level of education		
Pre-school	2	0.80
Standard 1	39	15.60
Standard 6	76	30.40
Standard 10	68	13.60
Higher	34	12.40
None	31	
Total	**250**	**100.00**
Years of experience		
1-6	35	14.00
7-12	118	47.20
>12	97	38.80
Total	**250**	**100.00**
Household income (rands)		
60 000;	204	81.60
60 000 - 120 000	36	14.14
120 001 - 180 000;	3	1.20
180 001 - 240 000;	6	2.40
240 001 – 300 000;	1	0.40
>300 000	0	0.00
Total	**250**	**100.00**

N (list wise) = 250

Table 4.5: Demographic characteristics of respondents (Continued)

Variable	Frequency	Percentage
Farm ownership		
Individual company	30	12.00
Family members	30	12.00
Farmers' group	84	33.60
Cooperative	7	2.80
Private	13	5.20
Trust	71	28.40
Traditional heads	15	6.00
Total	**250**	**100.00**
Major occupation		
Farming	193	77.20
Employed	32	12.80
Business	25	10.00
Total	**250**	**100.00**

N (list wise) = 250

4.4 Prevalent factors that affected smallholder cattle and sheep farming

The descriptive statistics (percentage, mean, standard deviation and variance) of the most prevalent factors affecting smallholder cattle and sheep farming in the Free State were presented. Percentages were used to determine the most prevalent factors among all the influencing factors listed in the questionnaire. The influencing factors were grouped into categories, such as problems with the camp system; factors affecting the camp system; climate change-related factors; feeding-related factors; service/advice/training-related factors; reproduction-related factors; marking-related factors; management-related factors; animal health-related factors; animal-loss related factors; and factors affecting grazing of livestock, grazing land condition and land acquisition.

Table 4.6 presents factors that affected smallholder cattle and sheep numbers in the Free State. Of the 250 smallholder cattle and sheep farmers interviewed about whether or not they encountered any problems with the camp system, 77.2 percent indicated that they indeed encountered problems and only 22.8 percent indicated that they did not encounter any problems. Of the 77.2 percent of the farmers who encountered problems with the camp system, 8.8 percent encountered problems with water circulation on the camps and 12.0 percent encountered problems with dilapidated fences. At least 7.6 percent indicated an insufficient number of camps, 5.6 percent encountered problems with inadequate water points on the camps, and the majority (43.2%) ranked the problem of having no camps at all on the grazing land as the most prevalent factor with reference to the camp system.

The climate change-related factors were grouped into four categories, namely flood, drought, increased temperature (heat stress) and decreased temperature. At least 2.0 percent of the 250 smallholder cattle and sheep farmers interviewed indicated flood as the most prevalent factor. Most of the farmers (about 96.4 percent) ranked drought as the most prevalent factor. Only 1.6 percent indicated increased temperature (heat stress) as the most prevalent factor. No farmer indicated decreased temperature as a prevalent factor in the study area.

The feed-related factors that affected smallholder cattle and sheep numbers were grouped into five categories. Of the 250 small holder cattle and sheep farmers

interviewed, 12.8 percent indicated poor forage quality as the most prevalent feed-related factor. At least 33.2 percent indicated increased feed cost as the most prevalent factor; 27.2 percent indicated feed shortage as the most prevalent factor; 22.0 percent indicated poor or no access to grazing land as the most prevalent factor; and only 4.8 percent did not encounter a feeding-related problem.

Of the 250 smallholder cattle and sheep farmers interviewed, 11.6 percent indicated lack of practical knowledge as the most prevalent factor under the service, advice / training-related factor. Poor veterinary services were ranked by 37.2 percent of the respondents as the most prevalent factor; 18.4 percent indicated poor or no access to credit as the most prevalent factors; 4.8 percent of the farmers indicated little or no extension services as the most prevalent factor; 15.2 percent indicated skills development as the most prevalent factor and only 12.8 percent of the farmers interviewed indicated no prevalent factors related to service, advice / training.

In the category for reproduction-related factors, of the 250 smallholder cattle and sheep farmers interviewed 26.4 percent ranked insufficient breeding stock as the most prevalent factor; 15.2 percent indicated premature death as the prevalent factor; at least 18.4 percent indicated poor breeds as the most prevalent factor; and 11.6 percent indicated low birth weight as the most prevalent factor. Only 28.4 percent indicated that no prevalent reproduction-related factor affected their farming.

Of the 250 smallholder cattle and sheep farmers interviewed across the province, 45.2 percent ranked the high cost of fuel and transportation as the most prevalent marketing-related factor. Poor market price was indicated by 33.2 percent as the most prevalent factor under this category. At least 11.2 percent indicated market competition as the most prevalent factor, and only 10.4 percent did not observe any market related prevalent factor.

Concerning management-related factors, at least 48.4 percent of the 250 smallholder cattle and sheep farmers interviewed ranked lack of equipment as the most prevalent factor. Lack of equipment was indicated by 5.6 percent as the most prevalent factor, whereas 39.2 percent indicated grazing land management as the

most prevalent factor. Only 6.8 percent did not observe any management-related prevalent factor.

The animal health-related factor was grouped into five categories. Of the total number of smallholder cattle and sheep farmers interviewed, 25.6 percent indicated pest and parasites as the most prevalent factor. The majority, 32.0 percent, ranked diseases as the most prevalent factor, and about 4.0 percent indicated vaccines and inoculation as the most prevalent factor. At least 30.8 percent indicated purchase of dosing products as the most prevalent animal health-related factor.

Concerning animal loss-related factor, 53.2 percent of the 250 farmers interviewed (the majority) ranked stock theft and pilfering as the most prevalent factor. High mortality was indicated by 27.2 percent of the farmers as the most related factor and only 19.6 percent indicated that no prevalent factor related to animal loss.

Factors that affected livestock grazing were also considered as a factor affecting cattle and sheep faming. Of the 250 smallholder cattle and sheep farmers interviewed, 21.6 percent indicated small grazing land as the most prevalent factor; 3.6 percent indicated weed encroachment as the most influencing factor; and 8.0 percent indicated water supply and water-related factors as the most prevalent factor. At least 10.8 percent indicated veld fires as the most prevalent factor and 5.2 percent and 15.2 percent indicated overstocking and overgrazing respectively as the most prevalent factor. Both water supply and weed encroachment were indicated by 2.4 percent of the farmers as the most prevalent factor, 23.2 percent ranked insufficient grass on grazing land as the most prevalent factor and only 10.0 percent indicated no prevalent factor.

When the 250 smallholder cattle and sheep farmers interviewed were asked to describe the condition of the grazing land, the majority (64.0 %) described it as very poor; 13.2 percent described the condition as poor; and 12.0 percent described the condition as fair, with a reasonable number of grass species. Of the farmers interviewed, 8.4 percent described the condition as good with plenty of grass species and only 2.4 percent described the condition as very good and improving. Furthermore, 8.8 percent of the 250 farmers interviewed indicated that they could

acquire additional grazing land very easily; at least 2.0 percent of the farmers indicated acquiring additional grazing land as easy; 20.8 percent indicated that acquiring additional grazing land was difficult; the majority, 66.0 percent, indicated it as very difficult and 2.4 percent indicated they did not know because they had never tried to acquire additional grazing land.

Despite the factors influencing smallholder cattle and sheep farming, 96.8 percent of the 250 farmers interviewed indicated an interest in increasing their stock and only 3.2 percent did not indicate any interest in increasing their stock due to high stock theft. Of the 96.8 percent who indicated their interest in increasing the stock, 43.2 percent would like to do so by acquiring more land. The majority, 47.6 percent, indicated they would increase stock by getting both good breeding stock and more land, and 4.0 percent would only increase the stock by getting good breeding stock. Of the farmers interviewed, 2.0 percent wanted to fence and divide their grazing land into camps in order to increase their livestock numbers.

The majority of the farmers (96.8 %) interviewed indicated their desire to increase the stock that they kept. However, it can be concluded that lack of camp systems, drought prevalence, increased feed costs, poor veterinary interventions, insufficient breeding stock, the high cost of fuel and transportation, lack of equipment, disease, stock theft and pilfering, and lack of suitable grazing land (which made acquiring additional grazing land very difficult) were the most prevalent factors that affected smallholder cattle and sheep farming in the Free State province.

Table 4.6: Descriptive statistics for prevalent factors that influenced smallholder cattle and sheep farming

Variable	Percentage %	Mean	Standard Deviation	Variance
Influencing factors:				
Do you encounter any problem with the current camp system?		1.23	0.420	0.177
Yes = 1	77.2			
No = 2	22.8			
Factors affecting camp system		4.31	1.615	2.608
Water circulation = 1	8.8			
Bad and old fence = 2	12.0			
Insufficient number of camps = 3	7,6			
Inadequate water points = 4	5.6			
No camp system = 5	43.2			
No prevalent factor = 6	22.8			
Climate change related factor		2.00	0.190	0.036
Flood = 1	2.0			
Drought = 2	96.4			
Increased temperature (heat stress) =3	1.6			
Feeding related factor		1.089	0.221	1.187
Poor forage quality = 1	12.8			
Increased feed cost =2	33.2			
Feed shortage =3	27.2			
Poor or no access to grazing land =4	22.0			
No prevalent factor = 5	4.8			
Service, Advice/Training related factor		3.13	1.624	2.637
Practical knowledge =1	11.6			
Poor veterinary interventions=2	37.2			
Poor or no access to credit =3	18.4			
Little or no extension services=4	4.8			
Skills development =5	15.2			
No prevalent factor = 6	12.8			
Reproduction related factor		3.00	1.572	2.470
Insufficient breeding stock=1	26.4			
Premature death=2	15.2			
Poor breeds=3	18.4			
Low birth weight=4	11.6			
No prevalent factor = 5	28.4			
Marketing related factor		1.87	0.983	0.966
High cost of fuel/transportation=1	45.2			
Poor market price=2	33.2			
Market competition=3	11.2			
No prevalent factor = 4	10.4			
Management related factor		2.04	1.073	1.151
Lack of equipment = 1	48.4			
Maintenance=2	5.6			
Grazing land management=3	39.2			
No prevalent factor=4	6.8			
Animal health related factor		2.63	1.351	1.825
Pest / parasite =1	25.6			
Disease =2	32.0			
Vaccines / inoculation = 3	4.0			
Purchase of dosing products =4	30.8			
No prevalent factor = 5	7.6			

(N = 250)

Table 4.6: Descriptive statistics for prevalent factors that influenced cattle and sheep farming (continued)

Variable	Percentage %	Mean	Standard Deviation	Variance
Influencing factors				
Animal health related factor		2.63	1.351	1.825
Pest / parasite =1	25.6			
Disease =2	32.0			
Vaccines / inoculation = 3	4.0			
Purchase of dosing products =4	30.8			
No prevalent factor = 5	7.6			
Animal loss related factor		1.66	0.786	0.618
Stock theft / pilfering	53.2			
High mortality	27.2			
No prevalent factor	19.6			
Which of these factors affect the grazing of your animals		5.41	3.265	10.661
	21.6			
Small grazing land = 1	3.6			
Weed encroachment = 2	8.0			
Water supply & related factors =3	10.8			
Veld fire = 4	5.2			
Over stocking = 5	7.0			
Over grazing = 6	23.2			
Water and weed encroachment = 7	10.0			
Insufficient amount of grass =8	15.2			
No prevalent factor = 9	12.8			
Present condition of grazing land		1.72	1.113	1.239
Very poor with little grasses=1	64.0			
Poor with some grasses=2	13.2			
Fair with reasonable grasses=3	12.0			
Good with plenty grasses = 4	8.4			
Very good & improving = 5	2.4			
Land acquisition		3.51	0.932	0.869
Easily = 1	8.8			
Very easily = 2	2.0			
Difficult =3	20.8			
Very difficult = 4	66.0			
Don't know = 5	2.4			
Would you like to increase your stock		1.03	0.176	0.031
Yes = 1	96.8			
No =2	3.2			
How do you intend to increase stock		1.74	0.882	0.778
Getting bigger land=1	43.2			
Getting good breeding stock				
Getting bigger land and=2	47.6			
Good breeding stock =3	4.0			
Fencing and dividing grazing				
land into camps =4	2.0			
Not increasing stock = 5	3.2			

N = 250

4.5 Socio-economic factors that affected smallholder cattle and sheep numbers

The Ordinary least square regression analysis (OLS) was used to determine the nature, pattern and direction of the relationship between the dependent variables (livestock numbers) and the independent variables (socio-economic factors). The results of the estimated coefficient for the OLS regression are presented in Tables 4.7 and 4.8 respectively. Table 4.7 shows that eight out of 21 independent variables significantly affected livestock numbers in 2008. Table 4.8 shows that five out of the same 21 independent variables significantly affected livestock numbers in 2012. The independent variables found to have significant effect on livestock numbers in 2008 were household size, livestock numbers in 2012, planted pastures, grazing land condition, service/ advice / training, veterinary services, purchase of dosing products and sales per year. The independent variables that were found to have significant effect on livestock numbers in 2012 were district, livestock numbers in 2008, grazing land acquisition, purchase of dosing products and sales per year. Comparing the two regression results, the independent variables that were found to significantly affect livestock numbers in both 2008 and 2012 were district, household size, livestock numbers in past year, planted pastures, grazing land condition, grazing land acquisition, service/advice/training, veterinary services, purchase of dosing products and sales per year. The adjusted R^2 values from the OLS regression for livestock numbers in 2008 and 2012 were 0.666 and 0.644 respectively. This indicated that the explanatory variables explain about 66.6 percent and 64.4 percent of the total variation in livestock numbers in 2008 and 2012 respectively. The value for adjusted R^2 also indicated that other explanatory variables that are not included in this study will affect the variation in livestock numbers by 33.4 percent and 35.6 percent in 2008 and 2012 respectively.

District had a negative but significant effect ($p<0.10$) on livestock numbers in 2012. Household size was found to significantly affect ($p<0.10$) livestock numbers in 2008. Of the farmers interviewed, 76.4 percent had up to five household members; this implied that members of the household provided family labour for farm activities. Livestock numbers in 2008 had a significant effect ($p<0.01$) on livestock numbers in 2012. The results indicated that 82.8 percent of the farmers kept fewer than 100 livestock in 2008, whereas in 2012 the percentage of farmers who kept fewer than

100 livestock had decreased to 71.2 percent. This shows that farmers who kept small numbers of livestock in 2008 had increased their livestock numbers by 2012.

Planted pastures had a significant but negative effect ($p<0.01$) on livestock numbers in 2008. The results show that 15.6 percent of the farmers planted pastures and 84.4 percent relied only on natural veld. Farmers who planted pastures were able to cope better with feed and feeding-related problems, as their livestock did not rely on natural veld only for forage. Grazing land condition also had a significant but negative effect ($p<0.10$) on livestock numbers in 2008. The results showed that the majority (64.0 percent) of the farmers described the condition of the grazing land as very poor with few grass species. Land acquisition had a negative but significant effect ($p<0.05$) on livestock numbers in 2012; 66.0 percent of the farmers indicated that acquiring additional grazing land was very difficult. Service, advice / training had a negative but significant effect ($p<0.05$) on livestock numbers in 2008. The results implied that 52.8 percent of the farmers encountered problems with getting services, advice and training related to their farming activities.

Veterinary services had a negative but significant effect on livestock numbers in 2008; from the results, 54.4 percent of the farmers encountered problems getting veterinary services. The majority of the farmers ranked poor veterinary interventions as the most prevalent service, advice / training-related factor affecting cattle and sheep farming. Purchase of dosing products had a negative but significant effect ($p<0.01$ and $p<0.10$) on livestock numbers in 2008 and 2012 respectively; 66.8 percent of the farmers encountered problems with purchasing dosing products due to the high cost of veterinary drugs. Sales per year had a negative but significant effect ($p<0.01$ and $p<0.01$) on livestock numbers in 2008 and 2012 respectively. The results show that 92.8 percent and 91.2 percent of the farmers sold up to 50 animals in 2008 and 2012 respectively.

Table 4.7: Ordinary least square regression results (2008)

Variable	B	Standard Error	t-value	Significance
Dependent variable:				
Y = Livestock numbers (2008)				
Independent variables:				
X_1 = District:	0.038	0.061	0.625	0.533
X_2 = Household size:	0.231	0.129	1.785	0.076*
X_3 = Gender:	-0.192	0.172	-1.114	0.266
X_4 = Age (Years):	-0.007	0.067	-0.099	0.921
X_5 = Level of education:	-0.031	0.048	-0.644	0.520
X_6 = Years of experience:	0.054	0.042	1.291	0.198
X_7 = Household income (Rand per year):	- 0.080	0.096	-0.832	0.406
X_8 = Farm ownership	0.007	0.032	0.212	0.832
X_9 = Camp system	-0.108	0.126	-0.857	0.392
X_{10} = Natural veld / grazing	-0.979	0.948	-1.032	0.303
X_{11} = Planted pasture	-0.577	0.183	-3.144	0.002***
X_{12} = Present grazing land condition:	-0.117	0.059	-2.000	0.047*
X_{13}=Grazing land acquisition	-0.080	0.067	-1.185	0.237
X_{14} = Services, advice and training	-0.286	0.129	-2.211	0.028**
X_{15}= Veterinary services	-0.264	0.134	-1.975	0.049*
X_{16}= Transportation	0.084	0.126	0.669	0.504
X_{17}= Vaccine and inoculation	0.137	0.128	1.072	0.285
X_{18}= Purchase of dosing products	-0.448	0.130	-3.451	0.001***
X_{19} = Major objective	0.050	0.102	0.487	0.627
X_{20}= Sales per year (2008)	0.683	0.103	6.621	0.000***

*** P<0.01; ** P<0.05; *P<0.10; Number of cases = 250; R-Square= 0.666; Durbin Watson = 1.688

Table 4.8: Ordinary Least Square regression results (2012)

Variable	B	Standard Error	t-value	Significance
Dependent variable:				
Y = Livestock numbers (2012)				
Independent variables:				
X_1 = District:	-0.159	0.087	-1.837	0.068*
X_2 = Household Size:	0.042	0.184	0.227	0.820
X_3 = Gender:	0.118	0.248	0.476	0.635
X_4 = Age (Years):	0.142	0.095	1.488	0.138
X_5 = Level of education:	0.088	0.068	1.289	0.199
X_6 = Years of experience:	-0.093	0.060	-1.553	0.122
X_7 = Household income (Rand per year):	0.169	0.135	1.252	0.212
X_8 = Livestock numbers in 2008	0.763	0.072	10.530	0.000***
X_9 = Farm ownership	-0.010	0.046	-0.214	0.831
X_{10} = Camp system	-0.202	0.180	-1.118	0.265
X_{11} = Natural veld / grazing	-0.349	1.354	-0.258	0.797
X_{12} = Planted pasture	-0.278	0.264	-1.052	0.294
X_{13} = present grazing land condition:	0.076	0.084	0.911	0.363
X_{14}=Grazing land acquisition	-0.223	0.096	-2.336	0.020**
X_{15} = Services, advice and Training	-0.076	0.185	-0.412	0.681
X_{16}= Veterinary services	0.069	0.192	0.358	0.720
X_{17}= Transportation	-0.158	0.180	-0.878	0.381
X_{18}= Vaccine and inoculation	0.141	0.183	0.767	0.444
X_{19}= Purchase of dosing Products	0.346	0.188	1.836	0.068*
X_{20} = Major objective	-0.002	0.146	-0.012	0.991
X_{21}= Sales per year (2012)	0.870	0.195	4.469	0.000***

*** P<0.01; ** P<0.05; *P<0.10; Number of cases = 250; R-Square= 0.644; Durbin Watson = 1.889

4.6 Discussion of results of the OLS regression analysis

District had a negative but statistically significant effect (p <0.10) on livestock numbers in 2012 as indicated in Table 4.8. The implication of this is that a unit change in the agro – ecological conditions in each of the four district municipalities decreased livestock numbers by 15.9 percent with all other factors held constant. This is most likely because climatic conditions such as summer and winter temperature, precipitation and other agro-ecological conditions vary in each of the four district municipalities. The more favourable the agro-ecological conditions are, the higher the livestock numbers expected in a particular district. Livestock ownership decision is highly dependent on the climate in which the farm is located; for example, when water flow is high in a district, the district is more likely to have livestock (Seo *et al*., 2008).

Household size had positive statistically significant effect (p <0.10) on livestock numbers in 2008 (Table 4.7). This implies that a unit increase in household size will increase livestock numbers by 23.1 percent with all other factors held constant. This is likely because some of the members of the household usually provide family labour for the farming activities. The findings in a study by Moyo (2010) on small-scale agricultural systems in Africa show that household size is the key factor in driving the labour availability for farming practices; timely completion of tasks by family labour is important in small-scale agricultural practices. Successful management of large herds for the maximum benefit of the household requires the labour from certain members of the family of both genders (Majekodunmi, 2011). The findings in a study by Kaimba *et al.* (2011) also show that household size has a significant (p<0.01) but positive effect on herd size, implying that large households own larger herds than small households, as larger households indicate availability of the family labour necessary to look after large herds.

Livestock numbers in 2008 had a positive and statistically significant effect (p <0.01) on livestock numbers in 2012 in the OLS regression result in Table 4.8. This implies that a unit increase in livestock number in 2008 increased livestock numbers by 44.0 percent in 2012. Of the farmers, 82.8 percent kept below 100 livestock in 2008 whereas in 2012, the percentage of the farmers who kept below 100 livestock had decreased to 71.2 percent in 2012. This indicates that some of the farmers who kept

small numbers of livestock in 2008 had increased their stock by 2012. The report on natural livestock statistics of South Africa shows that only cattle and pig numbers increased in 2008 (NDA, 2009). In 2012, the same statistics show that the numbers for cattle, sheep, pigs and goats all increased in South Africa by November 2012 (NDA, 2013). The results from the surveys carried out by the UK'S agricultural department in December 2012 show that the total number of cattle and calves in the UK increased in 2012, as against the trend of declining cattle numbers since 2005 at the same time of the year (DEFRA, 2013).

Planted pasture had a negative but significant effect ($p < 0.01$) on livestock numbers in 2008 (Table 4.7) but its effect was not significant in 2012 as indicated in the results in Table 4.8. The implication of this is that a unit increase in areas without planted pasture will decrease livestock numbers by 57.7 percent. This is likely because majority of the smallholder cattle and sheep farmers in the province depend on natural veld for feeding their livestock. The results show that 84.4 percent had natural pasture while only 15.6 percent of the farmers had both natural veld and planted pasture. Farmers who have planted pasture are more likely to cope better with feed and feeding-related problems because planted pastures can be used to relieve the pressure on the natural veld, reduce the quantity of conserved feed and thereby improve the performance of the livestock. Alemayehu (1998) estimates that 80–85 percent of the livestock feed comes from natural pasture. Livestock in sub-Saharan Africa are dependent primarily on native grasslands and crop residue (Teklu *et al*., 2010). High grazing pressure on the natural pastures results in overgrazing, leading to further degradation of the vegetation resources (Macharia and Ekaya, 2005). One way of improving the productivity of range lands is through integrating forage legumes into natural pastures, especially in smallholder livestock production systems. This could lead to enhanced forage production and increased grazing periods, as legumes can remain green long after grasses have dried (Macharia *et al.*, 2010).

Present grazing land condition had a significant but negative effect ($p < 0.10$) on livestock numbers in 2008. This implies that a decline in land condition by 11.7% decreased livestock numbers in 2008. Macharia *et al*. (2005) also showed that there has been a downward trend in range conditions, and that even affected livestock

productivity over the previous 30 years. Macleod *et al*. (2004) assessed the impact of grazing land condition on livestock performance using three different grazing land conditions in northern woodlands. The results indicated that as grazing land condition deteriorates by a unit, stocking rate reduces by 11.7 percent in 2008. However its effect on livestock numbers in 2012 was positive but not statistically significant. The results show improvement in the grazing land condition from 2008 to 2012 in the area.

Grazing land acquisition did not indicate any significance in 2008 but had a significant but negative effect ($p < 0.05$) on livestock numbers in 2012. The results in Table 4.8 show that a unit increase in grazing land acquisition will result in 22.3 percent decrease in livestock numbers. This implies that acquiring more grazing land in the area is insignificant although farmers who do not cut down on their stocking rate to the required grazing capacity would likely overgraze and overstock the grazing land, thereby ending up with unproductive animals with low market value. However, studies have revealed that the major production constraint to expanding farming is lack of grasslands due to increased population pressure. Farmers who wish to increase their livestock numbers cannot do so due to difficulty in obtaining additional grazing land (Premaratne *et al.*, 2003; Vithanage *et al*., 2014).

In 2008*, service, advice / training* had a significant but negative effect ($p < 0.05$) on livestock numbers. Thus, a unit increase in service / advice / training reduced livestock numbers by 28.6 percent, all factors held constant. Various extension services in agriculture have been designed to provide services, advice and training to smallholder farmers. Despite wide-ranging reform initiatives in agricultural extension, the access to and quality of information provided to marginalized and poor farmers is still uneven (Glendenning *et al.*, 2010). However, this does not still indicate poor services. The findings from the study of Adhiguru *et al*. (2009) showed that contact with extension workers for medium-sized and large-scale farmers was almost double that of smallholder farmers. Smallholder farmers relied primarily on other progressive farmers, input dealers and radio for information. On the contrary, Mogues *et al*. (2009) revealed that 92 percent and 94 percent of men and women respectively, who received extension service or expert advice, were satisfied with the services, although only 8 percent of respondents stated that they had tried

something new in the past two years. Some of the reasons why provision of agricultural services, advice and training may fail are general lack of capacity to provide the services in terms of staff and resources; lack of appropriate management of the service to make it effective and focus on outcomes; lack of political priorities to provide the services; and lack of knowledge about the relevance of the wellbeing of the farmers (Mogues *et al*., 2009).

Veterinary services had a significant but negative effect ($p < 0.10$) on livestock numbers in 2008. However, in 2012 its effect was positive but insignificant. Majekodunmi (2011) investigated the knowledge, attitudes and practices of farmers regarding animal trypanosomiasis. The findings showed that all the farmers (100 %) dosed the animals incorrectly, despite a good knowledge and general diagnostic ability. Farmers lacked the knowledge and resources for treatment and control because of poor availability and updating of veterinary services. Vithanage *et al*. (2014) observed that poor veterinary services are the major production constraints faced by dairy farmers.

Purchase of dosing products had a significant but negative effect on livestock numbers in the OLS regression result for 2008. However, in 2012 the effect was positive and significant at 10 percent level of significance ($p < 0.10$). A unit increase of purchased dose product increased livestock numbers by 34.6 percent all factors held constant. This is likely because quality dose products are expensive but still much more effective. Majekodunmi (2011) states that the most significant cost associated with cattle production is veterinary drugs, which accounted for 43 percent of the total production cost. Livestock farmers have alternatives to Western drugs and use locally available remedies for curing and preventing diseases (Moyo, 2010). Cassini *et al.* (2008) similarly observed that livestock farmers used traditional medicines for their livestock treatment because the costs of modern veterinary drugs were perceived to be high.

Sales per year had a significant and positive effect on livestock numbers in both years. In 2008, a unit increase in sales per year resulted in 68.3 percent increase in livestock numbers and 87.0 percent in 2012. This implies that farmers generated enough income from the sale of livestock to enable them to meet expenses such as

the purchase of more breeding stock, feed and supplements, which would help them increase and improve the productivity and overall performance of the livestock they keep. For many smallholder farmers, the sale of livestock provides the only outlet to the cash economy; livestock sales contribute 78 percent of the cash income for smallholder mixed crop and livestock farms (Kuriuku *et al*., 2013). The study by Lubungu *et al*. (2012) shows that as herd size increases, the proportion of households selling that particular type of livestock also increases.

4.7 Chapter summary

This chapter examined the socio-economic and demographic characteristics of smallholder cattle and sheep farmers in the Free State province. The most prevalent factors affecting livestock numbers as well as socio-economic factors that affected livestock numbers were also determined. A total of 250 smallholder cattle and sheep farmers in the four district municipalities of the Free State were interviewed with the use of a well-structured questionnaire. Information gathered from the questionnaire was analysed using descriptive statistics and the OLS regression model. Table 4.5 shows the demographic characteristics of the respondents. It can be deduced from the table that the majority population of the respondents comprised of adult farmers between the ages of 38 - 57 population, with educational level of up to standard six. Most of the farmers (77.2%) practiced farming on a full basis, indicating that they would have adequate time to supervise their farming activities. Only 12% of the farms were owned by individual farmers which implied that farmers did not have complete control over their farms during the period of study.

The results from the descriptive statistics in Table 4.6 show that lack of camp systems, drought, increased feed cost, poor veterinary interventions, insufficient breeding stock, high cost of fuel and transportation, lack of equipment, disease, stock theft and pilfering, and lack of grazing land, which makes acquiring additional grazing land very difficult, are the most prevalent factors influencing cattle and sheep farming in the Free State. The results from the OLS regression presented in Tables 4.7 and 4.8 show that 10 out of 21 independent variables had a significant effect on livestock numbers. The socio-economic factors that had a significant effect on livestock numbers were district, household size, livestock numbers in past year (2008), planted pasture, grazing land condition, grazing land acquisition, service,

advice / training, veterinary services, purchase of dosing products and sales per year. Tables 4.3 and 4.4 present the cross-tabulation of livestock numbers across the four district municipalities in 2008 and 2012 respectively. It shows that farmers kept more livestock in 2012 than in 2008.

CHAPTER 5

SUMMARY AND CONCLUSION

5.1 Introduction

The role livestock plays in the agricultural sector and economy of South Africa is significant. In South Africa, like in most countries in the world, livestock farming plays a very important role in the agricultural sector owing to its great potential to provide sustenance for most metropolitan and rural communities. Livestock farming is practised in all nine provinces of South Africa, both at smallholder and commercial level. However several factors, ranging from social to economic, affect livestock numbers. This study was aimed to investigate the prevalent factors that affected smallholder cattle and sheep numbers in order to gain a clear understanding of the problems encountered by smallholder cattle and sheep farmers. The objectives of the study were: to determine the socio- economic and demographic characteristics of smallholder cattle and sheep farmers, investigate the prevalent factors that affected smallholder cattle and sheep farming, determine the socio-economic factors that affected livestock numbers in the Free State and make recommendations on how smallholder livestock farmers can reduce their vulnerability to the factors affecting them.

5.2 Summary

The study was conducted in 21 towns across the four district municipalities of the Free State. Data were collected from 250 smallholder cattle and sheep farmers who owned 30 livestock or more. This data was collected in the form of interviews, using questionnaires. The farmers were interviewed either in their homes or on the farm, although farm visits were preferred to allow for personal observation of the farms to confirm some of the answers provided by the respondents. The questionnaires were prepared in English, although questions that seemed difficult to the respondents were explained in their local language (Sesotho) by local extension officers from the department of agriculture. Interpretation was also done in instances where the farmer could not communicate in English or felt more comfortable communicating in the local language. The OLS regression model was used to identify the socio-economic factors that affected livestock numbers in 2008 and 2012. Comparing the

two regression results, ten independent variables had a significant effect on livestock numbers (Tables 4.7 and 4.8).

5.2.1 Summary of results and discussion

Tables 4.3 and 4.4 present cross-tabulation of the total livestock numbers kept by smallholder cattle and sheep farmers in 2008 and 2012 in the four district municipalities. The majority of the farmers who kept fewer than 100 cattle and sheep had a total of 207 cattle and sheep in 2008 and 178 in 2012. This was an indication that the total of smallholder farmers who kept fewer than 100 cattle and sheep in 2012 decreased in 2012 by 14 percent. The total of farmers who kept between 100 and 200 cattle and sheep increased in 2012 by 37%. Also, comparing the total of farmers who kept between 201 and 300 livestock indicated an increase from 6 to 10 livestock in 2012. Furthermore, in 2008, of six (6) farmers who kept between 301 and 400 cattle and sheep decreased by one (1) farmer was indicated in 2012. The total of farmers who kept more than 400 cattle and sheep increased from two (2) in 2008 to 11 in 2012. Although more farmers kept between 301 and 400 livestock in 2008, it can be concluded that farmers kept more livestock in 2012 than in 2008.

Demographic analysis (Table 4.5) of the respondents indicated that the majority population of the respondents comprised of adult farmers between the ages of 38 - 57 population, with educational level of up to standard six. Most of the farmers (77.2 %) practiced farming on a full time basis, indicating that they would have adequate time to supervise their farming activities. Only 12% of the farms were owned by individual farmers which implied that farmers did not have complete control over their farms.

Table 4.6 presents the prevalent factors affecting smallholder cattle and sheep farming in the Free State in percentages. Of the 250 smallholder cattle and sheep farmers interviewed across the province on whether or not they encounter any problems with the current camp system, the majority (77.2%) said they did. Of the 77.2 percent, 43.2 percent ranked the problem of having no camps at all on the grazing land as the most prevalent factor. For climate change-related factors, 96.4 percent ranked drought as the most prevalent factor in the study area. For feeding-related factors affecting smallholder cattle and sheep farming, the majority of the

farmers (33.2%) indicated increased feed cost as the most prevalent factor. The majority (37.2%) of the farmers ranked poor veterinary services as the most prevalent factor related to service, advice / training. Of the farmers, 26.4 percent ranked insufficient breeding stock as the most prevalent factor for reproduction-related factors. Also, the majority (45.2%) indicated the high cost of fuel and transportation as the most prevalent marketing-related factor. In the category of management-related factors, most of the farmers (48.4%) indicated lack of equipment as the most prevalent factor. For the animal health-related factor, the majority (32.0%) ranked disease as the most prevalent factor.

In the category of animal loss-related factor, 53.2 percent out of the 250 farmers (the majority) interviewed ranked stock theft and pilfering as the most prevalent factor. Of the farmers, 27.2 percent indicated high mortality as the most prevalent factor, and only 19.6 percent of the farmers indicated that no prevalent factor related to animal loss.

Factors that affected livestock grazing were also considered as an influencing factor affecting cattle and sheep farming. The majority of the farmers (23.2%) indicated insufficient grass on grazing land as the most prevalent factor. The majority (64.0%) of the farmers described the present condition of their grazing land as very poor. The majority (66.0%) also indicated that it was very difficult to acquire additional grazing land. However, most (96.8%) indicated an interest to increase their stock. Of the 96.8 percent who would like to increase their stock, 43.2 percent would like to do so by acquiring more land. The majority, 47.6 percent, indicated they would increase stock by getting both good breeding stock and more land, and 4.0 percent would increase stock by getting only good breeding stock. Of the farmers, 2.0 percent want to fence and divide the grazing land into camps in order to increase the stock.

It can be concluded that the lack of camp systems, drought, increased feed cost, poor veterinary interventions, insufficient breeding stock, the high cost of fuel and transportation, lack of equipment, disease, stock theft and pilfering and lack of grazing land (which makes acquiring additional grazing land very difficult) were the most prevalent factors that affected smallholder cattle and sheep farming in the Free State province.

In the OLS regression results, the independent variables that had a significant effect on livestock numbers are district, household size, livestock numbers in past year, planted pasture, grazing land condition, grazing land acquisition, service, advice / training, veterinary services, purchase of dosing products and sales per year.

District had a negative but significant effect ($p<0.10$) on livestock numbers. Seo *et al*. (2008) also observed that the decision to own livestock is highly dependent on the climate in which the farm is located. Household size had a significant effect on livestock numbers. A high percentage (76.4%) of the smallholder farmers had up to five members in their households. The findings by Moyo (2010) also indicated that livestock farmers had an average household size of five. The findings of a study by Kaimba *et al.* (2011) also indicated that household size has a significant ($p<0.01$) but positive effect on herd size.

Cattle and sheep numbers in 2008 had a significant effect on numbers in 2012. Of the farmers, 82.8 percent kept fewer than 100 head in 2008 whereas in 2012, the percentage had decreased to 71.2 percent. This implied that some of the farmers who kept small numbers of livestock in 2008 had increased their stock by 2012. The results from the surveys carried out by the UK's Agricultural Department in December 2012 show that the total number of cattle and calves in the UK increased in 2012, as against the trend of declining cattle numbers since 2005 at the same time of year (National Statistics, 2013).

Planted pastures had a negative but significant effect on livestock numbers. The majority of the smallholder cattle and sheep farmers (84.4%) relied only on natural pasture for feeding their livestock; only 15.6 percent had both natural veld and planted pasture. Alemayehu (1998) estimated that 80–85 percent of the livestock feed came from natural pasture. Grazing land condition had a significant but negative effect on livestock numbers. The results show that the majority (64.0%) of the farmers described the condition of the grazing land as very poor with few grasses. The study by Macharia *et al*. (2005) also reveals that there has been a downward trend in range conditions, which has affected livestock productivity over the last 30 years. Grazing land acquisition has a significant but negative effect on

livestock numbers; 66.0 percent of the farmers indicated that acquiring additional grazing land is very difficult and almost impossible.

Service, advice/training had a significant but negative effect on livestock numbers. From the results, 52.8 percent of the farmers encountered problems in getting the services, advice and training they require to improve their farming practices. Veterinary services had a significant but negative effect on livestock numbers; the results show that 54.4 percent of the farmers encountered problems getting veterinary services. Purchase of dosing products had a significant but negative effect on livestock numbers in the OLS regression results. The results show that 66.8 percent of the farmers encounter problems with purchasing dosing products. Cassini *et al.* (2008) observed that livestock farmers used traditional medicines for their livestock treatment because the costs of modern veterinary drugs were perceived to be very high.

Sales per year had a significant and positive effect on livestock numbers. For many smallholder farmers, the sale of livestock provides the only outlet to the cash economy; livestock sales contribute 78 percent of the cash income for smallholder mixed-crop and livestock farms (Kuriuku *et al*., 2013). This means that farmers generate enough income from the sales of livestock to enable them cater for expenses such as purchasing more breeding stock, feed and supplements and other important expenses that would help them increase and improve the productivity and overall performance of the livestock they keep.

5.3 Conclusion and recommendations

The OLS regression results presented in Tables 4.7 and 4.8 shows the degree of significance of different independent variables that affected livestock numbers. The study revealed that the independent variables found to significantly affect livestock numbers in both 2008 and 2012 were district, household size, livestock numbers in 2008, planted pasture, grazing land condition, grazing land acquisition, service, advice/training, veterinary services, purchase of dosing products and sales per year.

District had a negative but significant effect on livestock number which implied that livestock ownership decision is highly dependent on the agro-ecological conditions prevalent in a place in which the farm is located. Household size had a positive effect on livestock numbers. The conclusion is that large households own larger herds than small households, as larger households indicate availability of the family labour necessary to look after large herds as some of the members of the household can provide family labour for the farming activities. Cattle and sheep numbers in 2008 had a significant effect on numbers in 2012; this implied that some of the farmers who kept small numbers of livestock in 2008 had increased their stock by 2012. It can be concluded that farmers who kept few numbers of livestock in a previous year were able to make enough income from livestock sales to increase or rebuild their stock in following year or years after.

Planted pastures negatively affected livestock numbers. It was concluded that the majority of the smallholder cattle and sheep farmers in the province depended on natural veld for feeding their livestock and it is only farmers who had planted pastures that were more likely to cope better with feed and feeding-related problems as planted pastures can be used to relieve the pressure on the natural veld, reduce the quantity of conserved feed and thereby improve the performance of the livestock. Grazing land condition also had a significant but negative effect on livestock numbers. It can be concluded that as the grazing land condition degraded, farmers were forced to cut down the stocking rate in order to meet the feed requirements of the livestock. Grazing land acquisition had a negative effect on livestock numbers. The conclusion was farmers who did not cut down on their stocking rate would overgraze and overstock the grazing land, thereby ending up with unproductive animals with low market value.

Service, advice/training had a significant but negative effect on livestock numbers. Majority of the smallholder farmers encountered problems in getting the services, advice and training they required to improve on desired farming practices. Conclusions were that access to and quality of information provided to marginalized and poor farmers had improved but was still uneven despite wide-ranging reform initiatives in agricultural extension services. Farmers' access to veterinary services had a significant but negative affect on livestock numbers. It was concluded that

even though veterinary services in the area have improved, farmers still lacked the knowledge and resources for disease treatment and control because of poor availability and updating information on veterinary services.

Purchase of dosing products significantly affected livestock numbers but negatively. It can be concluded that farmers encountered problems with purchasing quality dosing products even though they are more effective, most likely due to the high cost and lack of storage facilities such as coolers or fridges to properly preserve the dosing products before or after use. This forces livestock farmers to develop alternatives to Western drugs and use locally available remedies which are sometimes not as effective for curing and preventing diseases. Sales of livestock per year had a significant and positive effect on livestock numbers. The conclusion is that farmers generated enough income from the sale of livestock to enable them to meet expenses such as the purchase of more breeding stock, feed and supplements, which would help them increase and improve the productivity and overall performance of the livestock they kept.

The results from the descriptive statistics in Table 4.6 show that lack of camp systems, drought, increased feed cost, poor veterinary interventions, insufficient breeding stock, high cost of fuel and transportation, lack of equipment, disease, stock theft and pilfering, and lack of grazing land, which makes acquiring additional grazing land very difficult, are the most prevalent factors influencing cattle and sheep farming in the Free State.

Table 4.5 explained the demographic characteristics of the respondents. It can be concluded that the majority population of the respondents comprise of adult farmers between the ages of 38 - 57 population, with educational level of up to standard six and that most of them practiced farming on a full basis, indicating that they would have adequate time to supervise their farms and farming activities. The age distribution of farmers indicated that the age indicated a potential of livestock numbers to improve because at that age farmers are more committed to farming because of the potential benefits that can be reaped from it. Lastly 12% of the farms were owned by individual farmers; this implied that most of the farmers did not have complete control over their farms. It can be concluded therefore that not owning a

farm can have negative long term effects on cattle and sheep farming in the area of study although in Tables 4.3 and 4.4 the smallholder cattle and sheep farmers kept more livestock in 2012 than in 2008.

The study therefore recommends that municipalities should make more commonage land available to the smallholder farmers in order to cope with the increasing population of emerging farmers. Commonage land management should be strengthened. It is also recommended that policies that provide guidance on how different groups of farmers should utilize the same commonage land should be strictly applied.

The study also recommends that extension and veterinary services should be strengthened. Extension officers should be well distributed and well equipped with necessary resources, which will enable them to increase their coverage in terms of the numbers of farmers they reach. Extension officers should give timely and professional advice on overall management practices which will assist farmers to improve their livestock activities as well as their standard of living.

Smallholder livestock farmers should be encouraged to engage in camp systems and practise rotational grazing. This will reduce overgrazing and uncontrolled breeding, as dividing land into camps will allow male and female animals to be separated and ensure that mating is only allowed when conditions are favourable.

Smallholder cattle and sheep farmers should be trained on how to make reserves such as hay and silage so they can conserve surplus forage in rainy seasons. They should also be advised to plant fodder plants to reduce pressure on the natural veld, and also to introduce legumes into their pastures in order to produce forage throughout the year. Farmers can also increase the land's productivity by establishing fodder grass and fodder shrubs along contour bands.

The study also recommends that government should provide subsidies for purchase of breeding stock and dosing products. Distribution policies that will ensure that all smallholder cattle and sheep farmers at grassroots level benefit should also be put in place. This should enable smallholder cattle and sheep farmers to cope with the high

transactional costs associated with purchasing equipment and facilities (e.g. windmills, crawl pens, head clamps, dipping tanks, veterinary drugs and feed supplements).

REFERENCES

Abdulrazak, S.A., Muinga, R.W., Thorpe, W. and Orskov, E.R. (1997). Supplementation with Gliricidia Sepium and Leucaena Leucocephala on voluntary food intake, digestibility, rumen fermentation and live weight of crossbred steers offered zea mays stover. *Livestock Production Science*, **49**(10):53-62.

Adhiguru, P., Birthal, P.S. and Kumar, B.G. (2009). Strengthening pluralistic agricultural information delivery systems in India. *Agriculture Economics Research Review*, **22**:71-79.

Adkinson, A. and Adkinson, R. (2013). The FecB (Booroola) gene and implications for the Turkish sheep industry. *Turkish Journal of Veterinary and Animal Science*, **37**:621-624.

Ahmad, M., Akram, M., Rauf, R., Khan, I.A. and Pervez, U. (2007). Interaction of extension workers with farmers and radio and television are sources of information in technology transfer: a case study of four villages of districts Peshawar and Charsadda. *Sarhad Journal of Agriculture*, **23**(2):515-518.

Alemayehu, M. (1998). *The Borana and the 1991-1992 droughts*. *A rangeland and livestock resource study*. Institute of Sustainable Development, Addis Ababa, Ethiopia.

Alemayehu, M., Amede, T., Bohme, M. and Peters, K.J. (2012). Increasing livestock water productivity under rain-fed mixed crop / livestock farming scenarios of Sub-Saharan Africa: a review. *Journal of Sustainable Development,* **5**(7):1-10.

Ali, J. (2006). Structural changes in consumption and nutrition of livestock products in India: implication for food security. *Indian Journal of Agricultural Economics*, **61**(3):419.

Amede, T., Tawaradi, S. and Peden, D. (2011). Improving water production in crop-livestock system of drought-prone regions. *Experimental Agriculture,* **47**(1):1-5.

Anaeto, F.C., Asiabaka, C.C., Nnadi, F.N., Ajaero, J.O., Aja O.O., Ugwoke, F.O., Ukpongson, M.U. and Onweagba, A.E. (2012). The role of extension officers and extension services in the development of agriculture in Nigeria. *Woodpecker Journal of Agricultural Research,* **1**(6):180-185.

Banda, L.J., Kamwanja, L.A., Chagunda, M.G.G., Ashworth, C.J. and Roberts, D.J. (2012). Status of dairy cow management and fertility in smallholder farms in Malawi. *Tropical Animal Health Production*, **44**:715-727.

Barnes, J., Cannon, J. and MacGregor, J. (2008). Livestock production economics on communal land in Botswana: effects of tenure, scale and subsidies. *Development Southern Africa,* **25**(3):327-345.

Benton, T., Gallani, B., Jones, C., Lewis, K., Tiffin, R. and Donohoe, T. (2012). *Severe weather and UK food chain resilience*. Food Research Partnership: resilience of the UK food system subgroup.

Blignaut, J., Ueckermann, L. and Aronson, J. (2009). Agricultural production's sensitivity to changes and climate in South Africa. *South African Journal of Science*, **105**(1-2):61-68.

Capper, J.L. (2013). Should we reject animal source foods to save the planet? A review of the sustainability of global livestock production. *South African Journal of Animal Science*, **43**(3):233-246.

Cardoso, L.A. (2012). Environmental and economic impacts of livestock productivity increase in Sub-Saharan Africa. *Tropical Animal Health and Production*, **44**:1879-1884.

Cassini, R., Guerreta, I., Dated, D., Morbin, D. and Pallottino, M. (2008). Traditional systems and development interventions in LVIA experience in Moyale, a pastoral

area of Southern Ethiopia. *Journal of Agriculture and Environment for International Development*, **102**:7-33

Chhabra, A., Manjunath, K.R., Panigraph, S and Parihar, J.S. (2013). Greenhouse gas emissions from Indian livestock. *Climatic Change*, **117**:329-344.

De Han, O., Steinfield, H. and Blackburn, H. (1997). *Livestock and the environment*: *finding a balance*. Report of a study coordinated by FAO, USAID and the World Bank. FAO publishers, Rome.

Delgado, C., Rosegrant, M., Steinfield, H., Ehui, S. and Courbois, C. (1999*). Livestock to 2020: the next food revolution*. Food, Agriculture and the Environment Discussion Paper 28. International Food Policy Research Institute (IFPRI), Washington DC.

Department for Environment Food and Rural Affairs (DEFRA). (2013). Farming statistics –livestock at 1 December 2012, in UK and England. A Joint Announcement by the Agricultural Departments of the United Kingdom, March, 13, 2013, United Kingdom. Available from: www.gov.uk/government/uploads/system/uploads/attachement_data/file/183227/defra-stats-foodfarm-landuselivestock-farmstats-dec2012-130314.pdf. (Accessed on 27/04/2014).

Dobell, D.B., Burke, M.B., Tebaldi, R.L., Mastrandrea, M.D., Falcon, W.P. and Naylor, R.L. (2008). *Prioritizing climate change adaptation needs for food security in 2030.* Policy Brief 5863 for Program on Food Security and the Environment. February, 01, 2008, Washington.

Fafchamps, M., Udry, C. and Czulcas, K. (1998). Drought and saving in West Africa: are livestock a buffer stock? *Journal of Development Economics*, **55**:273 -305.

Fan, S., Brzeska, J., Keyzer, M. and Halsema, A. (2013). *From subsistence to profit*. *Transforming smallholder farms*.IFPRI Food Policy Report, July 2012, Washington, DC.

FAO (2008). *Climate change adaptation and mitigation in the food and agriculture. S*ector. Technical background document from the expert consultation, 5-7 March, 2008 FAO, Rome.

FAO. (2009). *Livestock keepers – guardians of biodiversity*. Paper prepared by the Food and Agriculture Organization of the United Nations Animal Production and Health Division, FAO, Rome.

Gill, M. (1999). *Meat production in development countries*. Proceeding of the Nutrition Society, **58**:371-376.

Gill, M., Smith, P. and Wilkinson, J.M. (2010). Mitigating climate change: the role of domestic livestock. *Animal*, **4(**3):323-333.

Glendenning, C.J., Babu, S. and Asenso-Okyere, K. (2010). *Review of agricultural extension in India. Are farmers' information needs being met?* IFPRI discussion paper 01048. December, 2010.

Godber, O.F. and Wall, R. (2014). Livestock and food security: vulnerability to population growth and planet change. *Global Change Biology*. doi:10.111/gcb.12589.

Gujarati, D.N. (2003). *Basic Econometrics*. New York: McGraw Hill Book Co. New york.

Hailemariam, F., Melesse, A. and Banerjee, S. (2013). Traditional sheep production and breeding practice in Gamo Gofa zone, southern Ethiopia. *International Journal of Livestock Production Research*, **1**(3):26-43.

Herrero, M., Grace, D., Nsuki, J., Johnson, N., Enahoro, D., Silvestri, S. and Rufino, M.C. (2013). The role of livestock in developing countries. *International Journal of Animal Bioscience*, **7**:3-18.

Hinrichs, C.C. and Welsh, R. (2003). The effects of the industrialization of US livestock agriculture on promoting sustainable production practices. *Agriculture and Human Values,* **20**(2):125-141.

Hutcheson, G.D. and Sofroniou, N. (1999). *The multivariate social scientist*. London: Sage publications, London.

Ilea, R. (2009). Intensive livestock farming: global trends, increased environmental concerns and ethical solutions. *Journal of Agricultural and Environmental Ethics***,** **22**(2):153-167.

Imai, K. (2003). Is livestock important for risk behavior and activity choice of rural households? Evidence from Kenya. *Journal of African Economics*, **12**(2):271-295.

Intergovernmental Panel on Climate Change (IPCC). (2001). *Climate Change 2001: The Scientific Basis.* Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

Intergovernmental Panel on Climate Change (IPCC). (2007). *Impacts, adaptations and vulnerability*. Fourth assessment report. Cambridge: Cambridge University Press.

International Fund for Agricultural Development (IFAD). (2009a). *Livestock and land* Livestock thematic papers: Tools for project design. IFAD publishers, Rome, Italy.

International Fund for Agricultural Development (2009b). *Livestock and climate change*. Livestock thematic papers: Tools for project design. IFAD publishers, Rome, Italy.

International Fund for Agricultural Development (IFAD). (2013). *Smallholders, food security, and the environment*, IFAD publishers, Rome.

Kaimba, G.K., Njehia, B.K and Guliye, A.Y. (2011). Effect of cattle rustling and household characteristics on migration decision and herd size amongst pastoralists in Barlingo district, Kenya. *Pastoralism: Research Policy and Practice,* **1**(18):1-16.

Kuriuku, J., Njuki, J., Mbubju, S. and Waithanji, E. (2013). *Livestock ownership and food security*. International Livestock Research Institution brief.

Kumar, A., Staal, S., Elumalai, K. and Singh, D. (2007). Livestock sector in North-Eastern Region of India. An appraisal of performance. *Agricultural Economics Research Review*, **20** (2):255-272.

Lange, G., Barnes, J. and Motinga, D. (1998). Cattle numbers, biomass, production and land degradation in the commercial farming sector of Namibia. *Development Solutions Africa*, **15**(4):555.

Livestock in Development (LID), (1999). Livestock in poverty-focused development. Crewkerne, UK. Available from: http://www.theidlgroup.com/documents/IDLRedbook_000.pdf (Accessed on 26/04/2014).

Lubungu, M., Chapoto, A. and Tembo, G. (2012). *Smallholder farmers' participation in livestock markets*: *the case of Zambian farmers*. IAPRI working paper 66. August 2012, Lusaka, Zambia.

Macharia, P.N., Kinyamario, J.I., Ekaya, W.N. Gachene, C.K.K., Mureithi, J.G.and Thuranira, E.G. (2010) Evaluation of forage legumes for introduction into natural pastures of semi-arid rangelands of Kenya*. Journal of the British Grasslands Society*, **65**:456-462.

Macharia, P.N. and Ekaya, W.N. (2005). The impact of rangeland condition and trend to the grazing resource of a semi-arid environment in Kenya. *Journal of Human Ecology*, **17**(2):143-147.

Macleod, N.D., Ash, A.J. and McIvor, J.G. (2004). An economic assessment of the impact of grazing land condition on livestock performance in tropical woodlands. *Rangel Journal*, **26**(1):49-71.

Mapiye, C., Chimoyo, M., Dzama, K., Raats, J.G. and Mapekula, M. (2009). Opportunities for improving Nguni cattle production in smallholder farmers' systems in South Africa. *Livestock Science*, **124**:196-204.

Mariara, J.K. (2009). Global warming and livestock husbandry in Kenya: impacts and adaptations. *Journal of Ecological Economics*, **68**(7):1915-1924.

Majekodunmi, A. (2011). *Pastoral livelihoods and the epidemiology of emergent trypanosomiasis on the Jos plateau, Nigeria*. PhD thesis. University of Edinburgh.

Mandleni, B. and Anim, F.D.K. (2012). Climate change and adaptation of small-scale cattle and sheep farmers. *African Journal of Agricultural Research,* **7** (17): 2639-2646.

Mandleni, B. (2011). *Impact of climate change and adaptation on cattle and sheep farming in the Eastern Cape province of South Africa*. PhD thesis. University of South Africa, Pretoria.

McDermott, J.J., Rondolph, T.F. and Staal, S.J. (1999). The economics of optimal health and productivity in smallholder livestock systems in developing countries*. Scientific and Technical Review of the Office International des Epizooties*, **18**(2):399-424.

McManus, C., Louvandini, H., Paim, T.P., Martins, R.S., Julio, O.J.O., Caio, C., Guimaraes, R.F. and Santana, O.A. (2011). The challenge of sheep farming in the tropics: aspects related to heat tolerance. *Brazilian Journal of Animal Science,* **40**:107-120.

Meena, H.R. and Singh, Y.P. (2013). Importance of information and communication technology tools among livestock farmers: a review*. Scientific Journal of Pure and Applied Science*s, **2**(2):57-65.

Meissner, H., Scholtz, M. and Palmer, A. (2013). Sustainability of the South African livestock sector towards 2050. Part 1: worth and impact of the sector. *South African Journal of Animal Science*, **43**(3):282-297.

McCosker, T. (2000). Cell-grazing – the first 10 years in Australia. *Tropical Grasslands,* **34**:207-218.

Mogues, T., Cohen, M.J., Birner. R., Lemma, M., Randriamamonjy, J., Tadesse, F., and Paulos, Z. (2009). *Agricultural extension in Ethiopia through gender and governance lens*. Ethiopia Strategy Support Programs (ESSP2) Discussion paper No ESSP2007. October, 2009.

Molua, E.L. (2002). Climate variability, vulnerability and effectiveness of farm-level adaptation options: the challenges and implications for food security in South Western Cameroon. *Environmental Development Economics*, **7**(3):529-545.

Moll, H.A.J., Staal, S.J. and Ibrahim, M.N.M. (2001). *From meat to milk: smallholders' livelihoods and markets.* Paper presented at the 12th Symposium of Tropical Animal Health and Production, Dairy Developments in the Tropics. University of Utrecht.

Maree, J.G. (ed.) (2007). *First steps in research*. Van Schaik Publishers, Pretoria.

Morgan, E.R. and Wall, R. (2009). Climate change parasitic disease: farmer mitigation? *Trends in Parasitology*, **25**(7):308–313.

Morton, J.F. (2007). The impact of climate change on smallholder and subsistence agriculture. *Proceedings of the National Academy of Sciences (PNAS),* **104**(50):19680-19685.

Moyo, B.H.Z. (2010). *The use and role of indigenous knowledge in small-scale agricultural systems in Africa: the case of farmers in northern Malawi.* PhD thesis. University of Glasgow.

Munyai, F.R. (2012). *An evaluation of socio-economic and biophysical aspects of small-scale livestock systems based on a case study from Limpopo province: Muduluni village.* PhD thesis. University of the Free State, Bloemfontein.

Mupawenda, A.C., Chawatama, S. and Muvavarirwa, P. (2009). Gender issues livestock production: a case study of Zimbabwe. *Tropical Animal Health and Production*, **41**(7):1017-1021.

Murad, W.M., Rafiqul, I.M., Mazlin, B. and Murad, A.R. (2010). Climate change and agricultural growth: an examination of the link in Malaysia. *International Journal of Climate Change Strategies and Management*, **2**(4):403-417.

Musemwa, L., Mushunje, A., Chimonyo, M., Fraser, G., Mapiye, C. and Mchenje, V. (2008). Nguni cattle marketing constraints and opportunities in the communal area of South Africa. *African Journal of Agricultural Research*, **3**(4):239-245.

Mwangi, J.G (2013). Developing a vibrant livestock industry in East Africa through market driven research. *Journal of US-China Public Administration*, **10**(6):608-617.

National Department of Agriculture (NDA). (2009). National livestock statistics – August 2008 and May 2009. *Newsletter on national Livestock Statistics*. National Department of Agriculture, Pretoria, South Africa.

National Department of Agriculture (NDA). (2013). National livestock statistics – August 2012 and May 2013. *Newsletter on national Livestock Statistics*. National Department of Agriculture, Pretoria, South Africa.

Ngigi, M. (2005). *The case of smallholder dairying in Eastern Africa*. International Food Policy Research Institute (IFPRI). Environment and Production Technology Division Discussion Paper 131. February, 2005.

Nouman, W., Basra, S., Siddiqui, M., Yasmeen, A., Gull, T. and Alcayde, M.A.C. (2014). Pontential of Moringa Oleifera L. as livestock fodder crop: a review. *Turkish Journal of Agriculture and Forestry*, **38**(1):1-14.

Ntshepe, L. (2011). Marketing information needs of smallholder livestock farmers in the Moretele area in the Bojanala Platinum district municipality of the North-West province. MSc Thesis. University of South Africa, Pretoria.

Nyariki, D.M., Mwang'ombe, A.W. and Thompson, D.M. (2009). Land-use change and livestock production challenges in an integrated system: the Masai-Mara ecosystem, Kenya. *Journal of Human Ecology*, **26**(3):163-173.

Ouma ,E.A. (2003). An analysis of the economic value of cattle in smallholder livestock production systems in western Kenya. MSc Thesis. Egerton University, Kenya.

Ouma, E.A., Obare, G.A. and Staal, S.J. (2004). *The socio-economic dimensions of smallholder livestock management in Kenya and its effects on competitiveness of crop-livestock systems.* Paper prepared for presentation at the Naro Conference on Integrated Agricultural Research for Development: Achievements, Lessons Learnt And Best Practice. September 2004, Kampala, Uganda.

Palmer, T. and Ainslie, A. (2006). Country pasture/forage resource profiles South Africa. FAO, Rome Available from: http://www.fao.org/ag/AGP/AGPC/doc/counprof/PDF%20files/SouthAfricaEnglish.pdf . (Accessed 27/04/2014).

Papachristoforou, C. and Markou, M. (2006) .Overview of the economic and social importance of the livestock sector in Cyprus with particular reference to sheep and goats. *Small Ruminant Research*, **62**(3):193-199.

Patra, A.K. (2012). Enteric Methane Mitigation technologies for ruminant livestock: a synthesis of current research and future direction. *Environmental Monitoring and Assessment,* **184**:1929-1952.

Peden, D., Taddesse, G. and Haileselassie, A. (2009). Livestock water productivity: Implications for sub-Saharan Africa. *The Range Land Journal,* **31**, 187-193.

Pittock, B. (ed.) (2003). *Climate change: an Australian guide to the science and potential impacts.* Australian Greenhouse Office.

Premaratne, S., Premalal, G.G.C. and Jayawardena, V.P. (2003). Sustainable management of grassland resources in ruminant livestock resources in Sri Lanka. *Tropical Agricultural Research Extension,* **6**:60-65.

Rae, A. (2008). China's agriculture, smallholders and trade: driven by the livestock revolution? *Australian Journal of Agricultural and Resource Economics*, **52**(3):283-302.

Randolph, T.F., Schelling, E., Grace, D., Nicholson, C.F., Leroy, J.L., Cole, D.C., Demment, M.W., Omore, A., Zinsstag, J. and Ruel. M. (2007). Invited review: role of livestock in human nutrition and health for poverty reduction in developing countries. *Journal of Animal Sciences*, **85**:2788-2800.

Reid, H., Sahlen, L., Stage, J. and MacGregor, J. (2008). Climate change impacts on Namibia's natural resources and economy. *Climate Policy*, **8**(5):452-466.

Roger, P.A. (2008). The impacts of diseases and disease prevention on sheep welfare. *Journal of Small Ruminant Research*, **76**(1):104-111.

Rutherford, A. (2001). *Introducing ANOVA and ANCOVA: a GLM approach*. London: Sage Publications.

Ryschawy, J., Choisis, N., Choisis, J.P., Joannon, A. and Gibon, A. (2012). Mixed crop livestock systems: an economic and environment friendly way of farming? *Animal*, **6**(10):1722-1730.

Salem, B.H. and Smith, T. (2008). Feeding strategies to increase small ruminant production in dry environments. *Journal of Ruminant Research*, **77**:174-194.

Scholtz, M.M., Van Ryssen, J.B.J., Meissner, H.H. and Laker, M.C. (2013). A South African perspective on livestock production in relation to greenhouse gases and water usage. *South African Journal of Animal Science*, **43**(3):1-9.

Schultze, M.S., Rischkowsky, B., Da Veiga, J.B. and King, J.M. (2007). Cattle are cash-generating assets for mixed smallholder farms in the East Amazon*. Journal of the Agricultural System*, **94**:738-749.

Scollan, N., Moran, D., Joong Kim, E. and Thomas, C. (2010). The environmental impact of the meat production system. Report to the International Meat Secretariat. July, 2nd, 2010.

Seo, S.N., Mandelsohn, R., Dinar, A. and KuruKulasuriya, P. (2008) *Differential adaptation strategies by agro-ecological zones in African livestock management*. Policy Research Working Paper 4601. April, 2008, Washington.

Seré, C. (2009). Livestock, food and climate change*. Issues*, **89**:40-43.

Seré, C., Steinfeld, H.and Groenewold, J. (1995). World livestock systems. Current status, issues and trends. FAO Animal Production and Health, Paper No 127. Rome, Italy.

Silvestri, S., Bryan, E., Ringler, C., Herrero, M. and Okoba, B. (2012). Climate change perception and adaptation of agro-pastoral communities in Kenya. *Regional Environment Change*, **12**:791-802.

Slingo, J.M., Challinor, A.J., Hiskins, B.J. and Wheeler, T.R. (2005). Introduction: food crops in a changing climate. *Philosophical Transactions of the Royal Society Series B*, **360**:1983-1989.

Smith, J. Tarawali, S., Grace, D. and Sones, K. (2013a). Feeding the world in 2050: trade-offs, synergies and tough choices for the livestock sector. *Tropical Grasslands – Forajes Tropicales*, **1**:125-136.

Smith, J., Sones, K., Grace, D., Macmillan, S., Tarawali, S. and Herrero, M. (2013b). Beyond meat, milk and eggs: role of livestock in food and nutrition security. *Animal Frontiers*, **3**(1):1-8.

.

South African Government information. (2012). About SA. South Africa's provinces. Available from: www.info.gov.za/ aboutsa/province.html [accessed 23/05/12].

Statistics South Africa (2013). *Mid-year population estimates 2013*. Statistics South Africa, Pretoria.

Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M. and De Haan, C. (2006a). *Livestock's long shadow: environmental issues and options*, FAO.

Steinfeld, H., Wassenaar, T. and Jutzi, S. (2006b). Livestock production systems in developing countries: status, drivers, trends. *Revue Scientifique et Technique (International Office of Epizootics)*, **25**(2):505-516.

Steinfield, H. (2004). The livestock revolution: a global mission. *Veterinary Parasitology*, **125**(1-2):19-41.

Steinfield. H. and Maki-Hokkonen, J. (1995). A classification of livestock production system. *World Animal Review*, 83-94, FAO, Rome.

Teklu, B., Negesse, T. and Angassa, A. (2010). Effects of farming systems on floristic composition yield and nutrient content of forages at the natural pasture of

ASSOSA zone (Western Ethiopia). *Tropical and Subtropical Agro Ecosystems*, **12**:583-592.

Thomas, D. and Rangnekar, D. (2004). Responding to increasing global demand for animal products: implications for livelihood of livestock producers in developing countries. *British Society of Animal Science*, **33**:1-36.

Thornton, P.K. (2010). Livestock production: recent trends, future prospects. *Philosophical Transaction: Biological Sciences*, **365**(1554):2853-2867.

Tibbo, M. (2002). *The opportunities and challenge of enhancing goat production in East Africa.* Proceedings of a conference held at Debub University, Awassa, Ethiopia:92-106.

Todd, S., Milton, S.S., Dean, R., Carrick, P and Meyer, A. (2009). *Ecological best-practice livestock production guidelines for the Namakwa district.* Karoo Consortium June 2009, Draft 1.

Tolera, A. and Abebe, A. (2007). Livestock production in pastoral and agro-pastoral production systems of Southern Ethiopia. *Livestock research for rural development*, 19(12). Available from: http://www.lrrd.org/lrrd19/12/tole19177.htm [Accessed 4/4/2014].

Trollope, W.S.W., Trollope, L. and Bosch, O.J.H. (1990). Veld and pasture terminology in Southern Africa*. Journal of the Grassland Society of South Africa*, **7**(1):52-61.

Turpie, J., Wrinkler, H., Spalding-Fecher, R. and Midgley, G. (2002). Economic impacts of climate change in South Africa: a preliminary analysis of unmitigated damage costs. Research paper. Southern Waters Ecological Research and Consulting and Energy and Development Research Centre. University of Cape Town, Cape Town, South Africa, February 2002.

Umrani, A.P. (2000). Role of livestock production in economy. *Pakistan Economic Review* (05318955), **31**(2):27.

UNECA. (2011). *Agricultural water management in the context of climate change in Africa*. African Climate Policy Centre Working Paper 9. November, 2011.

United Nations. (2011). Effects of climate change on South Africa. United Nations Framework Convention on Climate Change. Available from: http://www.cop17-cmp7durban.com/en/south-africa-on-climate-change/effects-of-climate-change-on-south-africa.html [Accessed 23/04/12].

United Nations. (2009). Millennium Development Report 2009. New York. Available from: http://www.un.org/millenniumgoals/pdf/MDG_Report_2009_ENG.pdf [Accessed on 26/04/2014].

Uzma Ambreen, N.A., Mian Mudasalqbal, S. and Ikramkhan, S.U. (2013). Impact of livestock on growth of agriculture sector and GDP. *International Journal of Information, Business and Management*, **5**(4):195-208.

Van de Pol, R. and Jordaan, J.J. (2008). The fodder bank system: its current place in veld management**.** *Grassroots*, **8**(1):36-44.

Vithanage, U.Y.W., Gunaratne, L.H.P., Kumara, M.M.B.P and Cyril, H.W. (2014). Comparison of technical efficiency and socio-economic status in animal-crop mixed farming systems in any lowland in Sri Lanka. *Asian Journal of Agriculture and Rural Development,* **4**(1):128-141.

Vonnahme, K.A. (2012). How the maternal environment impacts fetal and placental development: implications for livestock production. *Journal of Animal Reproduction*, **9**(4):789-797.

Warburton, H., Blake, R., Coupe, S., Pasteur, K. and Phillips, E. (2011). *Bridging the gap between resource-poor performers and extension services: the roles of community-based extension systems*. Paper presented at the International

Conference on Innovations in Extension and Advisory Services. Nairobi, 15-18 November 2011.

Wilson, R.T. (2007). Status and prospects of livestock in production in the Laos People's Democratic Republic*. Tropical Animal Health and Production*, **39**(6):443-452.

Wolfe, D.W., Ziska, L., Petzoldt, C., Seaman, A., Chase, L. and Hayhoe, K. (2008). Projected change in climate thresholds in the Northern US: implications for crops, pest, livestock and farmers. *Mitigation and Adaptation Strategies for Global Change*, **13**(5-6):555-575.

Wreford, A. and Adger, W.N. (2010). Adaptation in agriculture: historic effects of heatwaves and droughts on UK agriculture. *International Journal of Agricultural Sustainability*, **8**(4):278-289.

Wuebbles, D.J. and Hayhoe, K. (2004). Climate change projections for the United States Midwest. *Mitigation and Adaptation Strategies for Global Change*, **9**(4):335-363.

APPENDIX 1

QUESTIONNAIRE

SOCIO - ECONOMIC FACTORS THAT AFFECT LIVESTOCK NUMBERS: A CASE STUDY OF SMALLHOLDER CATTLE AND SHEEP FARMERS IN THE FREE STATE PROVINCE, SOUTH AFRICA.

N.B. This information is confidential and is between the interviewer and the respondent.

DATE: ……

NAME OF INTEVIEWER: ……..

HOW LONG HAS THE HOUSEHOLD BEEN IN THE AREA? (a). 0 – 10 yrs.....1 (b). 11 – 20 yrs....2 (c). 21 – 30 yrs.....3. (d). 31 – 40 yrs.....4 (e). Above 40 yrs.....5

DISTRICT MUNICIPALITY (please tick the appropriate box):

1. FEZILE DABI	2.LEJWELEPUTSWA	3. THABO MOFUTSANYANA	4. XHARIEP

LOCAL MUNICIPALITY: ……..

WARD: ……..

A.1 COMPOSITION AND CHARACTERISTICS OF HOUSEHOLD

Please fill in the household characteristics information with the interviewee.

A.1 FARM HOUSEHOLD CHARACTERISTICS

1	2	3	4	5	6	7	8
Size of household	What is your gender?	Which category describes your age (in years)?	What is your marital status?	What is your Educational level?	What is your Occupation?	Is farming your major source of Income?	How long have you been in cattle and sheep farming?
0 – 5 yrs…..1 6 - 10……..2 >10 yrs……..3	Male…….1 Female….2	18 - 27……..1 28 - 37……..2 38 - 47……..3 48 -57……..4 >58.....5	Single……..1 Married……2 Divorced……..3 Widowed…….4 Separated.……..5	Pre-school…….1 Std1 ……..2 Std 6. ……....3 Standard10…….4 Higher…….....5 None..……....6	Farming……1 Employed……..2 Housewife…….....3 Pensioner……..4 Business……5 No occupation …..6	Yes……..1 No……2	1 - 3 yrs.....1 4 - 6 yrs.....2 7 - 9 yrs.....3 10 - 13 yrs....4 14 - 16 yrs....5 More than 16yrs.....6

A.2 Household income

What is the household income range (per year)?

(a)Below R60 000.....1 (b) R60 000 - R120 000.....2 (c) R120 001- R180 000.....3

(d) R180 001 - R240 000.....4 (e) R240 001 – R300 000.....5

(f) Above 300 000.....6

A.3 What is your source of finance/capital (please tick where appropriate)

Sources of credit/ finance	**Tick**
Personal savings.....1	
Family inheritance.....2	
Friends /relatives.....3	
Traders and commission agents 4	
Money lenders.....5	
Government.....6	
Cooperative credit societies.....7	
Commercial banks.....8	
Regional rural banks (RRBs).....9	
Micro financing.....10	
Agric - credit societies.....11	
Others (specify).....12	

A.4 LIVESTOCK NUMBERS

A.4.1. How many animals (Cows, heifers, Bulls, Calves, Oxen, Ewes, Rams, Lambs and Withers) altogether did you keep in the year 2008?

(a)Below 50……..1 (b) 50 - 100……2 (c) 101 - 150……..3 (d) 151 - 200…….4

(e) 201 - 250…….5 (f) 251 - 300……..6 (g) 301 – 350……..7 (e) 351 – 400…….8

(e) Above 400…….9

A.4.2. How many animals (Cows, heifers, Bulls, Calves, Oxen, Ewes, Rams, Lambs and Withers) altogether did you keep in the year 2012?

(a)Below 50……..1 (b) 50 - 100……2 (c) 101 - 150……..3 (d) 151 - 200…….4

(e) 201 - 250…….5 (f) 251 - 300……..6 (g) 301 – 350……..7 (h) 351 – 400…….8

(i) Above 400…….9

B. LAND CHARACTERISTICS

B. 1. Who owns the farm?

1.Individual company	2.Family members	3.Farmers' group	4.Cooperative	5.Private	6.Trust	7. Other (specify) ……

B.2 If you own the farm how did you acquire it?

1.Own finance	2. Bond	3. LRAD	4. PLAAS	5. Restitution	6. Inheritance	7. Other (specify) ……

B.3 Number of stock: in relation to Camp system. (*Please tick (✓) or fill where appropriate*)

Do you have camp system?	**Number of camps**	**Do you have natural veldt/grazing?**	**DO you have Planted pastures**
Yes……1 No……2	1 - 5……1 6 - 10……...2 11 - 15……...3 No camps….4	Yes……1 No……2	Yes……..1 No……..2

B.3.1. Do you encounter any problems with the current camp system? (a)Yes……..1

(b) No……2

B.3.1.1. If yes, please state which of these factors affect your camp system? (*Please tick (✓) where appropriate)*

(a)Water circulation……..1 (b) Bad and old fence……2

(c) Insufficient number of camps……..3 (d) Inadequate water points……4

(e) No camp system……5 (f) No prevalent factors……...6

C. PROBLEMS ENCOUNTERED IN LIVESTOCK PRODUCTION

C.1 What are the problems you encounter in livestock production? (*Please tick the most prevalent problem out in each category)*

Influencing factors	**Tick (✓)**
Most prevalent climate change related factor	
Floods……1	
Drought……..2	
Increased temperature (Heat stress)……...3	
Decrease temperature……..……4	
No prevalent factors……..……5	
Most prevalent feeding related factor	
Poor forage quality……..……1	
Increased feed cost……..…..,……2	
Feed shortage……..…..3	
Access to grazing land (poor or no access)…..……..4	
No prevalent factors……5	
Most severe Service/Advice/Training related factor	
Practical knowledge……..……...1	
Poor veterinary interventions……..2	
poor or no access to credit……..3	
Little or no extension services……4	
Skills development……..…..…….5	
No prevalent factors……6	
Most severe Reproduction related factor	
Insufficient breeding stock……..1	
Premature death……..…....2	
Poor breeds……....3	
Low birth weight……4	
No prevalent factors……..……5	
Most severe Marketing related factor	
High cost of fuel/cost of transportation……..……..1	
Poor market price……..……..2	
Market competition……..3	
No prevalent factors……..4	
Most prevalent Management related factor	
Lack of equipment……..……1	
Maintenance ……2	
Grazing land management……..3	
No prevalent factors……4	

C.1 What are the problems you encounter in livestock production? (*Please tick the most prevalent problem out in each category) cont'd.*

Influencing factors	**Tick (✓)**
Most prevalent Animal health related factor	
Pests/ parasites……...1	
Diseases……2	
Vaccine/inoculation……3	
Purchase of dosing products……4	
No prevalent factors……5	
Most prevalent Animal loss related factor	
Stock theft/pilfering……..1	
High mortality……..….2	
No prevalent factors……3	

C.2 DO you encounter any problems doing the following? Yes/No (Please *tick (✓) where applicable)*

C.2.1. Do you encounter any problem getting services, advice and training? (a) Yes.....1

(b) No……2

C.2.2. Do you encounter any problem with getting veterinary services? (a) Yes.....1

(b) No……2

C.2.3. Do you encounter any problem with transportation? (a) Yes.....1 (b) No……..…2

C.2.4. Do you encounter any problem with vaccination and inoculation? (a) Yes.....1

(b) No……2

C.2.5. Do you encounter any problem with purchase dozing products? (a) Yes.....1

(b) No……2

C.2.6. Do you encounter any problem with Subscription to farmers' association?

(a) Yes.....1 (b) No……2

C.2.7. Do you encounter any problem with Labour? (a) Yes.....1 (b) No……2

C.3 Livestock identity

C.3.1. What is the most prevalent factor you encounter in relation to identification of your animals? (*Please tick (✓) or fill where appropriate*).

(a) Lack of animal handling facilities .....1 (b) No prevalent factors……...2

(c) Others specify……3

C.4 GRAZING OF LIVESTOCK

C.4.1. Which of these factors affect the grazing of your animals?

(a) Small grazing land.....1 (b) Weed encroachment……..2

(c) Water supply and water related factors……..……..……..3

(d) Veldt fires……4 (e) Over stocking.....5 (f) Over grazing……..6

(g) Veldt fire and weed encroachment related factors……..……..7

(h) Water and weed related factors……..……8

(i) Insufficient amount of grass on grazing land……..……..……9

(j) No prevalent factors……..……....10

C.5 How would you describe the condition of your grazing land? *Please tick (✓) where applicable.*

Deteriorating - very poor condition/little grass	1
Deteriorating - poor condition but some grass	2
Fair - reasonable amount of grass	3
Good - plenty grass	4
Very good – improving	5

C.6 How easily can you obtain additional grazing land? *Please tick (✓) where applicable*

Easily	1
Very easy	2
Difficult	3
Very difficult	4
Don't know	5

C.7 STOCK INCREASE

C.7.1. would you like to increase you stock? (a) Yes.....1 (b) No……2.

C.7.2. If yes, how do you intend? (a) By getting bigger land.....1

(b) By getting good breeding stock……..……2

(c) By getting bigger land and good breeding stock.....3

(d) By fencing and dividing grazing land into camps……..…..4

(e) Not increasing my stock……5

C.7.3.If No, why? (a) Stock theft is too much.....1 (b) Interested in increasing……2

(c) Not interested.....3

C.8 which of these internal parasites is the most problematic to your Livestock?
(Please tick the most prevalent out of all the parasites)

Internal Parasite	**Tick (✓)**
1. Tape Worm……1	
2. Round Worm……...2	
3. Liver Fluke……...3	
4. Nasal Worm……..4	
5. Conical worm……5	
6. No prevalent parasites……6	

C.9 which of these external parasites is the most problematic to your Livestock?
(Please tick the most prevalent out of all the parasites)

external Parasite	**Tick (✓)**
1. Lice/Scab/keds……...1	
2. Ticks……2	
3. Red water……3	
4. Heart water……..4	
5. No prevalent parasite……5	

C.10 What is your major objective of keeping these livestock? Tick in the relevant box.

OBJECTIVES	**Tick (✓)**
1. Major source of income 1	
2. Self-consumption …….....2	
3.Local status, success as a farmer, wealth.....3	
4. Lobola…….....……..4	

D. LIVESTOCK PRODUCTIVITY

D.1. How many animals altogether (cattle and sheep) did you sell from January – December 2008?

(a)Below 50……..1 (b) 50 - 100…….2 (c) 101 - 150……..3 (d) 151 - 200…….4

(e) 201 - 250…….5 (f) 251 - 300……..6 (g) 301 – 350……..7 (i) 351 – 400…….8

(j) Above 400…….9

D.2. what is the total value (Rand) of all animals (cattle and sheep) sold from January – December 2008?

(a) 0 – 100 000……..1 (b) 101 000 – 200 000……2 (c) 201 000 – 300 000……..3

(d) 301 000 – 400 000……4 (e) Above 400 000…….5

D.3. How many animals altogether (cattle and sheep) did you sell from January – December 2012?

(a)Below 50……..1 (b) 50 - 100…….2 (c) 101 - 150……..3 (d) 151 - 200…….4

(e) 201 - 250…….5 (f) 251 - 300……..6 (g) 301 – 350……..7 (i) 351 – 400…….8

(j) Above 400…….9

D.4. What is the total value (Rand) of all animals (cattle and sheep) sold from January – December 2012?

(a) 0 – 100 000……..1 (b) 101 000 – 200 000……2 (c) 201 000 – 300 000……..3

(d) 301 000 – 400 000……4 (e) Above 400 000…….5

Thank you for answering this questionnaire

.....

Complied by F.T. Ogunkoya, University of South Africa, Johannesburg.