INTEGRATED CROP-LIVESTOCK FARMING SYSTEM FOR SUSTAINABLE ECONOMIC EMPOWERMENT OF SMALL-SCALE AND EMERGING FARMERS IN THE FORMER HOMELAND OF THE EASTERN CAPE PROVINCE OF SOUTH AFRICA: CASE STUDY OF CISKEI AREA IN NKONKOBE MUNICIPALITY

BY

MISS V. NGXETWANE

200261568

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Department of Agricultural Economics and Extension
Faculty of Science and Agriculture

University of Fort Hare
Together in Excellence

SUPERVISOR: PROF AJURUCHUKWU OBI

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DECLARATION

I declare that this mini-dissertation describes my original work, except where specific acknowledgement is made to the work of others, and has not previously in its entirety or in part been submitted for a degree to any other university.

	Signature	Date
V. Ngxetwane	……………………………	…………………

DEDICATION

This thesis is dedicated to my family especially my son, Siliziwe Kusile Yondela Ngxetwane.

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ABSTRACT

For decades, there has been significant investment in the development of agricultural technologies that aim to increase productivity of smallholder farmers in Africa. But farm output and productivity have stagnated and poverty rates have remained high and even increasing in some areas. At the same time, increases in human population levels have resulted in rising demand for food as well as for arable land. The growing intensification of farming has been accompanied by degradation of wild lands, including tropical forests and wetlands, at an alarming rate. Further pressure on fragile land has come from associated urbanization, leading to agricultural land being converted to residential and industrial uses with serious consequences for agricultural production and food supply. The recent increases in food prices across the globe as well as South Africa have drawn attention to this problem even more strongly.

The main objective of the current study was to investigate farmer's perception of the relative importance of crop-livestock integration in the small holder farming systems. Data were collected from 70 emerging and smallholder farmers selected by stratified random sampling in the communities surrounding Alice, Middledrift and the Seymour-Balfour area of Nkonkobe municipality of the Eastern Cape Province. To collect the data, a semi-structure questionnaire was administered to the respondents through face-to-face interviews. Descriptive statistics were used to characterize the farmers in terms of their socio-economic and demographic backgrounds. A series of multiple linear regression models and a binary logistic regression equation were fitted to determine the factors influencing farmers' perception and how these in turn contribute to the decision to adopt or not to adopt crop-livestock integration. The results of the study reveal that small farmers in the Nkonkobe municipality have the possibility of realizing immense benefits from the integrated systems which also have the potential to lead to substantial improvements of the physical, chemical and biological soil properties. There is clear evidence of widespread interest to experiment with the practices based on the strong positive perceptions that a majority of the survey farmers exhibited during the course of the survey. But the farmers are facing challenges in coping with the associated

complexities of competition on land, and management skill which are often in limited supply. That in most cases is not enough and efficient even to manage one of these two enterprises alone and reduction in crops yield due to use of manure as a substitute of fertilizer.

Constraints to integrating crops and livestock include the competition for resources, especially land. Managing two types of farming on the same farm was perceived as difficult and many respondents held the view that use of waste of one enterprise as input to the other enterprise can reduce productivity. For example some farmers considered that the use of manure to improve soil fertility may not lead to output growth to the same extent as the use of fertilizer. A number of farmers (86%) pointed out that they only market their produce after deducting their consumption share, highlighting the crucial role of food security as a motivation for crop-livestock integration. Complementation of inputs rather than substituting inputs is required to render the system more productive and sustainable as costs are minimized and output is boosted. Associations of grain and livestock producers are useful for filling these gaps which include limited access to credit, technology and knowledge and can promote the adoption of a crop-livestock system.

Keywords: Integration, Crop-livestock farming system, income, development, farmers' perception, rural livelihood, production.

ACRONYMS AND ABBREVIATIONS

CASP	Comprehensive Agricultural Support Programmes
CGIAR	Consultative Group on International Agricultural Research
CLIFS	Crop- Livestock Integrated Farming System
DLA	Department of Land Affairs
DoA	Department of Agriculture
DW	Durbin-Watson
ECDC	Eastern Cape Development Corporation
EXPAGR	Expansion Agriculture
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
HEIA	High external Input Agriculture
HACOP	Hertzog Agricultural Co-operative
IDP	Integrated development Plan
IFAD	International Fund for Agricultural Development
IFS	Integrated Farming Systems
Kms	Kilometres
K	Potassium
LEIA	Low External Input Agriculture
LRAD	Land Redistribution for Agricultural Development
MAFISA	Micro-Agricultural Financial Institutional Schemes of South Africa
MFPP	Massive Food Production Programme
N	Nitrogen
NA	Not Applicable
NPK	Nitrogen Phosphorus Potassium
NCA	New Conservation Agriculture
P	Phosphorus
PGDP	Provincial Growth and Development Plan
SANPAD	South Africa Netherlands Research Programme on Alternatives in Development

SPSS	Statistical Package for Social Sciences
Sq	Square
SSA	Sub-Saharan Africa
TWC	Third World Countries
USA	United State of America

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CHAPTER 1

INTRODUCTION

1.1 Background of study

Agriculture accounts for a large share of Gross Domestic Product (GDP) and exports, and employs more than 70% of the work force in Sub Saharan Africa (SSA) (FAO, 2003). The failure or success of agriculture therefore determines the economic growth of most countries in the region. Agriculture is therefore central to social and economic growth in developing countries where the general welfare and farming fortunes are so closely linked. Since large portions of the population are still rural in most developing countries, any attempt to improve the income of the poor, cannot neglect the agricultural sector (Perret et al., 2005). For decades, there has been significant investment in the development and adoption of agricultural technologies with the aim to increase the productivity of smallholder farmers in Africa. However despite the effort, micro-level farm output and productivity have stagnated and poverty rates have remained high and even increased in some areas (Vink and Kirtsen, 2003).

Most of the Third World Countries (TWC) still do not meet their target food requirements, provide other basic commodities and generate stable incomes because of population growth and accelerated urbanization (Perret, Anseeuw, and Mathebula, 2005). The population of SSA will increase by 2.6 times reaching 1294 million by 2025, a figure almost equal to China's projected population for 2025 (Winrock International, 1992). Political, social, economic and cultural determinants of fertility and mortality are unlikely to change in the immediate future to reverse this trend in population growth. As human population grows so does the demand for food and, therefore, demand for land on which to grow food. Consequently, degradation of wild lands including tropical forests and wetlands is increasing at an alarming rate. Ironically, the demand to convert agricultural land to commercial and residential developments is also very high due to population growth and urbanization. This is reducing the amount of land available for agricultural purpose. This scenario is being noticed in most of the developing countries and South Africa is not an exception; rapid population growth and reduction in arable land are seemingly a developing country phenomenon.

Against this background, agriculture will be expected to help meet food, feed, and fiber demands of a world population that is anticipated to grow from approximately 6 billion in 1999 to between 8 and 11 billion by 2050 (USDA, 2008). This essentially guarantees an increase in demand for plant and animal products that are produced (World Bank, 2007). In the event of increasing demand for agricultural produce, FAO (2004) reports that farming systems are not able to absorb increased demand. Every farm is a complex system of interacting components that exists in both natural and socio-economic environment. Balancing such an environment for efficient and sustainable production requires high management skills and knowledge (USDA, 2008).

Though there are a lot of technological advancements in agriculture, on a global level. The pressure may be greater where the institutions are not well developed, especially developing countries in the Southern Africa region. Production is still not coping with the increasing demand for food as population is growing more rapidly and land use for agricultural purposes is declining sharply due to erosion and competition with other sectors of the economy. These have been exacerbated by macro-economic developments such as urbanization. The reorientation of agricultural technologies and styles of farming in response to concerns over sustainability has received much attention in recent years. At the same time, ways need to be found to preserve the natural resource base. Within this framework, an integrated crop-livestock farming system represents a key solution for boosting agricultural production on an overall basis and safeguarding the environment through prudent and efficient resource use. In crop-livestock systems, often referred to as mixed farming systems (Sere and Steinfeld, 1996), livestock and crops are produced within a co-ordinated framework. In many mixed systems, the waste products of one component serve as a resource or input for the other: manure from livestock is used to raise soil fertility in order to enhance crop production, whilst crop residues and by-products are used as feed for the animals. Mixed farming is the most popular agricultural production system in the world in terms of animal numbers, productivity and the number of people affected (Thornton et al., 2002).

The increasing pressure on land and the growing demand for livestock products makes it more and more important to ensure the effective use of feed resources, including crop residues. The necessity of integrating livestock and crop husbandry is becoming more pronounced due to deterioration in soil fertility, high cost of inorganic fertilizers and scarcity of fodder for livestock particularly during the dry season in many marginal areas with fragile ecosystems. South Africa is one of these because arable agriculture in its pure state is rendered impracticable due to poor soils, low rainfall and rough terrain. An integrated farming system consists of a range of resource-saving practices that aim to achieve acceptable profits and high and sustained production levels, while minimizing the negative effects of intensive farming and preserving the environment. According to the International Fund for Agricultural Development (2008), based on the principle of enhancing natural biological processes above and below the ground, the integrated system represents a winning combination that (a) reduces erosion; (b) increases crop yields, soil biological activity and nutrient recycling; (c) intensifies land use, improving profits; and (d) can therefore help reduce poverty and malnutrition and strengthen environmental sustainability.

The search for integrated farming systems that meet sustainable farming practices requires a systematic combination of knowledge on agriculture and stakeholders' joint agreement on normative objectives, optimal designs consistent with socio economic and technological circumstances of the area and farmers (Thomson and Bahhady, 1995). This should be followed by empirical work to test, adapt and refine these under real commercial farming conditions. Sustainable rural livelihoods can be achieved by exposing the rural people to resource management systems in such a way that they increase opportunities for generating local incomes.

1.2 Problem Statement

To meet the rapidly increasing demand for food both globally and for the region (estimated at 2.5% annually), by an ever-expanding human population, production from crop agriculture must expand by 4% annually while the production of food from animal agriculture must expand by more than 3% annually, by the year 2025 (World Bank, 2007). Efforts to raise agricultural productivity in the farming systems of the developing countries have dominated recent policy interventions. In South Africa, the government has promoted several programmes to enhance the productivity of small farms that now have to compete with the established commercial farms which have always been better able to withstand the harsh past and current socio economic environment.

Crop and livestock productivity is greatly hampered by inadequate availability of nutrients (i.e. metabolisable energy, protein and phosphorous for livestock production; and organic matter, nitrogen and phosphorous for crop production) in most of the Third World Countries (International Fund for Agricultural Development, 2008). Growth in human and livestock populations has led to an expansion of cultivated land and shortened fallow periods. This, in turn, has accelerated land degradation and decreased soil fertility. At the same time, low rural incomes, inappropriate public policies and infrastructure constraints have prevented the widespread use of purchased inputs such as inorganic fertilizers and feed supplements. High population growth has also resulted in some land which was used for agricultural purpose being converted to residential area. This therefore has resulted in great pressure on agricultural land, leading to intensification of land use. Under these conditions, full integration of crop and livestock production offers the greatest potential for increasing agricultural productivity, especially in the sub humid and wetter parts of the semi-arid zones (International Livestock Centre for Africa, 1998).
While crop-livestock integration systems have been practised for a long time, especially by marginal farmers, no evaluation exists as to how these contribute to household income or how they compare to the mono or single enterprise systems. What support is available to small farmers to deal with the associated complexity? Can integrated crop-livestock systems generate adequate income relative to the alternative? Why crop-livestock integrated farming system is not widely used when it seems that it makes sense? What are

the factors that detract from its widespread use? What are factors and obstacles that policy makers need to be aware of to ensure their widespread adoptions?

1.3 Objectives

The purpose of this paper is to gain deeper understanding of the farming systems as it pertains to the integration of crops and livestock. As a starting point, the perception of farmers regarding its relative value would be assessed and understood as a basis for judgement as to the viability of the system over the long term. The main objective of the study is therefore to investigate the farmer's perception of the relative importance of crop-livestock integration in the small holder farming systems. The specific objectives of the research are to:

- Describe the farming systems in the area and determine the extent to which farmers practice crop-livestock integration.
- Assess the perception of farmers about the relative value of crop-livestock integration and the extent to which they consider that it can be a viable path out of poverty for them.
- Determine production, marketing and institutional problems that farmers encounter in their efforts to practise integrated crop – livestock system.
- Make recommendations on how the system can promote optimal crop – livestock integration to achieve sustainable economic empowerment of smallholder farmers in the former Ciskei homeland of South Africa.

1.4 Hypothesis of the study

A key proposition of this study is that the farmer's perception of the relative importance of crop-livestock integration in the smallholder farming systems is an important factor in whether or not they adopt or sustain the practice. Just as these perceptions are important, they are equally influenced by multiple other factors. It is therefore hypothesized that farmer's decision about whether or not to integrate crop and livestock enterprise on their small farms is influenced by their perception about relative profitability of the system. The alternative hypothesis would suggest that farmers perceptions do not influence their decision- making regarding the adoption or sustainance of crop-livestock integration in the farming systems.

1.5 Justification of the study

Recent policies in the country have focused on the question of access to agricultural land and credit for the small scale and merging black farmers. However, these small scale and emerging farmers are facing serious constraints. While the existing farming system requires intensive use of expensive capital equipment and other agro-inputs, small farmers are constrained by lack of credit to purchase even the most basic inputs (Kirsten and Van Zyl, 1998). At the same time, the technical support structures that served these farmers during the apartheid era have been dismantled as part of agricultural restructuring in the wake of democratic rule. If efforts to empower the black population are to be meaningful, their profitability must be enhanced by introducing systems that allow them to produce their crops and animals at minimal costs. This has been the focus of a number of policy initiatives at the national and provincial levels, including the Comprehensive Agricultural Support Programmes (CASP) and the Micro-Agricultural Financial Institutional Schemes of South Africa (MAFISA) being implemented at the national level. Within the Eastern Cape Province, a majority initiative to boost small holder farming has been the Massive Food Production Programme (MFPP) which remains a flagship component of the Provincial Growth and Development Plan (PGDP) launched in 2002 (Buthelezi, 2007). But all these programmes have generally focused on just one factor at a time, usually credit, and have not systematically explored the scope for modifying the existing system and/or supplementing it with more effective systems of production and marketing.

1.6 Outline of the dissertation

This dissertation is organized into five chapters. The first chapter is the introduction to the study which highlights the background to the study as well as the problems context, research objectives, research hypothesis, and justification/motivation. The second chapter presents the literature review on the incidence and popularity of crop-livestock integration as well as the benefits and opportunities of crop-livestock integration.

Research on the subject forms part of the review which also explores the problems faced by farmers that integrate procedures followed by other studies to examine farmers perception are also reviewed. The analytical and conceptual framework for the study of crop livestock integration and farmers' perception is also reviewed. The third chapter presents the research methodology in addition to the describing the study area. The sampling methods, as well as the methods employed in data collection and analysis are also comprehensively discussed in the chapter, in addition to a detailed discussion of the challenges encountered during the research and ways the study tried to deal with them. Chapter four presents and discusses the major findings of the study. Finally chapter five summarizes the study findings and makes recommendations aimed at addressing the challenges encountered in livestock-crop integration production system in Nkonkobe municipality of the Eastern Cape Province, South Africa.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to review the vast literature on the key aspects of this study, namely farmers' perception, the incidence and importance of crop-livestock integration, and the role of good agricultural practices in poverty reduction strategies. In addition to these, the chapter reviews literature in respect to the benefits and opportunities of crop-livestock integrated farming systems as well as the challenges and constraints faced by the farmers who integrate, while also shedding light on why farmers may choose not to integrate. Finally, the chapter reviews the literature in respect to the conceptual and analytical framework for research on crop-livestock integration, in addition to examining related methodological questions commonly encountered in studies on crop-livestock integration.

2.2 Crop-Livestock Integrated Farming System

Continuous agricultural activity which is the main manifestation of agricultural specialization has been blamed for much of the environmental problems experienced today across the globe (Clark, 2004). According to Clark (2004), "enterprise diversity was the norm", and mankind only developed single-enterprise agriculture and specialization in the early decades of the 20^{th} century. While specialization initially resulted in dramatic increases in yields and overall output of the farm, it is now known that it has also contributed to the deterioration of land resources, which has contributed to environmental degradation and is probably subsequently leading to low agricultural productivity. In order to address these issues, a large body of problem-solving and adaptive research reported in the literature since the 1940s have tended to advocate for a different approach to farming based on the harnessing of the positive aspects of both crop and livestock systems (Clark, 2004). Other studies have also suggested quite explicitly that crop-livestock integrated farming is preferable because it is said to be a way of enhancing agricultural productivity (Block and Webb, 2001). According to the contemporary literature, the renewed interest in crop-livestock integrated farming is a response to the disappointing results of the specialization approach and is motivated by a belief that the system improves the output of both crops and livestock products. In other words, in situations where the approach has been adopted within a systematic setup, the main goal has been to improve the efficiency of the farming systems. However, in order to optimise productivity, crop-livestock interaction needs to be enhanced through development and dissemination of appropriate crop-livestock conditions and technologies that take account of the technical, economic, social and environmental dimensions as has been the approach of the Future Harvest centres or the members of the Consultative Group on International Agricultural Research (CGIAR) (Thomas, Mourid, Ngaido, Halila, Bailey, Shideed, Malki, Nefzaoui, Chriyaa, Awawdeh, Hassan, Sweidan and Sbeita, 2003). In this chapter, the focus will be on the specific matters of clarifying what crop-livestock integration stands for and what its features and contributions are, how it is being adopted, what constraints are identified as working against its widespread application, and what motivate households into adopting the practice.

2.2.1 Meaning of the Concept

A common view of the term Crop-Livestock Integrated Farming System (CLIFS) refers to it as an agricultural system that is characterized by the systematic production of livestock and crops on the same farm. A number of researchers often tend to describe CLIFS as Integrated Bio-System or Mixed farming system (Block and Webb, 2001; Thomson and Bahhady, 1995). In crop-livestock integrated farming systems the most visible feature is the synergy between crops and livestock. At one level, animals gain from crops produced on the farm. For example, crops provide animals with fodder from grass, leguminous forages, and crop residues. At the other level, crop farming takes advantage of the animals on the farm to improve the environment in which crop production takes place. The animals provide draught power in crop production where the practice of animal traction is popular and their dung (or waste matter) can be used as manure to improve soil fertility on crop fields. Animals can also be used in weed control when they graze under trees and on stubble. Over and above the foregoing, livestock serve the traditional purposes of being a source of food and income, and as an asset for insurance (Thomson and Bahhady, 1995). There are other dimensions of integration as captured by the literature. For instance, crop-livestock integration may occur at other segments of the supply and value chain in both production and marketing. The more familiar one is when the integration of crops and livestock in a farming system occurs in terms of products or by-products of one component serving as a resource or input for the other products in the chain. That is, where the system is capturing synergies and complementarities among the two enterprises which is feasible when the farming activities are treated as interdependent entities rather than being viewed as isolated enterprises even if they are existing on the same farm. For example, dung produced by the animals is used by the crops and the straw produced by the crops is eaten by the animals which in turn defecate the waste matter, thus repeating the cycle (Block and Webb, 2001; Singh, 1994). In general, where farming is not mechanized and there is a culture of animal traction, especially among small-scale farmers in developing countries, draught power and crop residues are the main links between crops and livestock.

As already noted earlier, there are several reasons for implementing crop-livestock integrated farming system, although the main reason put forward is that it is one important strategy to improve sustainable productivity. As compared to other farming systems, Chan (2003) states that it is possible to reap the same or higher levels of output with integrated farming, whereas integrated farming uses relatively less inputs, making it a highly efficient system in terms of resource use. It is further contended that the yield would be inherently more sustainable because the waste of one enterprise becomes the input of another, leaving almost no waste to pollute the environment or to degrade the resource base. In this way, crop-livestock integration becomes an effective and at the same time productive means for achieving waste recycling (Thornton and Herrero, 2001). Campaigns to introduce crop-livestock integrated systems therefore are often combined with schemes to improve on their usefulness. There is recognition for the necessity to study linkage and complementarities of different enterprises that contribute to the development of the system as this is a way to ensure that the waste of one enterprise is more efficiently used as input to another within the system (Chan, 2003).

2.3 Background of Livestock and Crop Integration

There is some interest in the academic and policy circles to gain some understanding of what could be the main driver of change to adopt crop-livestock integration. As is well-known, smallholder farmers depend on the land for their subsistence. However, these farmers often severely constrained by lack or insufficient capital and expertise, which expose them to a variety of risks. As revealed by Dercon (2002), examples of such risks include harvest failure resulting from climatic changes, labour shortage and policy shocks, and it seems that the risks have tended to increase with increased population pressure for the land (Dercon, 2002). As observed in Nigeria, farm sizes have declined under the weight of increasing pressures on land as as the population density continues to increase (Mortmore *et al*, 1990; Manyong *et al,* 2006). This is one of the risks associated with crop farming which have made farmers to explore alternative income opportunities, especially looking at income generated outside arable agriculture which is believed to be vital to their enhanced livelihoods. An integration of crop and livestock, which is consistent with low dependency on external inputs as factors, is therefore increasingly seen as a way to decrease vulnerability to risks (Block and Webb, 2001). It is probably this consideration that has contributed significantly to the spate of adoptions of the practice as people embark on systematic combinations of livestock and crop production on the same farms as a way to spread the risks in smallholder as well as commercial production. In effect, the decision to adopt the crop-livestock mixed farming systems seems to have been heavily influenced by considerations of the beneficial effects of the inter-relationships and complementarities between crop and livestock production.

Expectedly, the integration of crop and livestock has evolved over the years from more restricted trials by both smallholder farmers and commercial farmers on one or a few aspects of their total operations to full-scale undertakings. Subsequently, the process has moved from merely cutting and carrying the plant/grass feed from the grasslands included on the farm to completely and vertically integrating operations whereby the grass is processed into livestock feeds for the farm's animals. The manifestation of this is that livestock are now increasingly being kept at home rather than being left to graze freely on common/communal grazing lands (Mortmore *et al*, 1990), which has the added advantage of minimizing conflict between community members on the utilization of common property.

There are also differences in the extent to which different groups of farmers benefit from integrated farming systems. According to a number of research studies (for instance, Rufino, 2008), in comparison to commercial farmers, it is often argued that the poorest smallholders benefit the most from integrating livestock with crops because the extent of reduction in the vulnerability to risk (through the exploitation of the insurance function of livestock), is greater for smallholders than for commercial farmers and because of the much greater opportunities created for recycling and maintaining soil productivity (Rufino, 2008).

2.4 Reasons for practising crop-livestock integration farming

As already noted, the integration of crop and livestock production into the same farming unit is an evolutionary process principally determined by, among others, differences in climate, population densities, disease, economic opportunities, and cultural preferences (Powell, Pearson and Hiernaux, 2004). These factors can be divided into external and internal factors. External factors have been identified chiefly as weather patterns, market prices, political stability and technological developments, among others. Internal factors, on the other hand include such factors as local soil characteristics, composition of the family and farmers' ingenuity. For example, McIntire *et al* (1992) state that at low population densities, agricultural systems tend to be more extensive, with crop and livestock production often being operationally separate enterprises. As population densities increase however, the picture changes as more and more pressure is brought to bear for the implementation of more intensive systems which may lead to an increase in the interactions between crop and livestock production.

The circumstances of the farmers can also play a crucial role in the degree of intensity of resource use and in whether or not the separate enterprises are integrated on the farm. Studies like those conducted by Tarawali (1998) and Rufino (2008) suggest that farmers can opt for mixed enterprises as a strategy to save resources by interchanging them on the farm. Without a doubt, within this line of thinking, integration permits wider crop rotations and thus reduces dependence on chemicals. Since mixed systems are evidently more conventional and are viewed to be closer to nature and allow for diversification for better risk management, they are considered more sustainable. According to Powell *et al* (2004), mixed farming systems can be further determined by the extent and patterns of water use, that is, whether or not they are rain-fed or rely on irrigation systems to support crop and pasture production.

An article by Russelle, Entz, and Franzluebbers (2007) suggest that farmers see crop-livestock integration as fostering diverse cropping systems, utilizing animal manure, enhancing soil tilth, fertility and efficiency of carbon storage and use. But what motivates decision varies from one environment to the other, depending on local circumstances such as on the environmental and socioeconomic conditions of the place where they would be established (Jordan *et al*, 1997). In Sub-Saharan Africa, crop-livestock integration systems are viewed as a strategy for expanding and intensifying agriculture in contrast with the current low input/output modes (Tarawali, 1998).

According to Slingerland (2000), in the regions of highly intensive input/output use for agriculture, crop-livestock systems act as a buffer or check against excessive use of resources resulting from intensification. This is probably as a result of the opportunity created by crop-livestock systems to recycle resources and production wastes within the production system. In general, monoculture systems are technologically sophisticated which leads to a high conversion rate from raw product to final product, resulting in highly profitable operations. However, the monocultural systems of production have a narrow margin of adaptation and limit action against any undesirable outcomes associated with the agricultural production, ultimately threatening the system's profitability (Tarawali *et al*, 2002). Under such conditions, integrating crops and livestock is the answer.

A growing body of research suggests that crop-livestock production represents an important phase in the evolution of agricultural systems (Powell et al, 2004). These stages are illustrated in Figure 2.1.

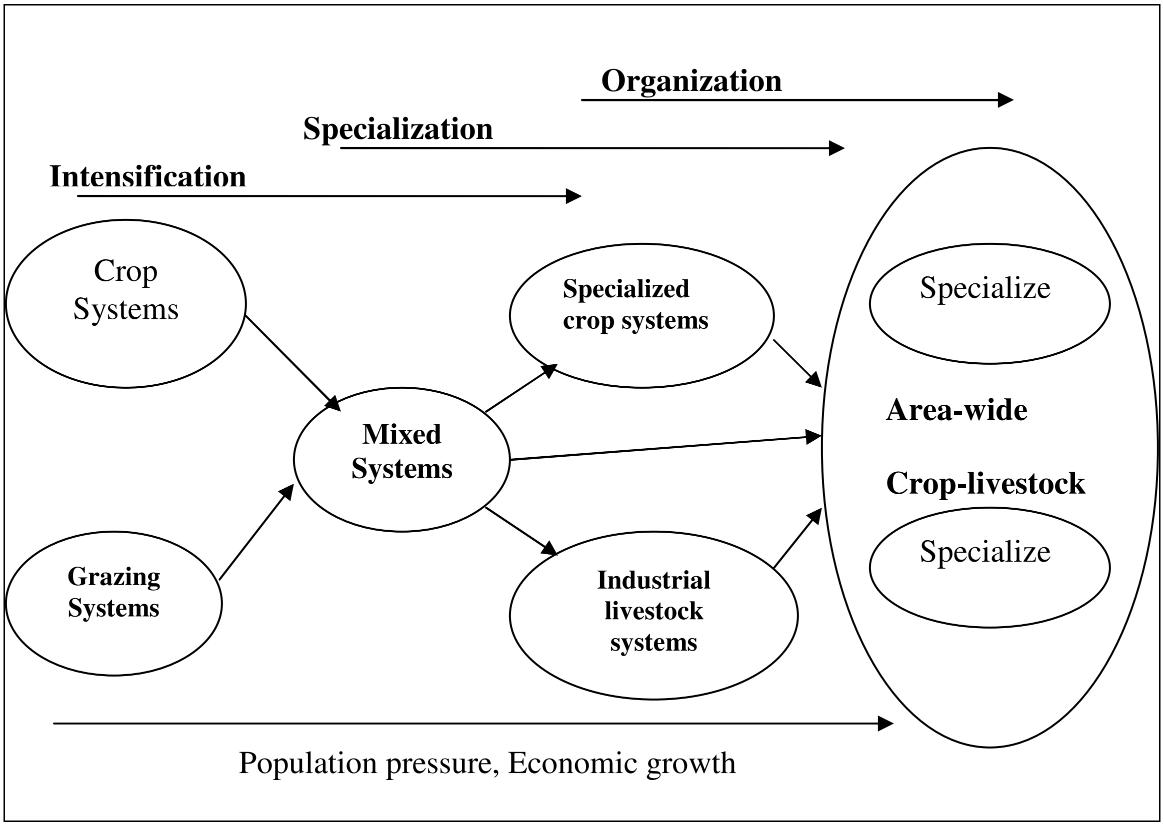

Figure 2.1: Pathways of crop–livestock integration
Source: Powell *et al* (2004)

As illustrated in the diagram above, it is suggested that intensification of crop and livestock production evolves through four main stages in the process of agricultural and overall economic development. These stages are: (i) **pre-intensification phase**, when crop and livestock production are operational in separate enterprises; (ii) **intensification phase,** when crop and livestock production integrate mostly through animal draught power, feed, and manure linkages; (iii) **income phase**, when investments are made to improve forage supply and quality, possibly through vertically integrated processes to compound feed on the farm from fodder crops and other processing activities; and (iv) a **return to specialization** which is done through commercialization (Powell *et al,* 2004).

Pingali (1993) suggested that a key driving force in moving through the four stages, from crop and livestock systems specialization to integration and back to specialization is the opportunity costs of land, labour and income growth. It is explained that at low population pressures and when high labour and few external inputs are used for agricultural production, specialized and independent crop and livestock production systems are more attractive than integrated systems. That is mainly because at this stage land is relatively abundant. Labour acts as the major constraint, and its cost is high as compared to land. Cropland productivity is maintained through fallowing, which is preferred to land application of manure because it requires less labour. With an increase in population pressures, the demand for arable land increases. Since fallows occupy too high a proportion of the land, farmers look for alternatives to maintain soil fertility. In such cases, the utilization of manure and integration of crops and livestock within the same production system offer increased efficiencies and productivity to farmers (Pingali, 1993; Powell *et al,* 2004).

2.5 Linkages between Livestock and Crop Production

The combination of Livestock and Crop activities has helped small-scale farmers all over the world to use manure as fertilizer for crops, and the crop residues as feed for livestock (Chan, 2003). Integration is done to recycle resources efficiently. The Integrated Farming System (IFS) has revolutionized Conventional Farming of Livestock, Aquaculture, Horticulture, Agro-Industry and Allied activities in some countries, especially in tropical and subtropical regions that are not arid (Tarawali, 1998).

Chan (2003) has noted that farming all over the world has not been performing very well, which requires addition of relatively numerous inputs to sustain yields. However, that can compromise economic viability as well as ecological sustainability. According to FAO (2001), the IFS has a potential to remove some of these constraints, by not only solving most of the existing economic and even ecological problems, but also by providing means of production such as fuel, fertilizer and feed. The use of IFS may lead to increased productivity and through controlled resource flow, farms, especially in poor countries can be made economically viable and ecologically balanced. As a result, integrating farming systems have a potential to alleviate or even eradicate poverty (Chan (2003; FAO, 2001). Several practices of integrated crop-livestock systems have been noted throughout the world. Tarawali (1998) noted that farmers in Ghana defoliate maize tops and cut leaves from standing maize (before grain harvest) to feed animals. Feeding animals in such a way helps to alleviate feed stress during the late wet season/early dry seasons, where there is restricted animal movement and people are busy with cropping. A clear advantage of this method is that the animals benefit from the more nutritious green material. Figure 2.2 shows the different resource flows in mixed crop-livestock systems.

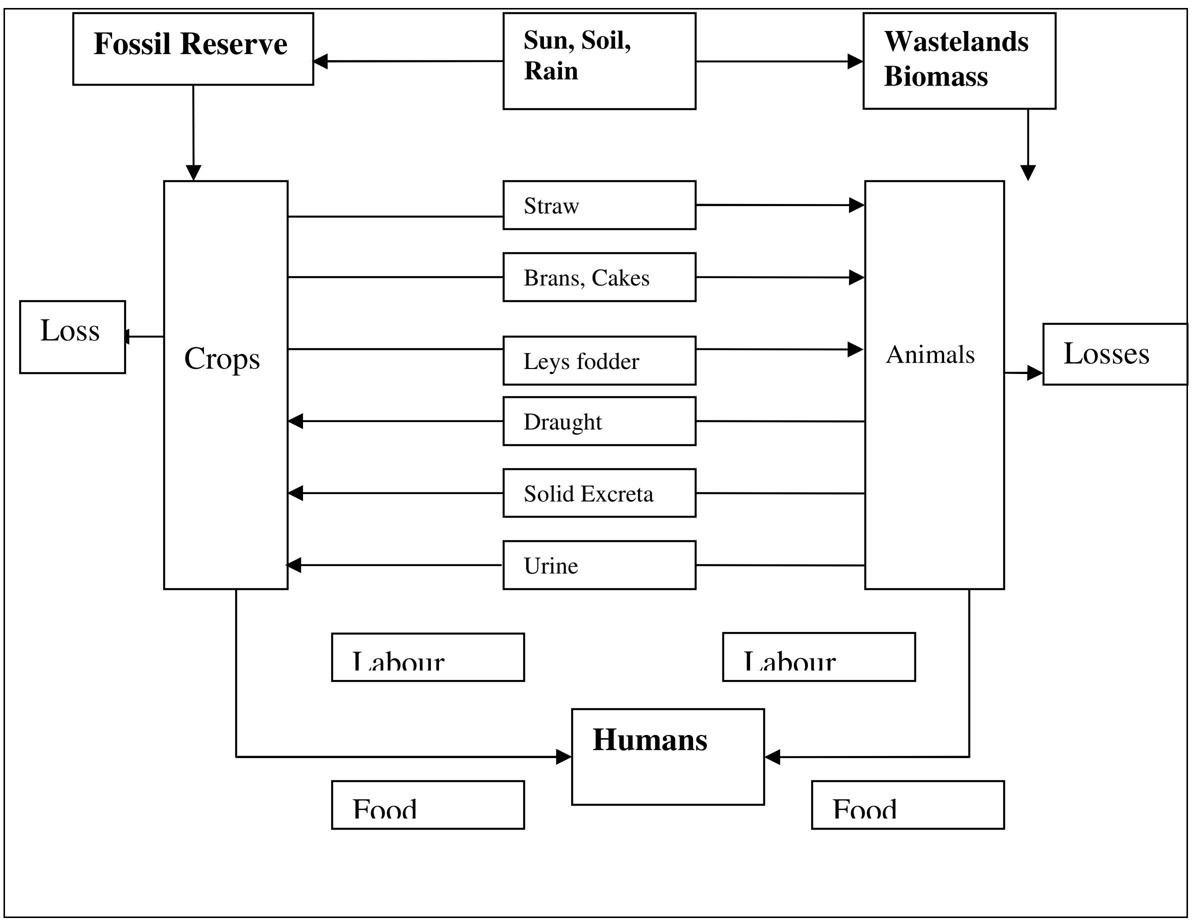

Figure 2.2: An outline of different resource flows in mixed crop-livestock systems
Source: FAO (2001)

Tawarali (2002) noted several outcomes of research based on IFS in Burkina Faso, Niger, Nigeria, and Mali. The researches demonstrate the beneficial effects of manure on crop yields and soil conservation. In Nigeria, application of organic manure showed appreciable yield increases. The effects of applying manure and artificial fertilizers on sorghum crops in Burkina Faso showed that the application of chemical fertilizers to tropical soils leads to a stagnation of crop yields but a combination of manure and NPK resulted in sustainable increases in crop yield (Tawarali, 1998; International Fund for Agricultural Development, 2008). There are several examples of completely integrated crop–livestock production systems where sustainable increases in both crop and livestock production have been achieved after considerable periods (30–40 years) of continuous cropping without resulting in land degradation. IFS prove useful because they recycle wastes and renew resources, thereby providing the essential means of production such as fertilizer, feed and fuel that can make most farming activities economically viable and ecologically sustainable (Obi *et al*, 2007).

IFS are common worldwide, in spite of a tendency towards specialized forms of farming (Schiere *et al,* 2006). Mixing crops and livestock on the same farm has both advantages and disadvantages. For example, farmers in mixed systems have to divide their attention and resources over several activities, thus leading to reduced economies of scale. Advantages include the possibility of reducing risk, spreading labour and re-utilizing resources. The importance of these advantages and disadvantages differs according to the socio-cultural preferences of the farmers and the biophysical conditions as determined by rainfall, radiation, soil type and disease pressure. Chan (2003) argues that trees in and on the edge of a crop field generally reduce the grain yield, but the combination of the trees (for fodder and timber) and crops is valuable, because each of the components produces useful products for the farm.

FAO (2001) wrote that in integrated systems the exchange of resources such as dung, draught power and crop residues takes place in degrees that differ among the so-called modes of farming introduced by Schiere *et al* (1995). These are on the availability of land, labour and capital respectively, as shown on Table 2.1:

Table 2.1: Characterization of different modes of mixed crop-livestock farming

Mode of farming	EXPAGR	LEIA	HEIA	NCA
Relative access to production factors1:				
Land	+	-	-	-
Labour	-	+	-	+/-
Capital	-	-	+	+/-
Characteristics of farming:				
Source of animal feed	Outfield	Infield2 roadsides	Infield Import	Infield
Role of animals as savings account	High	Medium	Low	Low
Importance of excreta				
- Dung	Positive	Positive	Negative	Positive
- Urine	Neglected	Positive	Negative	Positive
Source of energy for labour	Humans/animals	Humans/animals	Fossil fuel	Fossil fuel/animals
Form of mixing	Diversity	Integration	Specialization	Integration
	Can be between and on-farm	On-farm	May be between farms	Mainly on-farm
Crop residue feeding	Irrelevant	Very relevant	Irrelevant	Relevant
Role of leys				
- For weed control	NA3	Low/NA	NA	Important
- For nutrient dynamics	NA	Low/NA	NA	Important
- For erosion control	NA	Low/NA	Low/NA	Important
Ratio outfield/infield2				
- Local level	High	Low	Low	Low
- International level	Low/NA	Low/NA	High	Low/NA
Output of milk or meat per animal	Low	Low	High	Medium
Attention to conservation of the resource base	Low	Medium	Low	High

[1] The access to land, labour and capital is to be read within a column, contrary to what has to be done for the comparison of system characteristics between modes (over rows). For example, a "-" for labour in the HEIA column means that labour is relatively scarce compared to capital inputs in that mode; not necessarily as compared with LEIA where it is indicated with a "+".
[2] Infield is defined as the crop area that depends on grazing from outfield for its nutrients.
[3] NA: not applicable.
Source: Based on Schiere and De Wit (1995).

- Expansion agriculture (EXPAGR)
- Low external input agriculture (LEIA)
- High external input agriculture (HEIA)
- New conservation agriculture (NCA)

The EXPAGR mode occurs where land is abundant, where shortage of land or local fertility are overcome by migration or by expansion into other regions where bush and forest fallow still occur. Animals are sent out to graze and would (occasionally) come home to "pull the plough or fertilize the crop fields". The crop fields themselves could move elsewhere if local soil fertility declined. However, according to Tarawali (1998), this mode is becoming rarer as land resources are exhausted throughout the world.

Mixed farming in LEIA occurs where the shortage of land can no longer be overcome by migration or use of substantial areas elsewhere for grazing. Lack of access to external inputs such as fuel, chemical fertilizers or pesticides implies that only increased use of labour and skills offers a way out. This also implies the introduction of modified practices, and the need to adjust demand according to resource availability. Dung is carried around on the farm by using more labour because a lack of soil fertility cannot be compensated by shifting to more land or by employing more livestock to "produce" more dung. In LEIA systems, the latter is considered a resource but a waste product in HEIA systems. If not managed properly and if demand for food and other crops is not adjusted to the carrying capacity of the soil, this can result in mining of soils and/or collapse of the systems. According to FAO (2001), the cotton-cereal systems in southern Mali earned 40 percent of their income by mining the soil. Chan (2003) argues that animals, when managed correctly, can serve to fill part of the gap that exists between the output and the input of nutrients in the system, together with a proper use of chemical fertilizer.

Mixed farming in the HEIA mode is not frequently found because it implies plentiful access to resources such as external feed and fertilizer that make exchange and recycling of resources at farm level irrelevant. Use of fertilizer forces farmers to recycle the waste. In the HEIA mode the demand for output determines the use of inputs. The use of external resources can reach such high levels that the environment is affected by emissions from the crop and/or animal production systems, ultimately leading to waste disposal problems, thus forcing HEIA into NCA (FAO, 2001). New Conservation Agriculture is a mode of farming where production goals are matched as closely as possible to the resource base. This approach represents a mix of HEIA and LEIA: it aims to replace the removed nutrients but it also aims to achieve keen farming and adjusted cropping and consumption patterns to suit local conditions. The use of leys (improved fallows for grazing) is important to regenerate soils, to add nitrogen, to mobilize phosphate and to suppress weeds (i.e. to avoid herbicides) (FAO, 2001).

2.6 Factors linking Crops and Livestock in a CLIFS

Integrated crop-livestock farming systems continue to dominate broad acre agriculture in most developing countries. The physical and financial stability of crop-livestock production systems arises from the complementary interactions between components of the production systems. This produces a whole-farm financial outcome that is buffered against economic fluctuations with similar profits generally achieved for a range of physical strategies.

2.6.1 Income linkages

Poor soil fertility and low and erratic rainfall remain to be major limitations to crop production in a number of agro ecosystems of West Africa (Pingali, 1993). When faced with such conditions, many households are diversifying into livestock with the intension of reducing risk through providing insurance in the case of crop failure. Also, livestock are used as a source of liquidity and investment capital in such systems, in the absence of savings and credit institutions.

In relation to crop production, income from the sale of livestock can be used to improve crop production by providing investment capital needed to enhance productivity. In addition, income earned from livestock production may increase the demand, and hence profitability, of food production (Hopkins and Reardon, 1993). Income obtained from the sale of livestock provides benefits to crop production both at household level and at macro level. At household level, income influences crop production directly by allowing households to invest in inputs such as fertilizer, hired labour, and carts. It also has an indirect influence by allowing poor households to improve the nutritional status, and thereby productivity of their own labour. At macro levels, when traded, livestock can serve as a source of export revenues, therefore they become a catalyst for economic growth. Such growth has an influence in stimulating the demand for locally produced food staples as well as other higher-valued non-staple products (Powell *et al,* 2004). This provides an opportunity for farmers to benefit from overall economic growth. Finally, the income derived from livestock can provide the capital needed to initiate remunerative non-agricultural activities, which in turn provide the cash needed to finance crop production activities (McIntire *et al,* 1992; Hopkins and Reardon, 1993).

2.6.2 Use of animal power in crop production

Animal power is used to assist farmers in the production, harvesting, processing, and marketing of crops. This reduces the amount of labour that is required by the farmers and helps intensify production (Pearson *et al*, 1998). Farmers owning draught animals tend to cultivate larger pieces of land and reap higher yields, than those without. This pattern is attributed to the ability of farmers with draught power to expand cultivated area due to labour-saving ability and the ability to cultivate in time (Sumberg and Gilbert, 1992). Thus, the use of animal power improves the timeliness of planting and therefore, increases yields in areas where growing seasons are short and time of planting is crucial. Nonetheless, there is a danger when the use of animal power results in the cultivation of less suitable marginal land. It can encourage soil erosion and land degradation, which may lead to poor crop yields. Kruit (1994) had identified such cases in south-western Niger where animal power has been largely used to extend the cropping area to increase total production.

Animals can also be used as a form of transport, usually together with a cart. According to Anderson and Dennis (1994), animal transport can reduce postharvest losses from pests by allowing timely removal of crops from the fields. Animal transport can also be used to move crop produce to the market, increasing the chances of selling crops at desired prices. Literature shows that small-scale farmers with a cart and animals can get a higher price for their goods since they can sell directly to markets. Farmers using animal power also find it easier to move manure and fertilizer to the field.

2.6.3 Nutrient cycling

The integration of livestock into cropping systems converts some crop residues into animal products such as meat and milk. Additional nutrients may also be introduced when animals are fed on purchased feed concentrates and forages. Part of these feed nutrients return back to the fields in the form of excreta. As stated by Stangel (1995), if soils, crops, fertilizer, and manure are managed intensively, the input/output for nutrients could be in balance and sometimes in surplus. Figure 2.3 shows the nutrient pathways in crop-livestock farming systems.

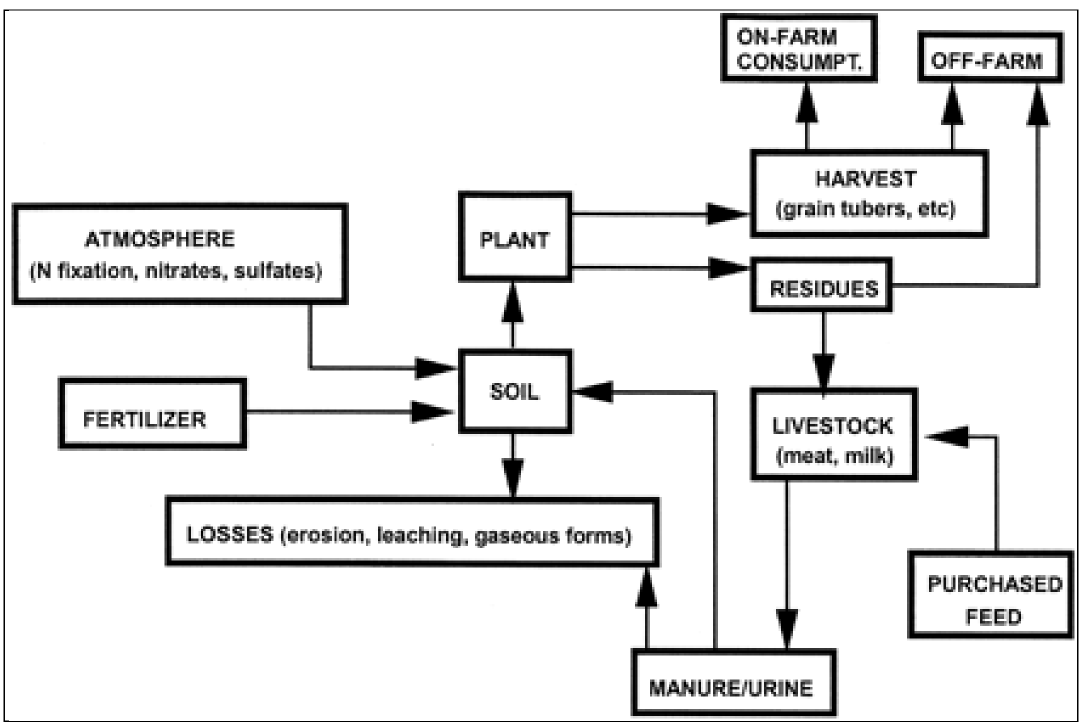

Figure 2.3: Pathways of nutrient flow in mixed crop–livestock farming systems
Source: Stangel (1995)

2.6.4 Crop Residue

In crop-livestock farming systems, crop residues are used as livestock feed and sometimes provide income through their sale. Farmers use various methods to feed crop residues to their livestock, such as animals having open access to residues left on harvested fields, harvest and removal of stalks, storage of residue for feed or harvest of crop thinning from fields for selective feeding before harvest of main residue (Powell *et al,* 2004). In drier parts of Africa, crop residues form a vital source of animal feeds. Feeding crop residues and using manure to fertilize cropland is a rational farming strategy used by many farmers (Sandford, 1990). The main disadvantage associated with feeding crop residues to livestock is that the removal can exacerbate soil nutrient depletion. Retention of surface residues can help conserve soil and water and maintain favourable soil organic matter and nutrient levels.

2.6.5 Manure for Crop Production

In sub-Saharan Africa, manure remains the most effective and efficient way for small-scale farmers to fertilise the soil. The availability of manure for cropping is influenced by livestock types, numbers, the location of livestock during the time when manure is needed; and the efficiency of manure collection by the farmer. As argued by Powell *et al* (2004), the N and P content in manure of grazing cattle is up to three times greater during the wet season and crop residue–grazing period than during the dry season. Therefore, the availability of manure for crop production declines during drought periods (Stangel, 1995).

Powell *et al* (2001) state that manure applications have their own weaknesses. Although the application of manure has potential to improve soil conditions and increase crop yields, it has some properties that make it an unbalanced source of crop nutrients. For instance, the N/P ratio of ruminant livestock manure is often lower than the N/P requirement of cereal crops, requiring additional nutrients. Also, fertility management using manure is also less flexible than using fertilizer. As such, manure can burn the crop and negatively affect crop yield in environments having low and erratic rainfall. Overfertilization can occur if the time is not enough for small-scale farmers to accurately determine the exact nutrient requirements of the soil.

2.7 Eastern Cape Farming systems

According to Machethe *et al* (2004), Eastern Cape's rural sector consists of three sectors: (a) the smallholder (subsistence or semi-subsistence) sector consisting of self-employed farmers producing staple food and some commercial goods; (b) the commercial farm sector comprising medium and large size farmers and provides employment to a significant number of the landless; and (c) the rural non-farm sector. In the Eastern Cape, 64% of the land is used for stock farming, including beef cattle, sheep, goats and game. Crops are farmed on 20% of the land and include maize, vegetables, pineapples and citrus. Commercial forestry makes up 5% of land use and only 1% of land is set aside for conservation. Overall, the area of land used for crops and grazing is decreasing; it decreased slightly during the period 1988–98 (Machethe *et al,* 2004).

The importance of smallholder agriculture in Eastern Cape has been widely recognized, which is the reason there is a wide range of government policies aimed at small farmer development (DLA/DoA, 2005). The proponents of smallholder farming argue that with enhanced technological advancement, smallholder agriculture has potential to commercialise and contribute towards food security and poverty alleviation through increased production and reducing the costs of production. Efficient smallholder agriculture leads to increased incomes and promotes equitable distribution of income, creates backward and forward linkages necessary for economic growth. In this way, the smallholder agriculture sector is not only important for the revitalization of the agricultural sector, but for the economy at large. In South Africa, the potential contribution of smallholder farmers to economic growth still remains unlocked. As for Zimbabwe, the major challenges facing smallholder agricultural growth are closely associated with high inputs cost (Chawatama *et al,* 2005) and this may be a similar situation in the Eastern Cape provinces as the condition facing there , small-scale farmers are almost similar in the Sub Saharan Africa.

Farming in Eastern Cape ranges from agro forestry, crop farming, operation of gardens and livestock farming. The experience of citrus farmers can be used to illustrate crop and livestock farming systems for sustainable economic empowerment in Eastern Cape (Obi et al, 2007).The experiences of small-scale citrus growers in the Ciskei homelands illustrate the declining fortunes of agriculture quite vividly (Steyn, 1988). According to Obi *et al,* (2008) in the closing years of the Apartheid regime a programme was launched to establish a black entrepreneurial class in agriculture. Pursuant to this goal, the government of the former Ciskei homeland (now the part of the Eastern Cape Province) introduced a scheme in 1988 to resettle a total of 22 black farmers on the land expropriated from former white farmers with emphasis on citrus production. This programme has since evolved into a low-equilibrium trap characterized by under-production arising from a wide range of technical and institutional constraints. Of the 22 farmers resettled at the inception of the programme, only about 14 are operational today (Jari 2008; Pote 2007).

Farmers in Eastern Cape own both livestock and crops. In the context of South Africa, livestock and crop production systems are an integral part of one another (Bembridge 1984). Crop residues provide fodder for livestock while, occasionally, grain provides supplementary feed for productive animals (Mapiye et al, 2007). Animals improve soil fertility through manure and urine deposition and animal power for farm operations and transport. Sale of animals sometimes provides cash for farm labor and agricultural inputs. Farmers in Eastern Cape keep various animal species, including cows, sheep, goats and small number of poultry, to meet their domestic needs (Musemwa et al, 2008). Besides livestock farming, farmers also practice crop husbandry, gardening and to some extent horticulture. These units are operated either alone or in combination depending upon the size of the farm holdings and other available resources. The livestock manure fertilizes the crops, and the crop residues feed the livestock. In order to produce more and improve the quality, they need costly inputs such as chemical fertilizers and artificial feeds, which make their farming activities uneconomic (Cousins, 2000).

2.8 Advantages and Constraints of Integrated systems

2.8.1 Advantages

In an integrated system, livestock and crops are produced within a coordinated system. Much of this coordination derives from the inherent interdependence that is exploited under integrated crop-livestock systems (Timsina, 1991). In such a system, waste products of one component serve as a resource for the other. If this system is well managed, it can lead to an increase in productivity on both crops and livestock (Mayong et al, 2006). Animals transform plant energy into useful work for example animal power is used for ploughing and transport and also provide manure, as already highlighted. On the other hand, crops provide a valuable, low-cost feed resource for animal production, and are the major source of nutrients for livestock in developing countries (IFAD, 2009; Powell *et al,* 2004). According to IFAD (2009) and Powell et al (2004) the benefits of crop-livestock integration include:

- Agronomic, through the retrieval and maintenance of soil productive capacity
- Economic, through product diversification and higher yields and quality at less cost. It helps to increase profits by reducing production costs where farmers can use fertilizer from livestock operations, especially with high fertilizer prices. It provides diversification of income sources, guaranteeing a buffer against trade, price and climate fluctuations (Van Keulen and Schiere, 2004; IFAD, 2009; Tarawali, 1998).
- Ecological, through the reduction of crop pests (less pesticide use and better soil erosion control). It helps improve and conserve the productive capacity of soils, with physical, chemical and biological soil recuperation. It results in greater soil water storage capacity, mainly because of biological aeration and the increase in the level of organic matter.
- Social, through the reduction of rural-urban migration and the creation of new job opportunities in rural areas (IFAD, 2009).

2.8.2 Opportunities and Constraints of Crop and livestock Integration

Existing literature has generally emphasized the relative importance of constraints to and opportunities for crop livestock integration (Tarawali, 1998). Table 2.2 presents a summary of the key features of the constraints and opportunities for crop-livestock integration in the Eastern Cape Province of South Africa. As highlighted in above, there are many benefits that farmers who integrate crop and livestock can obtain. But as would be expected, there are associated obstacles and barriers. According to Tarawali (1998) and IFAD (2009), the main drawbacks associated with integrated farming systems include;

- Nutritional values of crop residues are generally low in digestibility and protein content.
- Crop residues are primarily soil regenerators, but most of the time they are either disregarded or misapplied.
- Intensive recycling can cause nutrient losses.
- If manure nutrient use efficiencies are not improved or properly applied, the import of nutrients in feeds and fertilizers will remain high, as will the costs and energy needs for production and transportation, and the surpluses lost in the environment.
- Farmers prefer to use chemical fertilizer instead of manure because it acts faster and is easier to use.
- Resource investments are required to improve intake and digestibility of crop residues (IFAD, 2009; Sandford, 1990).

Table 2.2: Opportunities and Constraints related to crop-livestock integration

Opportunities for crop–livestock integration	**Constraints that militate against fostering crop–livestock**
• The farming systems in Eastern Cape show an increase in the proportion of mixed farmers, providing farmers with manure and animal power. • Intensification of agriculture which is currently occurring in most farming systems favors crop–livestock integration. • Poor soil fertility, unavailability or increases in prices of fertilizers, and labor shortages, have forced farmers to rely on alternatives such as manure and traction. • In South Africa, there is scope for improving the efficiency of the integration by diversifying the use of animals. For instance, the use of cows for traction will also provide milk and manure. Farmers can also crop in the wet season and engage in livestock enterprises in the dry season. • Livestock enterprises are more lucrative than crop farming so it is advantageous to integrate livestock into farm activities. • Many indigenous, emerging, and developed technologies are available to support sustainable crop–livestock integration. These include improved cereal and grain legume varieties, cropping systems, weed and nutrient management strategies, the eradication of most livestock diseases, and the development of modeling and all-year-round feed packages for animals.	• Competition for resources such as land, labor, capital, management, and water by the crop and livestock sectors. • Land use and tenure policies that inhibit livestock mobility and limit farmers' access to manure and livestock access to feed. • Keeping livestock in villages to produce manure sometimes fails because shortage of feed and water encourages transhumance. • Since manure is bulky and is required in large quantities, high labor and transportation costs may be involved. • Wrong targeting of crop–livestock integrated systems. • Lack of research on holistic approaches; this requires in-depth knowledge of integrated crop–livestock systems. • Smallholder farmers are reluctant to grow improved forages; this is related to the whole systems approach. • Bias, including policies, towards the crop sector to the detriment of livestock production as many politicians think crops are more important as most of them give carbohydrates whish are more essential in a human diet.

Source: (IFAD, 2009 and Tarawali, 1998)

2.9 Conceptual and Analytical Framework

Crop-Livestock Integration is a conceptually vast subject which embraces several conceptual and theoretical issues. Some of the most common conceptual and theoretical issues include food security, commercialization (or semi-commercialization), agricultural intensification, sustainability, intra-household bargaining and resource allocation, technical efficiency, gender, among others. Several studies on crop-livestock integration have approached the subject from an adoption perspective, looking at the determinants of household decision to adopt practices that optimize a wide range of household objectives. For these reasons, the agricultural economics literature presents a wide diversity of models that look at different aspects of crop-livestock integration some of which will be briefly reviewed in this section.

To a large extent, the bulk of the recent literature on the subject has reflected a huge intellectual interest in the aspect of the role of crop-livestock integration on sustainable natural resource management. In the research carried out by the Future Harvest Centres around Africa and Asia, there has been considerable interest in exploiting the high degree of interdependency inherent in the system whereby products and by-products are recycled internally, thus promoting resource use efficiency (Timsina et al., 1991; Timsina, 1998). Expectedly, sustainability models have featured prominently in research on crop-livestock integration. In general, these studies have started by identifying and establishing the sustainability indicators through an elaborate indicator selection process based on research and consultations with a wide stakeholder community (for instance, Smyth and Dumanski, 1993; Lefroy and Habbs, 1992; Wei, White, Chen, Davidson, and Zhang, 2007, among others). On the basis of such indicators, these studies develop a framework for evaluating sustainable land management (Smyth and Dumanski, 1993). According to Wei et al, (2007), these indicators are ideal for evaluating the sustainability of intensive cropping.

Studies involving the identification of performance indicators as highlighted above usually proceed to obtain information on the perception of farmers regarding the extent to which the associated targets set for those reported indicators are being met. Wei et al (2007) used this approach in their study on farmers' perception of sustainability for crop production in China. In the study, Wei et al (2007) attempted to quantify the perceptions by ranking them according to their judgement on the significance of the particular indicator in respect to the sustainability of crop production in the area of study. Obtaining the relevant information has generally followed the procedure popularized by Martilla and James (1977) and commonly referred to as the "Importance-Performance Analysis" procedure. Semi-structured questionnaires are commonly used and incorporate questions which require respondents to express judgments on the degree of performance, satisfaction, etc (Wei et al, 2007). Exploring farmers' perception in this way is justified on the grounds that such opinions serve as a "guiding concept of behaviour and/or decision making" and are crucial in the decision to adopt or not to adopt alternative practices in farming (Adesina and Zinnah, 1993; Adesina and Baidu-Forson, 1995; Negatu and Parith, 1999; and, Rahman, 2003).

The crucial questions of what determines whether or not farmers integrate crop and livestock enterprises and what role perceptions play in the decision making have been by previous research with analysis at various levels. Once the farmers' perceptions have been determined and quantified as described above, the factors influencing those perceptions are determined by means of a range of statistical and econometric procedures. Wei et al (2007) have approached the subject in the crop production sustainability study by carrying out a series of regression analyses. Similar inferential analyses have been applied in the specific cases where the studies have attempted to assess the impact of farmers' perceptions. For instance, in a recent study in Southern Iran to assess farmers' perception of pesticide efficacy, Hashemi and Damalas (2011) fitted a series of linear models with farmers' perceptions as the dependent variables. In that study (Hashemi and Damalas, 2011), the farmers' perceptions were rankings of the importance of adopting a variety of pest management practices by farmers. Prior to fitting the regression models, the study presented the results of correlation analysis which showed the strengths of linear associations of pairs of independent variables (Hashemi and Damalas, 2011).

A study on gender and agricultural change in the context of crop-livestock integration in Senegal has employed a variety of analytical and theoretical models (Fisher, Warner and Masters, 2000). The aim of the study was to analyze the decision to adopt crop-livestock integration practices and the impacts of adoption of crop-livestock integration on the household livelihoods (Fisher et al., 2000). For purposes of addressing these goals, the study reviewed the unitary household models introduced and used by such researchers/theorists as Becker (1981) and Senauer (1990) around the overall assumption that the family works to enhance its welfare and decides between alternatives on the basis of its assessment of their relative utilities which the family tries to maximize. However, there have been reservations about its robustness expressed by Folbre (1988), Blumberg (1991) and Whitehead (1990) on grounds of the validity of its assumptions, the possibility being raised that the family may sometimes act in ways that do not clearly promote household welfare and that there may actually be conflicting and multiple objectives and aspirations working simultaneously. There is also the concern that the unitary household models may not fully explain the differences between social and economic development. To accommodate those views, alternative frameworks of households decision making have been developed and applied to reflect the complexity of household needs and goals and the bargaining and negotiations that are often necessary to deal with these (World Bank, 1995; Fisher et al., 2000).

2.10 Summary

The chapter reviewed the literature on Crop-Livestock Integrated Systems as an option to improve productivity among small-scale farmers. It has been highlighted that if properly managed, these integrated farming systems can be a powerful tool for poverty reduction and socio-economic empowerment of the rural population. Also, Crop-Livestock integration systems have been identified in the literature as being sustainable because they promote the interaction of animals and plants in as natural condition as possible. The advantages associated with this system have been identified as an improvement in productivity and increased incomes, in addition to a range of benefits that include agronomic, ecological, economic and social sustainability. The disadvantages of the system have also been identified. The main constraints faced by small-scale farmers who integrate crop and livestock are reduction in yields both for crops and livestock. For example in crops use of manure as a substitute of fertilizers reduces yield as manure acts more slowly and is not rich in nutrients compared to chemical fertilizers. For livestock, nutritional values of crop residues are generally low in digestibility and protein content and this in turn reduces body condition and height of livestock than using concentrate feeds. Finally, the review examined the conceptual and analytical framework employed in the large number of research conducted on the subject matter of crop-livestock integration, showing that the bulk of these studies have assumed a modified household model and have employed diverse statistical and econometric procedures for analyzing the resulting data.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

This chapter gives an overview of the study area and on how the study was conducted. The chapter commences by describing the study area, following which the model is specified and the nature of the data collected is described. The sampling procedure, data collection techniques and data analysis methods are also explained in this chapter. The chapter closes by highlighting the limitations of the study.

3.2 Background of the study area

The Eastern Cape is situated on the southernmost coast of South Africa and is the second largest of the country's nine provinces, covering some 170 000 sq kms - about one-seventh of South Africa (ECDC, 2004). Sixty five percent of the province's 7 million people live in far-flung rural areas, while the remaining population live and work in towns and cities, especially the two main cities of Port Elizabeth and East London on the coast. Two thirds of the population lives in the former-homeland areas of Transkei and Ciskei (Bembridge, 1984)

The Eastern Cape Province was formed in 1994, when the Bantustans of Transkei and Ciskei were merged with the eastern portion of the old Cape Province. The Eastern Cape is the traditional home of the Xhosa nation. It is therefore not surprising that 83% the people of the Eastern Cape speak Xhosa as home language with only (9.6%) speaking Afrikaans (3.7%) English (Bembridge, 1977). The province has always been a livestock farming area. Colonial wars once raged for possession of prime grazing lands, and still today, rural Xhosa see their cattle as a symbol of wealth and status (Musemwa *et al,* 2008). Today the province is the country's premier livestock producing region and presents excellent opportunities for meat, leather and wool processing. The province however, has a low cropping potential/intensity and fragile environment. It is anticipated that sustainable food production in this harsh environment could only be achieved through crop–livestock integration. It is against this background that the province was selected to identify the opportunities for promoting sustainable crop–livestock integration. The research was conducted in one of the local municipalities in the province namely Nkonkobe Local Municipality which is representative of the conditions is the former Ciskei homeland. It is the second largest local municipality covering 3 725 km^2, and constituting 16% of the surface area of the Amatole District Municipality (Amatole IDP, 2006).

Nkonkobe Municipality has an average population density of 43 persons per km or 0.43 persons per ha). The population of Nkonkobe Local Municipality has been estimated to be in the region of 133 434 people with an average household size of 4.0 (Amatole IDP 2006; Nkonkobe IDP 2007; Jari, Fraser and Obi, 2011). In terms of population distribution amongst the administrative districts within the municipality, of about 18 135 people that residing in Fort Beaufort, 62 719 people in Middledrift, 65 472 in Alice, 2 281 people in Seymour and 703 people in Hogsback (Nkonkobe IDP 2007). The population in the area is rural in nature, with a rural: urban ratio of approximately 4:1. According to the Amathole IDP (2006), unemployment (68 %) and poverty levels (71 %) are high in the district and are coupled with development and service backlogs. Sixty nine percent of Nkonkobe Local Municipality residents do not have an income at all and roughly 74 % of all households have no access to sanitation. In Figure 3.1 below is a map of the Eastern Cape Province where Nkonkobe municipality is clearly shown and the areas in which this study was conducted, namely Middledrift, Alice and Seymour- Balfour area.

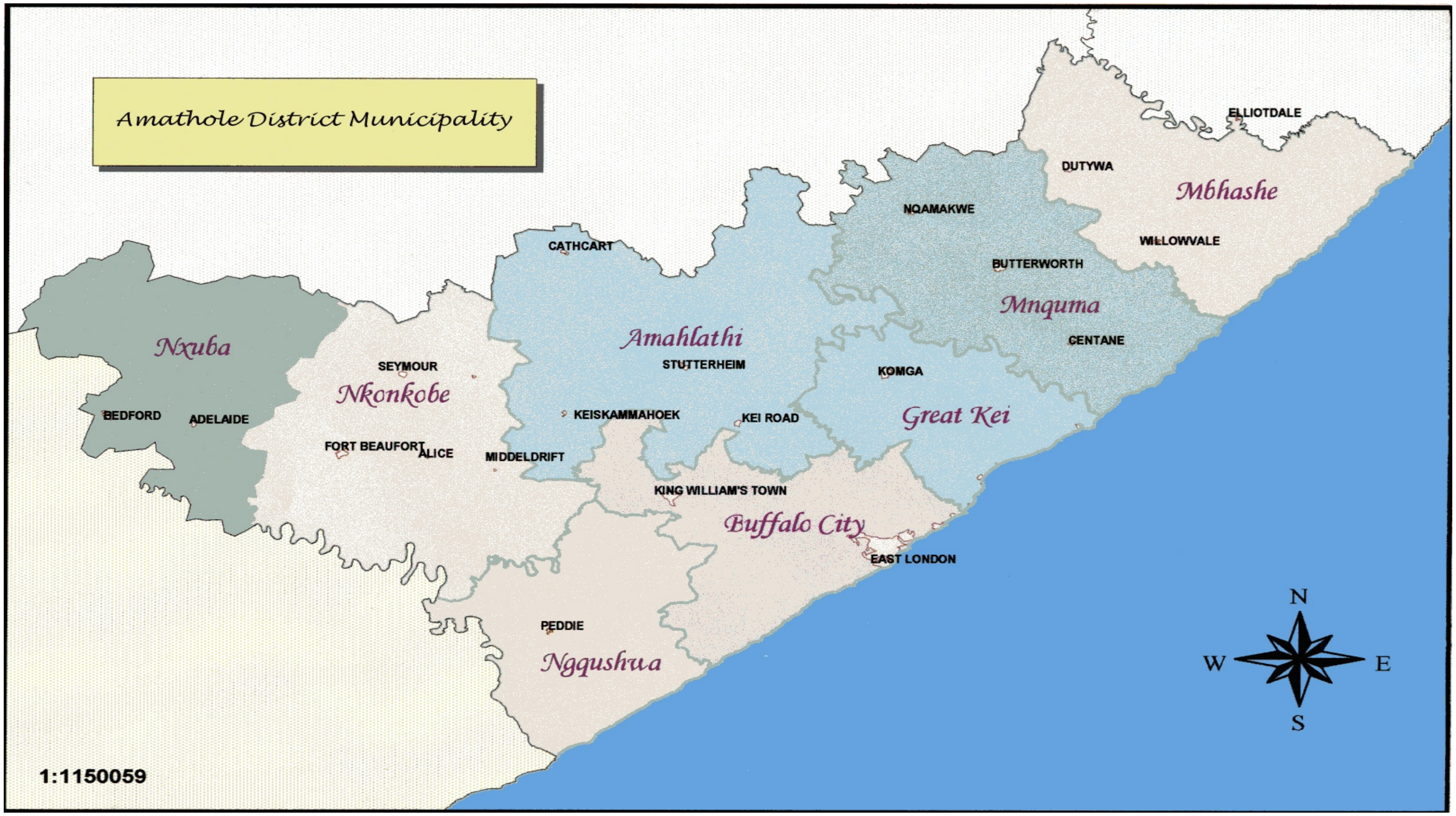

Figure 3.1: Map of Eastern Cape Province
(Source: http://www.amathole.gov.za/files/map/Map.JPG)

3.2.1 Climate

According to Magni (1999), Nkonkobe Local Municipality climate can be described as mild. The rainfall is unevenly distributed within the area ranging from 400mm to 1200mm, with the least rainfall being received in the inland areas of Alice and Middledrift and the highest in the mountainous region of Seymour and Balfour area (Acocks, 1988; Magni, 1999; Shackleton & Shackleton 2006). Although rainfall is relatively high in the mountainous region, much of the area in the catchment can be regarded as sub-humid to semi-arid. Nkonkobe receives both summer and winter rainfall. Approximately 75% of the mean annual precipitation is received between October/November and February/March, where the highest rainfall figures are recorded in March (Magni, 1999). The temperatures range from moderately hot summers to cool moderate winters (Acocks, 1988; Motteux, 2001).

3.2.2 The Agricultural Sector of Nkonkobe Local Municipality

The Agricultural sector has in the past 12 years been in state of decline. Government institutions such as Ulimocor which used to provide substantial support in citrus and beef farming in the 1980s were closed down in 1997 without any alternative or back-up support for farming in the area. What further compounded the problem was the restructuring at the University of Fort Hare, which consequently resulted in a substantial gap regarding technical support to the agricultural sector for the whole Nkonkobe area. The current situation is that the agricultural sector performs below the expected standards and it is an area that has got potential to grow. Agriculture is producing 30% of food needs despite the fact that there is a lot of arable land. Citrus is a major contributor in the economic development of the area and it employs workers on seasonal and permanent basis. The continuing technical and institutional constraints facing the agricultural sector of the local municipality have recently been well documented by Monde (2005), Hebinck and Lent (2007), and Jari, Fraser and Obi (2011).

The Nkonkobe local municipality’s IDP (2007) document recognizes the need of reviving old abandoned/ underutilised large irrigation schemes that have potential to contribute to municipal economic development. The identified schemes to be revived include Kamma Furrow Irrigation Scheme, Qamdobowa Irrigation Scheme and

HACOP irrigation scheme with specific reference to Hertzog and Phillipton areas. A number of high value crops have been identified by numerous scientific studies that have been carried out in the Nkonkobe Municipal area namely paprika, olives and essential oils.

Alice fresh produce market has been constructed for the marketing of vegetables in the area. The market is utilized by all farmers within the area for selling their produce. It is gaining the support from the local businesses and hawkers within the area and has got a huge potential to grow and be sustainable. Fishing and forestry have also been identified as important sources of growth. Value adding activities can be done in the municipality as the resource permit to do so. For instance instead of selling timber, furniture can be manufactured in the municipality and this may have multiplier positive effects to residents of the municipality as returns from their agricultural products who be increased through value adding. This also creates employment for the rural poor as the activities require additional labour, both skilled and unskilled. The challenging issue is awareness creation with communities around value adding activities and also capacity building.

a) Negative factors that contribute to non-performance of sector

It can be seen that there is still a lot dependency syndrome within communities of Nkonkobe Municipality that contributes to why agricultural sector's performance is not improving and funded communities still depends on the government and they still continue to look for more funding support Funded irrigation schemes still lack commitment despite the fact that Government has invested a lot of money into the irrigation schemes that is driven by poverty and underdevelopment.

According to Amatole IDP (2006), marketing skills are still a challenge within the sector although the municipality has built a vegetable market in response to need as farmers. One major challenge to the agricultural sector especially to the irrigation schemes that have been funded by the various government institutions including the municipality through infrastructure development is exploitation by big investors e.g. Da Gamma in cotton manufacturing, there is no clear contracts between the said company and the farmers and that makes farmers not to be happy and to lose. The initiative is supposed to be contributing towards their development. Lastly there is a lack of business management skills as some of these entities are supposed to be operating on business principles since they have been funded with big monies.

b) Positive Factors

Although the sector is performing below the expectations it has immense potential to grow and there are some positive factors that can be explored, namely mentorship and learnership support provided by the Department of Agriculture. These could play a major role by assisting farmers to learn and implement new innovative ways of cultivating their lands. The Nkonkobe Municipality have strengthened working relations with the Department of Agriculture that have got expertise as the Municipality does not have any agricultural expects. Relations between the Municipality and Department of labour must be improved. The Department of labour provides capacity building programmes in previously disadvantaged communities through various programmes which are likely to improve agricultural productivity within the small scale farmers of the Nkonkobe Municipality.

3.2.3 Limiting factors to rural livelihood development

According to the Amatole IDP (2006) other limiting factors to rural livelihood development in Nkonkobe municipality include; Lack of interest in farming by the youth (and a perspective that farming is a lower status occupation). Older residents who may not have the abilities to carry out the hard work largely hold to the "dream" of rural development. The inability to attract industry to the rural areas / small towns, The lack of services / service centres, capital, infrastructure and equipment to enhance farming. The existing tenure patterns of large arable fields far away from the homestead were seen to inhibit production. A large number of restitution claims that cryptic have not been settled were highlighted. The delays were causing resentment among the claimants and in one case the claimants had begun invading the claimed land. Redistribution initiatives were underway which was meeting the demand of emerging farming. However problems with these projects often failing due to group dynamics and a lack of commitment were highlighted. The LRAD planning process needed to focus on identifying committed farmers, and screen out those just looking for land and/or a grant.

3.3 The Analytical Framework and Specification of the model

3.3.1 Introduction

This study has several dimensions all of which have informed the analytical model adopted for analyzing the data. As the specific objectives suggest, there is an initial attempt to profile and characterize the farming system and understand the importance of the crop-livestock integration in the study area. The next major component of the study involves a test of associations between pairs of independent variables.

In the profile carried out a number of variables that are crucial to understanding of the farmers and the farming environment are matched with one another to see if there are important relationships that can be followed up. This called for the adoption of systematic procedures so that valid predictions about future behaviour change can be made. To further strengthen the reliability of these predictions variable that revealed significant associations were tracked through a series of multiple linear regression analyses. Finally, the major research question concerning the main reasons for farmers to integrate or otherwise was examined by means of a binary logistic regression. The specific procedures followed in this study are described in the next sub-sections that follow:

3.3.2 Descriptive Analysis

Descriptive statistics was applied on the basic characteristics of the sampled households. This employed both frequencies and means to describe the data which included age, education, gender, marital status of head of household, land size owned and cultivated, and importance of integrating crops and livestock. Frequencies and mean values are useful in analyzing household characteristics as well as analyzing the relationship of variables. The results were cross-tabulated and where necessary, charts, graphs, and other diagrams were used to summarize and interpret the data.

3.3.3 Inferential Analysis

It was necessary to also carry out inferential analysis on the data. For this purpose, three distinct analyses were carried out, namely a correlation analysis, the multiple linear regression (step-wise) and the logistic regression. The broad reasons for the multilayered analysis have been given in the introduction above but will be revisited in the subsections below within which they are elaborated and specified.

3.3.3.1 Correlation analysis

The correlation analysis is one of the most common and useful statistics employed to determine the extent of linear association between two independent variables. The measure of the degree of correlation is the correlation coefficient. A correlation coefficient is a single number that measures the degree of relationship between the two variables. A correlation analysis was carried out as part of the analytical framework for the present study.

This study enumerated the farming households in the study area with respect to a range of standard perceptions associated with crops and livestock integration. The preliminary investigation that precedes the field survey revealed that the community members are pushed into practicing integrated crops and livestock farming because of their perceived benefits with associated farming system. These perceptions were divided into nine distinct cases namely, source of milk production, production of meat, source of income, wealth status, food security, cultural reasons, draught power, source of manure and feed. Specifically, farmers were asked to rate these perceptions using a five-point Likert-type scale from 1 to 5 as follows: 1= very low, 2= low, 3= intermediate, 4= high, and 5= very high. A correlation matrix (Table 4.10) was drawn to explore the association between the household demographic and socio-economic characteristics and the above set of perceptions.

3.3.3.2 Multiple linear regression

A linear regression model was used to test and analyse several relationships. One set of relationships was between a chosen index of successful crop-livestock integration and a number of variables that might affect it one way or the other. Regression analysis is a statistical technique that attempts to investigate and model the relationship between two or more variables such relationship may be linear or non-linear (Gujarati, 1992). A linear regression attempts to model the relationship between two or more variables by fitting a linear equation to a data set. In such a case, a direct relationship is assumed and the variables appear with a power of 1 only (Gujarati, 1992). In a linear equation, the variable that is influenced by other variables is known as the dependent variable. The other variables that have an influence on the dependent variable are known as explanatory or independent variables (Gujarati, 1992).

A linear regression model that contains more than one predictor variable is called a *multiple* linear regression model. Economic theory predicts direction relationships between a vary range of socio-economic and community variables and the willingness or otherwise of economic actors to participate in the process of exchange. It is therefore possible to fit a simple linear regression model.

$$Y = f(X_1, X_2 \ldots X_n) \quad \ldots(1)$$

Where;

Y is the dependent variable representing some measure of adoption of crop-livestock integrated farming system, while X's are the explanatory variable and livestock.

Following conversion, the model can be specified as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots \beta_n X_n + \mu_i \quad \ldots(2)$$

Where:

β_0 = the intercept or constant term

$\beta_1, \beta_2, \ldots \beta_n$ = slope or regression coefficient

$X_1, X_2 \ldots X_n$ = explanatory or independent variables

μ_i = error or disturbance term.

The model was estimated to identify the perception of farmers on integration crops and livestock.

Three diagnostic tests to detect (i) Serial correlation, (ii) Heteroskedasticity, and (iii) Multicollinearity, were performed in SPSS and the tests are described below:

(i) Serial correlation

The Durbin–Watson statistic is a test statistic used to detect the presence of autocorrelation, i.e. a relationship between values separated from each other by a given time. Durbin-Watson statistics (DW) can be used for assuming e_t in (2) is evenly distributed. The test was conducted to detect any possible serial correlation indicated by the size of the Durbin-Watson (DW) statistics by establishing that:

μ_i = □$_{\mu-1}$ + □$_t$..(3)

The DW statistics is calculated as followed:

$$d = \frac{\sum_{t=2}^{T}(e_t - e_{t-1})^2}{\sum_{t=1}^{T} c_t^2},$$

Test shows the DW statistics and □□ from (3) are linked as:

DW≈ 2(1- $^{\wedge}_{P}$)

The DW test is usually used for testing following null and alternative hypothesis:

$H_0 : p = 0$

$H_1 : p > 0$

From the equation (4), □^ ≈ 0 corresponds that DW≈2, and □^ > 0 corresponds to that DW< 2. We test this null hypothesis as follows:

- Choose a significance level, say 5%, and with the number of observations and the number of regressors, find two sets of critical values: d_l (for lower) and (for upper).
- Make a decision:
  - If DW < d_L, we reject H_0 against H_1: p > 0
  - If DW > d_U, we fail to reject H_0.

- If DW $\leq d_U$, the test is inconclusive.

The only advantage of the DW statics over the t-test from (3) is that an exact sampling distribution for DW can be computed. Given that the DW statistics requires the normal distribution of e_t and a wide inconclusive region, $d_L \leq DW \leq d_u$, the disadvantage of the DW test is substantial.

(ii) Heteroskedasticity

To test for the presence of heteroskedasticity in time series regression, the same method for cross-sectional applications could be used. This test requires that error terms V_t be serially uncorrelated. Heteroskedasticity is calculated as follows:

$$\hat{U}_t^2 = \delta_0 + \delta_1 X_{t1} + \ldots\ldots + \delta_k X_{tk} + V_t \ldots\ldots(4)$$

The null hypothesis is H_0: $\delta_0 = 0$, $\delta_1 = 0, \ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ \delta_k = 0$.

Then the decision can be made using F statistics.

(iii) Multicollinearity

Given the rather large number of variables enumerated, the likelihood of correlation among independent or predictor variables is high. For this reason, the test of multicollinearity was applied. Assuming two variables, X_1 and X_2, collinearity is suggested if:

$$X_1 = fX_2 \ldots\ldots (5)$$

However, the equation (2) demands that a more robust function be developed to cater for the several predictor variables in the model. This can be presented as:

$$f_1 X_{li} + f_2 X_{2i} + \ldots\ldots f_k X_{ki} = 0 \ \ldots\ldots(6)$$

Where f_i are constants and X_i are the explanatory variables that might be linearly correlated.

The speed with which variances of an estimator is inflated by the presence of multicollinearity. A formal detection tolerance or the variance inflation factor (VIF) for multicollinearity as illustrated by Gujarati (2003) can be as follows:

$$VIF_j = \frac{1}{1 - R_j^2}$$

Where tolerance = 1 – R^2

Tolerance of less than 0.21 or 0.10 and / VIF of 5 or 10 and above indicates multicollinearity of variables. Where multi-collinearity was detected on the basis of these values of the VIF, the highly collinear variable, that is those with very high VIF, were detected from the model.

3.3.3.3 Logistic regression

Following Gujarati (2003), the cumulative logistic distribution function for factors affecting the perception of farmers was specified as,

$$P = \frac{1}{1 + e^{-z}} \qquad (1)$$

Where P was the probability of integrating crops and livestock by a farmer and Z is a function of m explanatory variables (X) and was expressed as

$$Z = B_0 + B_1X_1 + B_2X_2 + \ldots\ldots\ldots\ldots\ldots B_mX_m \qquad (2)$$

The probability of not integrating crops and livestock was given by

$$1 - P = \frac{1}{1 - e^{z}} \qquad (3)$$

The conditional probability of the outcome variable follows a binomial distribution with probability given by the conditional means $P_{(i)}$. The logistic model in terms of logs is

$$\log(\frac{p}{1-p}) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k \qquad (4)$$

Where $\log \frac{p}{1-p} = Z$

the log of odds ratio is not only linear in X but also linear in the Bi variable and as a result, OLS is used. Taking the stochastic term μ into account, the logit econometric model to be used will be

$$Z = B_0 + B_1X_1 + B_2X_2 + \ldots\ldots\ldots\ldots\ldots B_mX_m + \mu \qquad (5)$$

To evaluate how well the logistic regression equation predicts outcomes of whether a small scale farmer will integrate livestock and crops given the variables in the model, the Hosmer and Lemeshow Goodness of Fit was used.

Data analysis was performed using SPSS version 18. SPSS is a system based on the idea of using statistics to turn raw data into information essential to decision making.

3.4 Description of variables used in the model

The questionnaire was designed to capture data on production, marketing and factors that influence integration of crops and livestock. The data that were collected included demographic data (age, sex, highest educational level attained, family size and income level), factors affecting productivity of both crops and livestock production such as land, labour, and capital, transport availability, amount of crop and livestock sold at the market, market proximity, market institutional arrangements and difficulties involved in selling of produce. Importantly, the questionnaire captured information pertaining to farmers' perception on livestock and crop integration. The key variables used in the model were divided into dependent and independent variables and are summarized in Table 3.1, showing the direction of their expected relationship with one another.

Table 3.1: Definition and units of measurements of key variables modeled

Dependent variable	**Definition**	**Anticipated sign**
(i)Total asset	Continuous	**+**
(ii) Integration (integr)	Dummy: Yes =1, 0 otherwise	**+/-**
(iii) Perception scores	Determinants of farmers perception on crop-livestock integration e.g. meat, milk, manure etc.	**+/-**
Total income	Continuous	+/-
Independent Variable	**Description**	**Anticipated sign**
Age	Discrete (years)	+/-
Gender	Categorical: Male =1, Female=0	+/-
Marital Status	Dummy: married =1, 0 otherwise	+/-
Household size (Hhsize)	Discrete (number)	+/-
Highest educational level (Educat)	Discrete (years of school attendance)	+
Religion	Categorical	+/-
Land size	Discrete (ha)	+
Arable	Discrete (ha)	+/-
Communal grazing	Dummy: Yes =1, 0 otherwise	+/-

3.4.1 Description of dependent variables

(i) Total assets - The total assets variable is an index of the household socio-economic status constructed by aggregating weighted scores of households' possession and durable assets. The asset index constructed in this study follows the same method as used when constructing indices in economic measurements. The guidelines established by the World Bank have been followed (Filmer *et al*, 2008). It aggregates various assets owned by the household, to which scores/numbers have been assigned on the basis of the relative importance or value to the household. Where data under household income may be difficult to obtain, this variable serves a very crucial role as a measure of the socio-economic standing that can both influence decision on enterprise choice as well as reflect the impact of the adoption of practices in the farming systems. This index gives a comparative picture across households and the distribution of assets. Farmers with higher asset scores are more likely to be the same farmers with more produce to market and are also likely to be those farmers with more diverse production from integrated crop-livestock farming systems. This quantity is quoted as a continuous variable which varies from one household to the other.

(ii) Integration – This variable indicates whether or not a household has adopted crop-livestock integrated systems. It is a binary categorical variable. Farmers who integrate are assigned a value of 1 while those who have not adopted crop-livestock integration are assigned a value of 0. The decision to adopt or not to adopt is expected to employs more than 70% of the work force in Sub Saharan Africa (SSA) (FAO, 2003) influenced by the perception of farmers depending on their unique circumstances. The asset ownership of the household is likely to be an important factor in their decision to adopt or not to adopt, as much as age, education, gender and other variables. Therefore positive and negative relationships with independent variables are possible.

(iii) Total income (Totinc) - The variable reflecting total income is a continuous variable, and was measured in rand. Household income measures relative material well-being and it illustrates the degree of dependence on farm and non-farm resources (Bembridge, 1987). But the precision of the data on household income is doubtful because of the reluctance of many farmers to provide all the information required to compute comprehensive income statistics. During data collection each component of income was considered. But, household income is derived from various sources that are rarely recorded (Galang, 2002). Sources of income for the purposes of this study household income were calculated on the basis of a summation of all sources of income, including the total revenue from crops and livestock and total value of assets owned. It was expected that the more income a household have, the more the probability of that household integrating crops and livestock.

(iv) Perception scores – The perception scores are a set of variables that have been constructed by ranking the opinions of farmers about the relative usefulness of crop-livestock integration. Within the project area and some literature, a number of attributes of crop – livestock integration have been identified. The questionnaire used for the farmer survey sought from the respondents to indicate the extent to which they accepted a particular attribute as their reason for integrating crop and livestock enterprises. A 5-point Likert scale was used to indicate the strength of the respondents' acceptance of the attribute in question. On the whole, the perceptions included in the analysis numbered 10 and refer to the opinions in respect to value of crop-livestock integration in respect to:

a. Increased profit from crop production
b. Provision of draught power
c. Enhancing food security
d. Increased production of meat
e. Increased production of milk
f. As a status symbol from having diverse economic participation
g. Increased production/availability of feed for livestock because crop residues are readily available from the crop component for livestock feeding
h. Increased production of farm yard manure for regeneration of soil fertility
i. Enhanced revenue from a more diverse economic activity
j. It is part of the culture to grow crops and raise livestock.

According to Rahman (2003), Negatu and Parith (1999), Adesina and Baidu-Forson (1995), Adesina and Zinnah (1993) and Wei, White, Chen, Davidson & Zhang (2007), farmers' perception is important as a guide to farmers' decision making and is a good reflection of the basis for farmer's adoption behaviour. Farmers' perception is a measure of the information available to the farmer and how much the farmer knows about the issue at hand. These perception scores were included in the model in two roles depending on what specific objective was being addressed; on one hand they were included as dependent variables whose variations are explained by a set of socio-economic and demographic characteristics of the respondents, while on the other hands they were employed as explanatory variables to explain variations in either total assets or income or in the binary choice model as predictor variables.

3.4.2 Description of independent variables

(i) Land size - The variable reflecting the land size is a continuous variable, and was measured in hectares. It was expected to positively influence the perception of farmers towards integration because more land is usually associated with more crop production as well as greater access to grazing land. In that case, larger land sizes will be expected to provide larger numbers of livestock units. It is therefore hypothesized that the larger the size of land the more production takes place and the greater the chances of integrating crop-livestock enterprises.

(ii) Marital status – This variable is treated as a dummy variable where 1 represent married and 0 for otherwise. In most African households, the priorities and stability of the household are usually judged on the basis of marital status of the household head. It is expected to influence the perception of farmers towards crop-livestock integration positively since it is normally believed that married household heads tend to be more stable in farming activities than unmarried household heads. In addition, some programmes that enhance agriculture such as land reform, seem to favour married household (Utete, 2003), resulting in the probability of married household integrating crops and livestock. There is also a reasoning that marriage imposes the obligations on the household head to take care of a family. The obligation to provide for a family which will obviously require that the household generates extra incomes. There is the possibility of cross-effects here. A married household head is therefore more likely to perceive crop-livestock integration as a beneficial if s/he also considers the practice as a better source of household income.

(iii) Gender - The gender variable is a categorical variable where 1 represents male and 0 represent female. It is expected to influence the perception of farmers since it is normally believed that male farmers are more engaged in farming activities than female farmers and are more likely to integrate crops and livestock. The gender of the household head is important as it influences the ability of the household to source income. Gender also influences access to assets such as land and capital that have a direct bearing on agricultural productivity. The general notion is that most households in rural areas are headed by females due to male migration to urban areas. This will obviously have serious implications for household's participation in key rural economic activities. For instance, in most female-headed households labour for herding livestock and for ploughing, weeding and other critical tasks are scarce. Decision making roles are normally divided between males and females depending on the nature of the economic and social activity involved. In many parts of the world the legal system regards females as minors who do not have the power to make decisions in relation to household allocations of productive resources. In many traditional societies, access to land is restricted to male members of the household and women only access land through their association with male members of the households. Inheritance laws also discriminate against women.

(iv) Age - Age is a continuous variable which was measured by the actual number of years of the household head. It is expected to influence the perception of farmers either positively or negatively since it has advantages and disadvantages associated with both older farmers and younger farmers. For example, older farmers may reflect better experience, therefore increased output (Ngqangweni and Delgado, 2003). It is also believed than older farmers believe in their own cultural ways of doing things. Therefore older farmers are expected to have greater inefficiencies because they are less adaptable to new technological developments. On the hand, older farmers may be resistant to change, even in times of globalization where the market environment is changing (Kherallah and Kirsten, 2001). Such can have a negative influence on output which can lead on the negative attitude towards engaging in the crop-livestock farming system. On the other hand, young farmers are more active than older farmers and might influence the adoption of crop-livestock integration since it is easier to access information and to adopt the new technologies.

(v) Arable - The variable reflecting the arable is a continuous variable, and was measured in hectares. It was expected to influence the perception of farmers towards integration positively because more land for crop is usually associated with more production. In that case, if more size is allocated for crop production, the more the residue provided for livestock feed since their grazing is communal therefore the space for livestock is greater. The influence of this variable on the decision to practice crop-livestock integrated system is therefore expected to increase, as traditional farmers believe that the waste of one enterprise will be useful to another, for example crop residues as feed. On the other hand this variable was expected to influence the perception of farmers negatively because more land is associated with more crop production. In that case, the reasoning would be that the more the arable land the farmer has the less the probability of integrating.

(vi) Communal grazing – The availability of Communal grazing land is vital to the decision of individual community members to maintain livestock enterprises in the first place or decide on making alternative arrangements to accommodate livestock enterprises where such communal grazing is not available. If a household cannot guarantee access to communal grazing land but is still intent on keeping livestock, it may decide to integrate the livestock enterprise with existing crop production in order to have access to own feed for the livestock. But such inaccessibility may be a reason for abandoning livestock production entirely. The variable is coded as **commgraz** and is treated as dummy assigned 1 where communal grazing is available and 0 otherwise. A large number of cattle farmers using smaller areas of arable can be explained by use of communal grazing land for animal feeding. The use of communal grazing land verifies research by Stroebel (2004), which pointed out that communal grazing areas are important sources of livestock feed among smallholder farmers in many developing countries. In such cases, it is difficult to measure the amount of communal grazing land that is available to each household. This situation leaves less arable land for farming purposes. In addition, most smallholder farmers do not own the land they farm on, even though they have rights to use it (Ngqangweni and Delgado, 2003). Therefore it may be stated that farmers that have access to communal grazing land are less likely to integrate than those that have private grazing land.

(vii) Household Size - Household size (HHsize) is treated as a continuous variable and is expected to influence the perception of farmers on crop-livestock farming positively or negatively. A larger family size means that a variety of labour capacity is available in the form of young, middle aged and elderly members used for production and more people will be engaged in the crop-livestock farming practice. This variable was measured by the actual number of people supported by a farming unit and subjected to the decision making of the household head in respect to contributing to the labour supply and sharing in the rewards of the farming activities. A hypothesis that is testable is that the larger households are more likely to integrate crops and livestock than smaller households as they can do division of labour than their counterparts. On the other hand, the larger the household size the more likely is the household to come under pressure to make more land available for residential houses and that may lead to negative relationship with an indicator depicting the tendency towards integrating crop and livestock in the farming system. Similarly, although a larger family size puts extra pressure on farm income for food and clothing and other household necessities, it most certainly ensures availability of enough family labour for the labour-intensive farm operations to be performed when necessary and without the family's direct cash commitment (Parikh *et al*, 1995).

(viii) Education (Educat) – According to Bembridge (1984), education is very important in the decision-making process with important practical implications for resource allocation decisions and adoption of improved practices, including the adoption of crop-livestock integration. Education is important to farmers because it determines the ability of a farmer to adjust to new innovations. Education catalyses the process of information flow and leads the farmers to explore as wide as possible, the different pathways of getting information about agriculture and technology (Berry, undated). People with more education are likely to be better informed and are likely to interpret information more correctly than uneducated. Particularly in a study where farmers' perception is a central element, education level of the respondent will be an important consideration because the ability of the farmers to perceive the advantages and to efficiently utilize new technology is often measured by education as well as farming experience and exposure to extension services. Illiteracy has been noted as one of the factors that limits the extent to which households adopt practices designed to improve their livelihoods and the attitude to integration of crops and livestock is most likely to be among such practices where decision may be strongly influenced by perceptions one way or the other. Educational considerations generally influence the adoption by new behaviour of farmers. (Ghosh R.K, Goswami A & Mazumdar A.K, 2000).

(ix) Religion - This variable was treated as a categorical variable, being coded 1 for adherence to a religious faith and 0 otherwise. Farmers were asked about their religion. Religion was included because some religions have an influence on the animals that are kept in a farming unit. For example, some religions do not allow their believers to keep or consume pigs while others are indifferent. Traditionalists are regardless in this definition to be those without a religion in a loose sense and it is observed by anecdotal evidence that such households are less restricted in their choices regarding pigs and are more likely to integrate crop and livestock than the Christians because traditional farmers need livestock when performing their traditional functions than Christians.

3.5. Sampling procedure

Alice, Middledrift and Seymour-Balfour areas were selected purposively because there are less logistical problems associated with conducting the research in these areas due to their close proximity to the University. Conducting this research in those times is also a way of achieving one of the university goals engaging with its surrounding communities and contributing to developing areas around the University. In this study, stratified random sampling method was applied in order to choose the units of observation, namely the farming household. Since the researcher was aware that a complete lists of farmers of Alice, Middledrift and Seymour-Balfour were available, a list of farmers provided by the three District offices of the Department of Agriculture (Alice, Fort Beaufort and Middledrift offices) using simple random sampling[1]. Simple random sampling requires the use of a sampling frame (list of the population), from which the sample will be drawn (Leedy and Ormrod, 2004). From these lists a sample of 70 respondents was randomly selected.

3.6 Tools used for data collection

A semi-structured questionnaire was the major tool used for data collection. The questionnaire consisted of both open ended and close-ended questions in order to improve the quality of data collected. Open-ended questions gave the respondents greater freedom of expression as respondent had an opportunity to qualify their answers thus reducing bias due to unlimited response ranges. Because of time constraint and the fear of researcher/interviewee bias that could arise from open-ended questions, the questionnaire was balanced with close-ended questions that

[1] Simple random sampling gives each member of the population an equal chance of being chosen.

could be posed and answered quickly. Consideration was also given to the ease of coding the responses in selecting the format in which the questions were structured.

The questionnaire was designed to specifically capture and enable the study to identify importance of crop-livestock integration farming system in rural areas. The questionnaire captured information about household characteristics (e.g. gender, level of education, sources and levels of income etc) and reasons for integrating.

3.7 Method used for Data collection

Face to face interviews were the means for administering the questionnaire because;

- The high response rate associated with these data collection techniques as the interviewer can ensure that all questions are answered.
- The high reliability of the data that could be obtained because the interviewer can probe with further questions if the respondents appeared to have misunderstood the question or appeared to be giving false information. In addition, the interviewer can explain to the respondent if they have any problems with comprehension.
- It accommodates communal farmers who are not literate in English and could require translation into local language, Xhosa.

In addition to the survey interviews, other methods of data collection included focus groups, observation and discussions with the extension officers and academics that had done research in Nkonkobe local municipality.

3.8 Limitations

Time constraint was the major reason that resulted in the study being carried out in only one local municipality (Nkonkobe). It is recommended that a larger study be done in all the municipalities in the province, in this case most of the importance of and constraints to crop-livestock integration would come out strongly. However the results obtained from this study will be a guide to the bigger picture of the reality on the ground.

3.9 Summary

In this chapter, the agricultural sector of Nkonkobe District municipality, with particular reference to the project area, is described. Studies completed by researchers at the University of Fort Hare have revealed serious technical and institutional constraints to smallholder farming and provide insights into the range of options available to farmers for enhancing livelihoods and welfare. These studies and insights have been articulated and summarized in this chapter. On the basis of these, the analytical and conceptual frameworks for the study have been specified. Methods that were used to collect and analyze data were reviewed and described. Data were collected from 70 emerging and smallholder farmers in the communities surrounding Alice, Middledrift and the Seymour-Balfour area. The research was mainly focused on the farmers identified as full time farmers without any prior knowledge of whether or not they practised crop-livestock integration. Stratified random sampling was applied in order to select the sample. To collect the data, a questionnaire was administered to the respondents through face-to-face interviews. The advantages that are associated with face-to-face interviews have been highlighted within the chapter. For analyzing data, SPSS software was used and all these are described in the chapter.

CHAPTER 4
PRESENTATION OF RESULTS

4.1 Introduction

In this chapter, the results of the field survey that was carried out in the former Ciskei homelands of the Eastern Cape province of South Africa are presented and discussed. The data analyzed in this chapter were collected from 70 small-scale and emerging farmers, in order to find out the farmer's perception of the relative importance of crop-livestock integration in the small holder farming systems and the extent to which they consider that it can be a viable path out of poverty for them. The chapter commences with brief description of the demographic and socio-economic characteristics of the sampled households. This is then followed by an overview of households' asset ownership and socio-economic factors. It goes on to discuss socio-economic aspects of households, giving special attention to aspects related to crop yields and the number of livestock kept/sold, i.e. livestock production or animal husbandry. The performance of farmers practising crop-livestock integration is compared to that of farmers specializing in either crop or livestock.

The objectives of the study were to assess the perception of the farmers about the relative value or importance of crop-livestock integration. Socio-economic characteristics that may be associated with the impact of the perceptions held by household heads on the decision as to whether to adopt or not to adopt the crop-livestock integration were discussed. Descriptive analysis is used to describe the demographic and socio-economic profile of the sample, looking specifically on variables such as gender, age, educational level, reported income and revenue earned, an asset index derived from household assets owned, and livestock ownership. In respect to these, the descriptive analysis made use of means, standard deviation and measures of skewedness. Following these, the study carried out several inferential analytical procedures including a correlation analysis, a multiple linear regression analysis in which total assets are used as the dependent variable to determine the factors influencing choices of crop-livestock integration, and logistic regressions.

Correlation analyses between certain demographic and socio-economic characteristics were analyzed to assess the farmers' perception about the importance of crop-livestock integration, as well as the correlation matrix of all variables that show significance in the model. The analysis of variables that measure the perception of farmers towards integrating or not integrating were also performed and discussed.

4.2 Demographic and Socio-economic Characteristics

This section discusses aspects such as gender, age, marital status and educational levels and the factors affecting the farmers' perception of the relative importance of crop-livestock integration. According to Makhura (2001), these aspects are important because most farming activities are influenced by such demographic aspects. The results related to the household size and the livestock units are also included in this section. Socio-economic factors refer to the social and economic environment under which households operate. Understanding the factors under which small-scale and emerging farmers operate, is useful in understanding their production and marketing behaviour. Table 4.1 presents the summary of the descriptive statistics of the demographic and socio-economic characteristics in respect to the categorical variables while Table 4.2 presents the summary of descriptive statistics in respect to the continuous variables. In the sub-sections that follow, the key elements of the descriptive statistics are explained in terms of how they have been measured and the rationale for including that specific variable in the study.

Table 4.1: Descriptive statistics of the demographic and socio-economic characteristics- Categorical variables

Variables		**Percentage**
GENDER	Male =1	71.4
	Female=0	28.6
MARITAL STATUS	Single=1	71
	Married=2	4
	Divorced=3	1
	Widowed=4	24
EDUCATION	Not educated=1	18.6
	Primary=2	45.7
	Secondary=3	27.1
	Tertiary=4	8.6
RELIGION	Christian=1	94
	Traditional=2	4
	Other=3	2
INTEGRATION	Integrate=1	45
	Not integrate=0	55
COMMUNAL GRAZING	Communal=1	98
	Not communal=0	2

Source: Field data, 2009

Table 4.2: Descriptive statistics of the demographic and socio-economic characteristics - Continuous variables

Variable	Minimum	Maximum	Mean	Std. Deviation
AGE	34	83	61.44	11.201
HOUSEHOLD SIZE	2	19	8.29	3.112
LAND SIZE	.5	112.0	6.413	14.9432
ARABLE	.1	45.0	3.644	7.08232
CATTLE NUMBER	0	78	14.17	11.622
GOAT NUMBER	0	80	16.91	14.116
SHEEP NUMBER	0	104	11.16	16.762
CHICK NUMBER	0	450	28.03	84.241
LIVESTOCK UNIT	.0000	5.5900	1.432286	.9029808

Source: Field data, 2009

4.2.1 Gender

Gender distribution of the sample household heads is shown on Table 4.3.

Table 4.3: Gender distribution of respondents

GENDER	Number	Percentage
Male	50	71.4
Female	20	28.6
TOTAL	70	100

Source: Field Data, 2009

The results show that 71.4% of the sample households in the survey were male farmers compared to just 28.6% female farmers. The gender distribution of a population is important for various reasons, including resource allocation decision since there are gender differences in the extent to which men and women take risks and their tolerance of outcomes that may be uncertain. Another reason gender is important is that it often has implications for previous or existing socio-economic standing which will exert a lot of influence on the decision to adopt practices to enhance profitability of farming. People coming from a desperately poor background may feel a greater need to adopt profit-enhancing practices. But such persons may also be limited in their ability to sustain such practices due to their limited means and the inherent riskiness of new practices and this may work as a demotivation to adoption. Where the decision making in a household is taken by a person most likely to be inhibited by considerations of limited financial means, or the restrictions imposed by cultural norms, or whatever, the outcome will naturally differ from what would have happened should the decision maker be of a different background. This variable was measured as a dummy.

4.2.2 Marital status

In most African families, the priorities and stability of a household is usually judged based on the marital status. It is normally believed that married household heads tend to be more stable in farming activities than unmarried heads. If this holds true, then marital status tends to have some influence on agricultural production and marketing (Randela, 2005). The marital status of the respondents was divided into four main groups namely single, married, widowed and divorced and their distribution is shown in Figure 4.1.

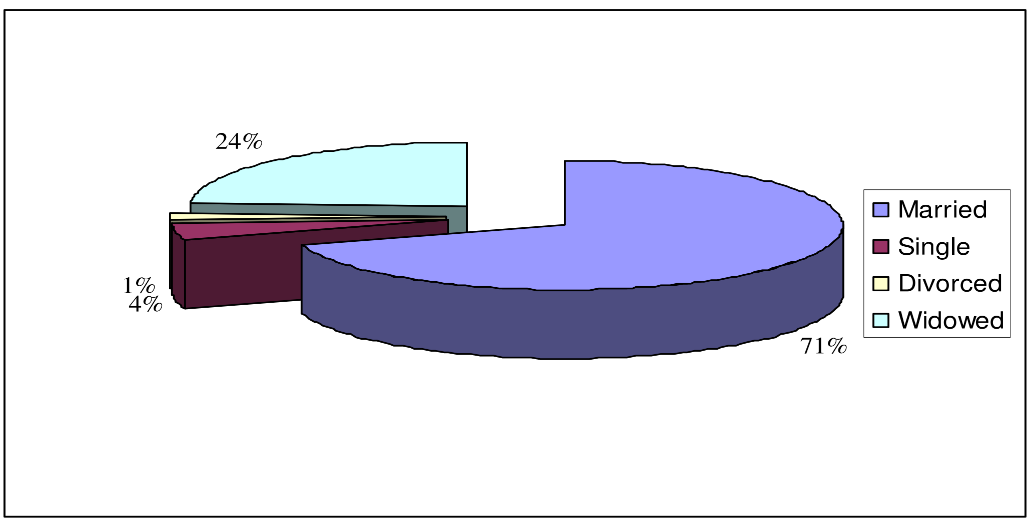

Figure 4.1: Marital status of respondents

Figure 4.1 shows that 71 percent of the respondents are married, which indicate that such households are relatively stable in farming. Only 4% of the respondents are single, whereas 24% and 1% are widowed and divorced, respectively. As noted by Musemwa et al 2008, households headed by females tend to sell more cattle and own less livestock as they are involved in many other household activities such as cooking and breast feeding.

4.2.3 Education

In this study, the highest educational level achieved by the household head was recorded to determine the human capital level of households and the ability to understand written information. According to Mather and Adelzadeh (1998) households who achieved a higher level of education have higher chances of being more informed because they can read and are more able to interpret information than those who have less education or no education at all. Thus, education levels affect economic decisions made by farmers, especially those related to marketing of produce. The results of the highest educational level achieved by sampled farmers are shown on Figure 4.2.

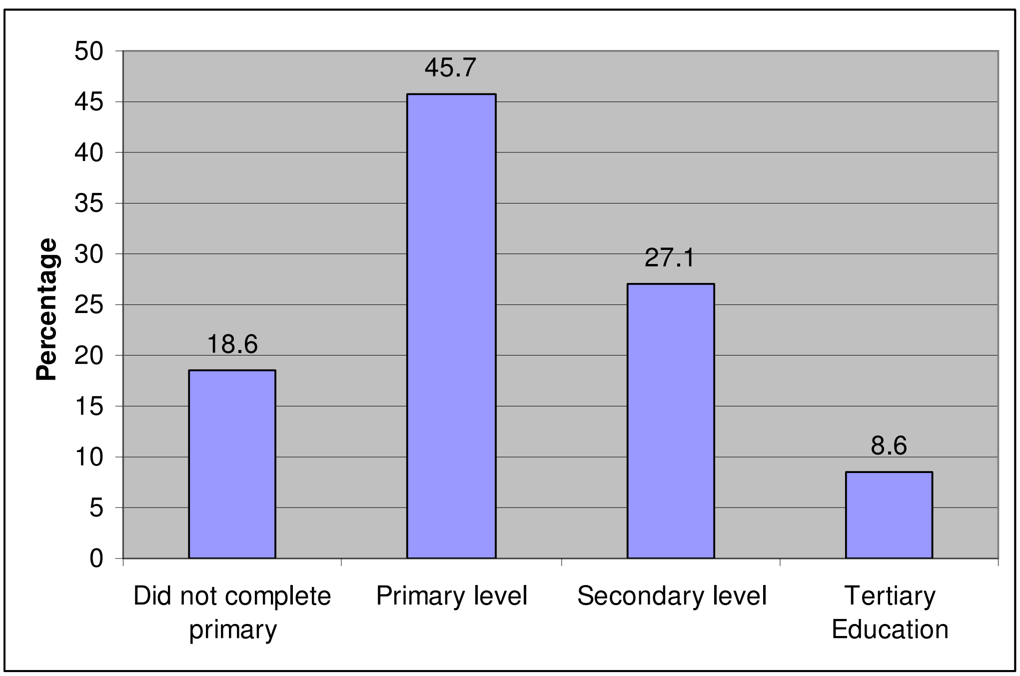

Figure 4.2: Education distribution of farmers

The illiteracy level is still high in the Eastern Cape Province of South Africa because 18.6% of the respondents did not complete primary school education. Those who completed primary education, but did not complete secondary level are 45.7% of the respondents. These results substantiate Randela (2005) who pointed out that it is evident that educational levels are still low in South Africa, especially in the rural areas. Only 8.6% of the respondents have gone up to tertiary level. A smaller number of people with higher education might have been influenced by the movement of people away from agriculture into industry as they acquire more education.

4.2.4 Age distribution

Age of the household head is an important variable because it determines experience one has in a certain type of farming. Thus, older farmers are believed to be more experienced compared to younger farmers. Household head's experience further influences household members' farming activities since they usually get guidance from the head. In addition, age indicates the position of the household in the life cycle. The household heads ranges in age from 34 years to 83 years, with the average age being 61 years. The standard deviation is low and suggests that there was little variation from one household to the other. This age range shows that the pensioners can still be involved in farming, especially if they are interested in livestock where there is no need of much physical strength (Mather and Adelzadeh, 1998).

4.3 Sources of income

Total assets which involve the total revenue from crops and livestock and the livestock unit were used to determine the level of income, self employment and other forms of grants. The majority of the respondents (59%), regard farming (includes both crop and livestock farming) as their main source of income. These results show that development of farming systems in the study area is likely to improve the welfare of the people in that community. Few respondents (18%) depend on a more reliable formal source of income. The results are shown in Figure 4.3 below.

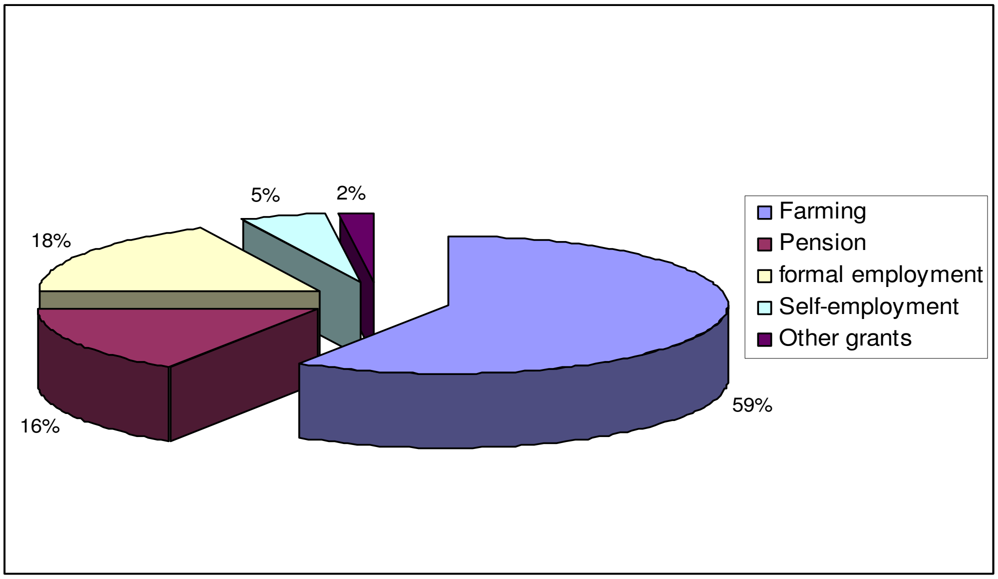

Figure 4.3: Sources of income

4.4 The farming system

The types of farming were divided into three groups where each farmer belonged to only one group. These groups were Arable farming only, Livestock farming only and an integration of crop and livestock. The results are shown on Table 4.4.

Table 4.4: Type of farming practiced by respondents

Type of farming	Percentage
Livestock only	27
Arable farming only	28
Crop-livestock integration	45

Source: Field Data, 2009

Table 4.4 shows that the idea of integrating livestock and crop on the same farm has been fairly accepted where 45% of the respondents integrate. There is an almost equal distribution of farmers involved in either livestock farming only or arable farming only. Those who practice arable farming only are mainly emerging citrus farmers.

The most common types of livestock that are kept among the small-scale and emerging farmers in the former homeland of the Eastern Cape Province include cattle, goats, sheep and chicken. On the other hand, arable farming mainly involves the production of citrus, vegetables (cabbage, spinach, potatoes, tomatoes, onion, beetroot) and crops (maize, beans).

4.4.1 Uses of animals

Most households (75%) owning animals, mainly cattle, use them for ploughing (Table 4.5). This is particularly because animal drawn ploughing is better than hand-digging using hoes and less expensive that using tractors as tractors are too expensive to hire though they do the job at a quicker rate which in some cases won't be of more benefit to farmers as they can time their activities well (Powell et al, 2004; Musemwa et al, 2008). In field activities, some responses (percentages shown on Table 4.5) have been noted where animals are used for planting, threshing and weeding. The most common use of animals in non-field activities includes its use as a form of transport where 59% of the respondents use animals for that purpose. Animals, together with carts are used to transport goods, people and more often, crops to the markets. The other uses include helping with household chores, such as fetching water, gathering wood and collecting thatch for roofing. Some households, about 29% on average, hire out their animals services to those who do not own any, as an additional source of income.

Table 4.5: Field and non-field uses of animals

Activities	Percentage respondent farmers (%)
Field activities	
Ploughing	75
Planting	10
Threshing	5
Weeding	38
Non-field activities	
Transport	59
Fetching water	45
Gathering wood	34
Collecting thatch	40
Hire service	29

Source: Field Data, 2009

4.4.2 Uses of crops

The three main uses of crops identified were consumption, sale and feeding of animals. Figure 4.4 show that most of the farmers (56%) grow their crops mainly for their own consumption. Very few farmers, about 6% grow crops for animal feed. This shows that even though people know the importance of livestock, where there exists competition between the uses of crops, farmers tend to prioritize feeding their families first before they think of feeding animals.

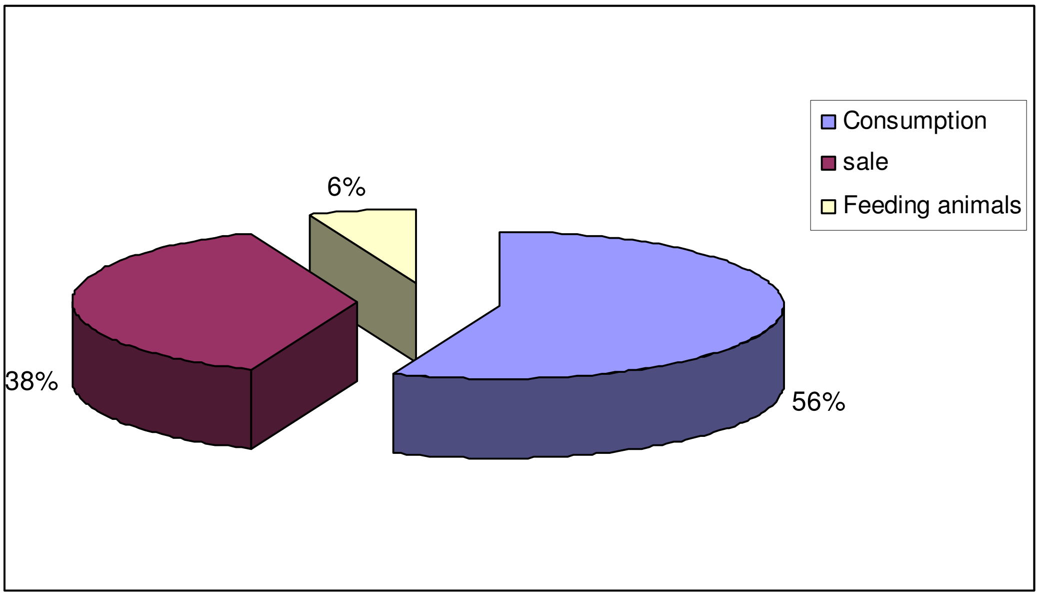

Figure 4.4: Uses of crops

Crops can only be used to supplement other sources of feed. For example, a number of small-scale farmers rely on the veld grass for feeding their animals (Aganga and Seabo, 1995). Those who sell their crops also pointed out that they only sell their surpluses. Therefore, if farmers are to be encouraged to integrate crops and livestock, it is necessary that they increase crop productivity in order to adequately provide for both household consumption and animal feeding.

4.4.3 Crop-livestock integration among sampled households

A close investigation was made on the farmers who are involved in crop-livestock integration. The most common mixes between the crops and the livestock were maize, cattle, goats and sheep. There were other cases though where vegetable farming was mixed with livestock farming. A possible explanation to a few farmers who mix vegetable farming with animal farming is that, vegetables rarely have residue that can be used to feed animals and vegetables are more affordable hence most households are able to consume them through buying hence see no need for planting them. On the other hand, crops such as maize have residues, for example stumps that are left after harvesting (Powell *et al*, 2004). When these are used for feeding animals, then animals will not be competing directly with humans. However, if animals were to have access to green feed, that would improve the productivity of animals (Stangel, 1995).

Table 4.6: Advantages of integrating crop and livestock

Advantages	Percentage
More profitable because manure for the crops is obtained from the same farm	87
Ability to cultivate larger pieces of land	79
Using animal power instead of human power shifts the use of human power to other profitable activities	73
Provides diversified income, because farmers get money from selling both livestock and crops	71
Reduces risks of losing out in times of low rainfall and where there are disease outbreaks	63
Improves the productivity of animals because they get feed from the same farm unlike where they depend entirely on the common grazing lands where they can face feed competition	54
Use of manure improves the soil fertility and allows to remain more natural for a longer period of time	46

Source: Field Data, 2009

Farmers involved in crop-livestock integration were asked about the reasons why they chose to integrate and the advantages and challenges associated with integrating. In terms of why farmers choose to integrate, the most common reasons were related to cultural preferences, economic opportunities and climate. Although Dercon (2002) states that most farmers have decided to integrate, as a way of responding to increased population densities, very few sampled farmers confirmed it. These results showing the advantages of integrating crops and livestock are presented in Table 4.6 above.

The main advantages are ranked in order of the proportion of farmers who stated them as advantages. The most common advantage, with 87% responses is the ability of getting more profits when crop production is mixed with animal production. These results show that the small-scale farmers are aware of the economic importance of their farming activities. With access to farming inputs such as manure which will be produced as the farm to substitute fertilizers which are harmful to the environment, small-scale farmers have potential to improve their economic positions more sustainably. All the advantages listed on Table 4.6 clearly indicate that the farmers involved in crop-livestock integration understand the importance of mixing the two types of farming on the same farm.

There were only three main constraints that were identified and these are listed on Table 4.7 below. The results show that although crop-livestock integration has some constraints related to it, such constraints are outweighed by the advantages. Therefore, it is important to consider crop-livestock integration system as a way of improving the welfare of small-scale farmers and find out ways of reducing the constraints.

Table 4.7: Constraints of integrating crop and livestock

Constraint	**Percentage**
It creates competition on resources, for example competition on land	47
It is difficult to manage two types of farming on the same farm and its difficult to balance attention to both the farming types	38
Use of manure only can reduce the productivity of crops	22

Source: Field Data, 2009

4.5 Household Asset Ownership

According to Stroebel (2004), household asset is the availability of agricultural related assets including the arable land, livestock and durables owned. Asset index was derived by using the livestock units coefficients that are used internationally (Chilonda *et al*, 2006). The asset index constructed in this study follows the same method as used when constructing an index variable for livestock unit. It aggregates various assets owned by the household, via the use of specific coefficients established initially on the basis of the importance or value of the assets to the household (see Appendices 2 for an overview of the most commonly used coefficients for different livestock). This index gives a comparative picture across households and the distribution of assets. Farmers who own farming related assets are more likely to produce and market their produce than those who lack assets and are likely to integrate crops and livestock.

4.5.1 Land

Land available to small-scale farmers in South Africa, like in most African countries is normally shared between residential and farming purposes (Ngqangweni and Delgado, 2003). With this given situation, less land is available for farming purposes. In addition, most smallholder farmers do not own the land they farm on, but they just have rights to use it. In such a situation, the decision on the amount of land to cultivate will depend on the means available to the farmer to cultivate the land. As shown in Table 4.8, the total amount of land available to farmers varies with different farming types.

Table 4.8: Land areas used by farmers

Farming Type	**Land areas (ha)**			
	Minimum	**Maximum**	**Mean**	**Std. Deviation**
Livestock only	0.5	4.0	1.305	0.863
Arable only	0.8	30.0	8.747	5.3733
Crop-livestock integration	0.7	42.0	17.214	4.863

Source: Field Data, 2009

In general, whereas livestock farmers use small pieces of land, there is no much difference between the land that is used for arable farming only and that for crop-livestock integration. Smaller areas of land that are used by livestock farmers can be explained by use of communal grazing land for animal feeding. In such cases, it is difficult to measure the amount of communal grazing land that is available to individual households. The larger pieces of land that were recorded are mainly used by emerging citrus farmers.

A comparison was made between the amount of land that is cultivated using either manual labour or animal labour and the results are shown in Table 4.9. Larger pieces of land were cultivated with animal drawn power as compared to the use of manual labour. These results show that crop-livestock integration can lead to the utilization of more labour. If it means cultivation of larger pieces of land leads to increased output, then crop-livestock integration can be considered as an option of increasing yield where more land is available.

Table 4.9: A comparison of cultivated areas using manual labour and animal power

Type of labour	Cultivated area (ha)			
	Minimum	Maximum	Mean	Std. Deviation
Manual	0.8	5.3	2.873	1.006
Animal Power	3	12	7.579	1.325

Source: Field Data, 2009

Animal power was also used for weeding and the results show that where animal power was used, manual labour requirement for weeding was reduced. Thus, rather than using a hoe for weeding the whole farm, manual labour was only used to weed the ridges that were left with animal drawn cultivators. These results confirm the findings in Tanzania carried out by Kwiligwa, Shetto and Rees (1994), which pointed out that use of manual labour is reduced by the availability of animal power.

4.5.2 Land ownership

The farmers were interviewed on the ownership of the land they use for agricultural purposes and the results are shown in Figure 4.5. Ownership of land can influence agriculture productivity, because farmers who do not have title deeds to the land can be reluctant to develop and maintain the land (Randela, Liebenberg, Kirsten and Townsend, 2000). Figure 4.6 shows that only 24 percent of the small-scale and emerging farmers interviewed owned and had title deeds to the land they cultivated or utilized in the year preceding the survey. Thus, the rest of the farmers have the right to use the land they are farming on, through communal permission, resettlement or rent.

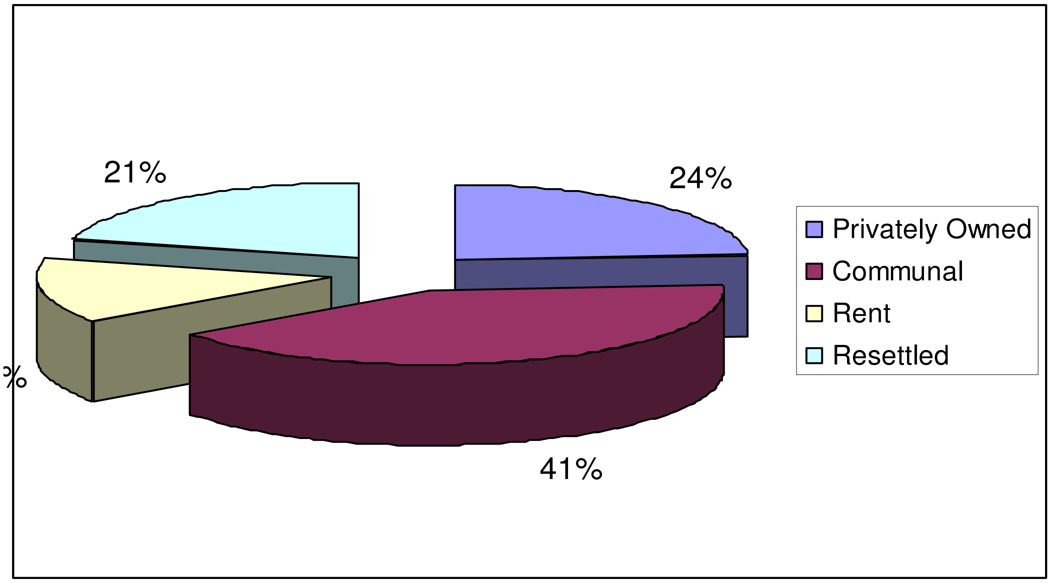

Figure 4.5: Land use system

Therefore, the fact that most farmers do not own the land they utilized for agricultural purposes can act as a disincentive to the development of farming land. In addition, farmers who do not own land or hold title deeds to land may have difficulty obtaining loans for agricultural purposes because they cannot use the land as collateral.

4.6 Institutional support

North (1990) defined institutions as rules of the game which have been formulated to govern transactions and people's behaviour. Institutions are further divided into formal and informal rules (North, 1990). In this study, North's definition is adopted. According to Kherallah and Kirsten (2001), institutions are important because they affect individual and society behaviour. They further explained that since institutions influence one's behaviour; they, therefore, influence economic performance, efficiency, economic growth and development. Of the same view, North (1990) posits that institutions are the underlying determinants of economic performance and shape the organisation of market transactions. Putting more insight to the importance of institutions, North (1990) explained that institutions provide for more certainty in human interaction. In marketing, institutions together with the technology employed determine the costs of transacting, which, in turn, determine the State's economic performance (Kherallah and Kirsten, 2001).

Farmer organizations are important means of linking producers with markets (Randela, 2005). In marketing, farmers who receive institutional support in the form of organizational support have a higher bargaining position compared to farmers operating individually. Also, farmers tend to share knowledge related to both production and marketing, within their organizations. It may also be easier to have access to credit for farmers belonging to organization than it is for individual small-scale farmers. Among the interviewed farmers, only 38% cited that they are members of farmer organizations. Those who belong to farmer organizations explained that they received financial support, market information and moral support from their organizations.

4.7 Sources of information

Information is very important to the farming business. Both production and marketing information need to be made available to the farmers in order to help them improve on their farming activities**.** Three main sources of information were identified among the interviewed farmers. The results of the survey are presented in Figure 4.6. These results show that 46% of the farmers rely on other farmers as their main source of information. Although this source of information is useful, it can be unreliable sometimes especially when the farmers reside in the same area. Under such cases, all the farmers are likely to have the same information and may not have access to other information available from other areas. Thirty-eight percent of the farmers rely on farmer organizations for information. Depending on these results, it can be pointed out that any type of information that may need to be communicated to the farmers in the study area can be done so either by meeting with the farmers or through farmer organizations.

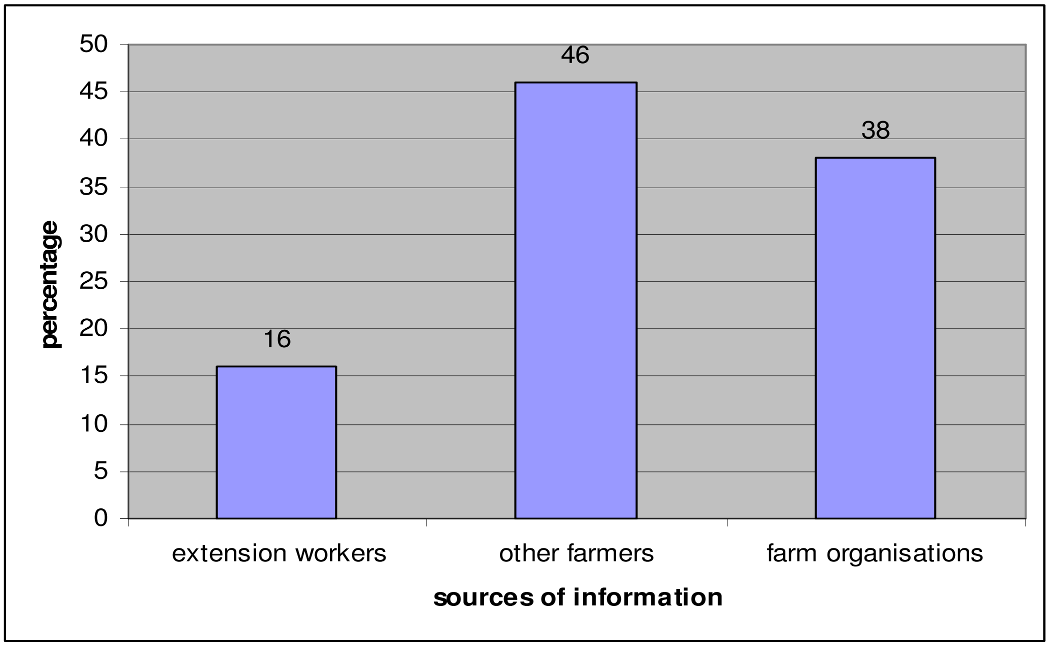

Figure 4.6: Main sources of information

4.8 Marketing

Farmers were interviewed on whether they are involved in marketing or not. A number of farmers (86%) pointed out that they only market their produce after deducting their consumption share. Marketing was less popular with livestock farmers as compared to crop/vegetable farmers. Livestock farmers pointed out that the animals serve a number of purposes, for example helping with household chores, as a store of wealth and provide other products (such as milk). Therefore, selling animals comes as a last resort. It was noted that farmers who integrate livestock and crops sold more produce compared to the farmers farming with crops only or those farming with livestock only.

4.9 Results of the Correlation Analysis

This study enumerated the farming households in the study area with respect to range standard perceptions associated with crops and livestock integration. The preliminary investigation that precedes the field survey revealed that the community members are pushed into practicing integrated crops and livestock farming because of their perceived benefits with associated farming system. These perceptions were grouped into nine distinct cases namely, source of milk production, production of meat, source of income, wealth or status symbol, food security, cultural reasons, draught power, source of manure and making feed more available for cattle. In particular, farmers were asked to rate these perceptions using a five-point Likert-type scale from 1 to 5 as follows: 1= very low, 2= low, 3= intermediate, 4= high, and 5= very high. The results of the correlation analysis are displayed in the correlation matrix in Table 4.10.

Table 4.10: Correlation analysis between certain household demographic and socio-economic characteristics and perceptions

	Meat	Milk	Revenue	Status Symbol	Food security	Culture	Draught power	Soil fertility	Feed
Gender	-0.003	0.110	-0.44	-0.33	-0.151	0.010	-0.264*	-0.033	0.271*
Marital status	-0.172	-0.142	-0.058	0.033	-0.043	-0.027	-0.199	0.090	-0.110
Age	0.104	0.104	-0.29*	-0.018	0.292*	0.035	-0.062	0.070	0.123
Education	0.097	-0.153	0.138	-0.31**	-0.383**	0.165	-0.128	0.047	0.043
Religion	0.050	0.080	-0.010	0.61	0.226	-0.136	0.105	0.218	0.184
Household Size	0.167	0.133	-0.235	0.017	0.385**	-0.173	0.011	-0.135	0.272*
Land Size	-0.042	-0.115	-0.001	-0.163	-0.544**	-0.061	-0.094	-0.136	0.375**
Arable Land	0.006	-0.065	0.088	-0.187	-0.418**	-0.002	-0.117	-0.151	-0.392**

** **Significant at 5%**

***Significant at 10%**

According to the results, the correlation analysis indicated a significant relationship between farmer's perception of food security and several variables such as age (r =0.292), education (r = -0.383), household size (r = 0.385), land size (r = -0.544) and size of arable land (r = -0.418). Gender and marital status were not statistically significant, implying that they are not important influences on farmer's opinion about integrated farming systems as a source of food security in the study area. Older farmers were found to be more likely to have positive opinions towards practising integrated farming systems to boost food security. The analyses show that at 5% level, farmers' age has a positive impact on food security, suggesting that the probability of adopting integrated farming system for the sake of boosting food security is higher among older farmers than among younger farmers. The level of education was significant at 10% implying that educated farmers also adopt crop-livestock integrated farming system to boost food security. It was also revealed that household size, land size and size of arable land are each strongly correlated with food security. The implication of these results is that adoption of crop-livestock integration in the farming system is dependent on the opinion held by the farm in respect to relative value of the practice. It is therefore crucial that farmers are very conversant with the very good quantities of the practice so that they make their decisions on the basis of knowledge.

A significant relationship was found between the perception of crop-livestock system as a rich source of feed for livestock and the four demographic and socio-economic characteristics: four variables, gender, household size, land size and size of arable land. This implies that decision whether or not to integrate crop and livestock could be influenced by household's need for animal feed. A significant positive relationship between both gender and household size and the feed perception scores implies that female household heads are more likely to adopt pushed integrated farming systems to meet animal feed requirements whilst larger households are also more likely to behaviour in a similar manner. Both land size and total size of arable land negatively influence the perception that integrated crop and livestock farming helps as a source of animal feed.

Three perceptions namely the views that integrated farming enhances household income, social status and draught power, were significantly explained by a single variable each. A significant negative relationship was found between gender and draught power. This implies that female farmers are less likely going to integrate crop and livestock for the sake of acquiring draught power relative to their male counterparts. A significant negative relationship between age and integrating as source of income implies that younger households are more likely going to integrate crop and livestock as a way of generating income relative to older farmers. Finally, the variable for education has a negative relationship with the view that crop-livestock systems can be a status symbol for the household. This implies that the educated farmers are less likely to view crop and livestock integrated farming system as a way of enhancing their image or social standing in the community.

4.10 Impact of farmers perception on the adoption of crop-livestock integration

An important specific objective of this study is to assess the extent to which farmers' perception influences the adoption of crop-livestock integration among smallholder farmers. The first step towards achieving this aim was the implementation of a correlation analysis. The purpose of the correlation analysis as has been explained is to test the strength of the linear association between the demographic and socio-economic variables and the indicators of perception so that the variables to be included in a multiple regression analysis can be identified. On the basis of those results seven separate regressions were run as follows:

(i) Total Asset on demographic and socio-economic characteristics
(ii) Total Asset on the farmers perception scores
(iii) Food security on demographic and socio-economic characteristics
(iv) Farmers' perception about feed value on demographic and socio-economic characteristics
(v) Farmers' perception about draught power on demographic and socio-economic characteristics
(vi) Farmers' perception about milk value on demographic and socio-economic characteristics.
(vii) Farmers' perception about culture value on demographic and socio-economic characteristics.

In the sections below, the relationships revealed by the foregoing regressions are presented and explained.

4.10.1 The Total Assets and Demographic and Socio-economic Characteristics

The results are presented in Table 4.11. The assertion here is that a household's belongings in terms of total assets reflecting the family's socio-economic standing will be influenced by the household head's demographic and socioeconomic background. While this is rather obvious, the purpose of this regression is to demonstrate the more omnibus impacts of the socioeconomic/demographic characteristics which are going to be subsequently used to explain differences in the perceptions about the value of crop-livestock integration.

Table 4.11: Total Asset on demographic and socio-economic characteristics

Variables		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	.612	1.741		.352	.726		
	GENDER	.587	.256	.064	2.295	.025*	.808	1.237
	MARITAL STATUS	-.105	.091	-.032	-1.159	.251	.793	1.260
	AGE	-.008	.011	-.022	-.722	.473	.677	1.477
	EDUCATION	.159	.152	.033	1.043	.301	.637	1.570
	RELIGION	.231	.599	.022	.386	.701	.183	5.457
	LANDSIZE	.076	.032	.271	2.339	.023*	.047	21.502
	ARABLE	.413	.054	.697	7.597	.000**	.074	13.518
	COMMUNAL GRAZING	.111	1.060	.003	.105	.917	.682	1.466
	INTEGRATION	.351	.230	.042	1.528	.132	.842	1.188
	TOTAL INCOME	-9.850E-5	.000	-.034	-1.132	.262	.674	1.483

Dependent Variable: TOTASST
R^2= 0.963, Adjusted R^2= 0.957, DW= 1.610
***Significance at 10%**
****Significance at 5%**

According to the results, a good deal of the variations of Total Assets from one household to the other is explained by the demographic and socio-economic characteristics of the household head interviewed in this study. The results show that the most important determinants of the level of Total Assets could be gender of the household heads and their land holding. A positive and significant relationship was found between land size (both grass land holding and cultivated land) and total assets, implying that as household belongings increase there are higher chances of household assets being substantially enhanced, a fact which can hardly be disputed. The gender variable was positively significant. As the results indicate that male farmers were more numerous in the sample, this result suggests that men were likely to command more assets in the project area than women which is also consistent with most viewpoints on the impact of gender on livelihoods in the area. The tests of model adequacy confirm that the regression analysis throws reasonable light on the determinants of wealth differences among households. For instance, the R^2 of 96% and adjusted-R^2 of 95% suggest a reasonable part of the variations are explained by the model, while the DW of 1.610 suggests minimal serial correlation.

4.10.2 Effects of Farmers Perception on Total Assets of Household

An important objective of this study was to determine how farmers' perception influenced decision to adopt integrated farming systems of crop and livestock enterprises. In order to address this question, it was decided to regress total assets on a number of indicators of farmers' perception. As indicated in the previous chapter, a Total Asset score was derived by assigning values to the durable assets owned by the household and observed by the researcher. This indicator was deemed more reliable as a measure of household socioeconomic status than reported income or production data which are often difficult to verify and may tend to be either overstated or understated. What is being examined here is to what extent the perceptions held by farmers about the relative value of crop-livestock integration influence their socio-economic standing measured by their Total Asset score. The perceptions found to be highly influential at this stage would then be followed up by investigating what socio-economic/demographic features of the respondents are consistent with such views about the relative values of crop-livestock integration. Investigating the relationships between perception and socioeconomic and demographic characteristics is useful as a basis for designing appropriate policy responses which may involve interventions to enhance access of the affected population to education, resources, etc within the context of existing socio-cultural setups.

The study revealed that local farmers hold several views about the value of crop-livestock integration, the most of which are that:

(i) It leads to enhanced profit from the crop enterprise
(ii) It leads to increased meat output
(iii) It leads to increased milk output

(iv) It is a source of draught power
(v) It is a source of manure for regenerating soil fertility
(vi) It is a source of increased farm revenue.
(vii) It is a status symbol to have diverse farm operations
(viii) It is part of the culture to diversify into crops and livestock
(ix) It is a source of food security
(x) It is a source of feed for livestock.

The results of the regression analysis are presented in Table 4.12. According to the results, perceptions in respect to crop-profit, manure, food security and feed production seemed to strongly influence the total assets. The indication is that respondents who consider making more profit from the crop enterprise as a legitimate reason to embark on crop-livestock integration are likely to be those with substantial total assets relative to their neighbours. This is an intuitively appealing finding given that such people are also more likely to be more confident to try new practices in order to explore the possibility of obtaining enhanced earnings.

For the other perceptions in respect to the usefulness of crop-livestock integration for providing manure, livestock feed, and for addressing food security, the results indicate significant negative relationships. These are very crucial findings that are also consistent with intuition. For instance, respondents who are likely to be impressed with the capacity of the alternative practice to fill gaps in the availability of manure and livestock feeds are those who are unable to meet those needs under current conditions probably because of their weaker asset base, in relative terms. So a negative relationship with total assets makes a lot of sense. This is also true for food security where it is expected that desperation to address food security goals will be more intense for people currently experiencing deprivation in one way or the other which can be manifested in low asset holding.

Table 4.12: Total Asset on the farmers perception scores

Variables		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	15.597	3.819		4.084	.000		
	Crop profit	1.245	.495	.266	2.517	.015*	.800	1.251
	Meat	.244	.277	.099	.881	.382	.703	1.421
	Milk	.194	.269	.077	.719	.475	.785	1.274
	Draught power	.412	.482	.100	.855	.396	.654	1.528
	Manure	-.701	.318	-.233	-2.202	.032*	.796	1.256
	Revenue	-.082	.244	-.034	-.336	.738	.875	1.142
	Status	-.057	.288	-.025	-.200	.842	.551	1.815
	Cultural	.629	.317	.200	1.983	.052	.880	1.136
	Food security	-2.511	.565	-.469	-4.444	.000**	.803	1.246
	Feed	-1.954	.455	-.439	-4.290	.000**	.854	1.172

Dependent Variable: TOTASST
R^2= 0.473, Adjusted R^2= 0.384, DW= 2.209
***Significance at 10%**
****Significance at 5%**

4.10.3 Relationships between Farmer's Perception and Demographic and Socio-economic Characteristics

On the basis of the results of the regression analyses presented and described above, it is concluded that the most important perceptions in respect to crop-livestock integration in the project area, for the survey period, were the importance of the practice for crop profits, manure, feed, and food security. For this reason, further regressions were run to determine the socioeconomic and demographic characteristics that best explain their variations from household to household. The purpose of regressing farmers perception is crucial for adopting crop-livestock integration on the demographic and socio-economic characteristics was to find out which factors could be manipulated by policy to achieve a desirable response in respect to the approach. The results are presented in Table 4.13 – 4.16.

As indicated above, food security was shown to be a significant motive for a sizeable number of households choosing to integrate crop and livestock enterprises in the farming system under investigation. The purpose here is to find out which socioeconomic and demographic characteristics of the farmers most closely explain the differences between households in terms of the perception that crop-livestock integration enhances food security of the household. The results appear in Table 4.13.

As Table 4.13 shows, the significant variables in this analysis were education (p=0.041), household size (p=0.017), land size (p=0.000) and arable land (p=0.002). These results suggest that these demographic and socio-economic characteristics influence the particular perception of farmers on whether to integrate or not. The implication is that respondents who are likely to consider food security an important reason to integrate would be those with larger household sizes and arable land while they may be those with less education than others. There was also a negative significant relationship with overall land size which may be consistent with a situation where respondent does not face the constraint to obtain adequate feed for the livestock. It is possible that persons owning large land areas are those who have

Table 4.13: Food security on demographic and socio-economic characteristics

Variables		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.580	.721		4.964	.000		
	GENDER	.227	.167	.132	1.360	.179	.860	1.163
	MARITAL STATUS	-.012	.060	-.020	-.203	.840	.817	1.223
	AGE	.003	.007	.050	.479	.634	.755	1.325
	EDUCATION	-.199	.095	-.220	-2.089	.041	.735	1.360
	RELIGION	.686	.404	.358	1.699	.094	.183	5.463
	HOUSE HOLD SIZE	.060	.025	.240	2.443	.017*	.840	1.191
	LANDSIZE	-.083	.021	-1.581	-3.895	.000**	.049	20.290
	ARABLE	.106	.032	.956	3.253	.002**	.094	10.635

Dependent Variable: food security
R^2= 0.505, Adjusted R^2= 0.440, DW= 1.954
*** Significance at 10%**
**** Significance at 5%**

access to communal grazing land and therefore can always obtain feed for their livestock whenever they need to.

The perceptions regarding the importance of obtaining feed for livestock as a reason for integrating crop and livestock on farms were investigated by regressing that farmers' perception on demographic and socio-economic characteristics. The results are presented in Table 4.14. However, the analysis failed to reveal any meaningful patterns in the relationships between this variable and the set of socioeconomic and demographic variables included in the model. The results show that the only significant variable in this analysis was gender (p=0.020), while very little of the total variations are explained by the model.

Table 4.14: Farmers perception about feed value on demographic and socio-economic characteristics

Variables		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.741	1.021		2.685	.009		
	GENDER	-.564	.237	-.272	-2.382	.020*	.860	1.163
	MARITAL STATUS	-.023	.085	-.031	-.267	.791	.817	1.223
	AGE	.009	.010	.103	.843	.403	.755	1.325
	EDUCATION	.267	.135	.245	1.979	.052	.735	1.360
	RELIGION	-.039	.572	-.017	-.069	.945	.183	5.463
	HOUSE HOLD SIZE	.041	.035	.137	1.185	.240	.840	1.191
	LANDSIZE	-.004	.030	-.057	-.119	.906	.049	20.290
	ARABLE	-.051	.046	-.386	-1.117	.268	.094	10.635

Dependent Variable: Feed
R^2= 0.315, Adjusted R^2= 0.225, DW= 1.551
*** Significance at 10%**
**** Significance at 5%**

As indicated above, there are perceptions that crop-livestock integration is valuable for its contribution in generating organic manures for purposes of restoring and enhancing soil fertility. The extent to which this particular perception was important and what factors determine such views were interrogated by regressing that perception on the same set of demographic and socioeconomic characteristics. The results are presented in Table 4.15 below.

Table 4.15: Farmers perception about manure on demographic and socio-economic characteristics

Variables		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.010	1.734		.006	.995		
	GENDER	.073	.403	.024	.182	.856	.858	1.166
	MARITAL STATUS	.023	.145	.022	.161	.873	.824	1.214
	AGE	.014	.018	.112	.800	.427	.753	1.327
	EDUCATION	.319	.231	.197	1.383	.172	.731	1.367
	RELIGION	1.328	.977	.224	1.360	.179	.551	1.816
	HOUSE HOLD SIZE	-.075	.060	-.166	-1.239	.220	.833	1.201
	LANDSIZ	.008	.033	.091	.256	.799	.118	8.447
	ARABLE	-.037	.069	-.189	-.540	.591	.122	8.206

Dependent Variable: Manure
R^2=0.106; Adjusted R^2= -0.014; DW=1.23
***Significance at 10%**
****Significance at 5%**

The analysis shows that regressing farmers' perception about soil fertility/manure on demographic and socio-economic characteristics does not help in clarifying the picture. The results show that none of the regression coefficients associated with the explanatory variables showed any significance. Expectedly, the proportion of the variations explained by the model is quite insignificant, especially when the sample size is considered (see the negative adjusted R-squared). There is also evidence that, even if the model could have been helpful in explaining some of the variations, it suffered from considerable serial correlation (DW=1.23). Thus, much as some households who integrated may have done so because of their expectation of obtaining adequate amounts of manure to maintain or restore soil fertility, this was not statistically significant and may have been important only in a limited number of cases.

As was noted earlier, the possibility of realizing increased profits from the crop enterprise as a result of tapping the synergies between crop and livestock enterprises was mentioned in a few cases. Since this variable showed some significance as a determinant of the total assets scores of the household, it was decided to follow up on the analysis by investigating the factors that may exert important influence on such perceptions. The results are presented in Table 4.16.

Table 4.16: Farmers perception about crop profit on demographic and socio-economic characteristics

Variables		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	.559	.976		.573	.569		
	GENDER	.018	.227	.010	.081	.935	.858	1.166
	MARITAL STATUS	-.084	.081	-.123	-1.027	.309	.824	1.214
	AGE	.037	.010	.460	3.680	.001*	.753	1.327
	EDUCATION	.237	.130	.231	1.822	.073	.731	1.367
	RELIGION	.677	.549	.180	1.232	.223	.551	1.816
	HOUSE HOLD SIZE	-.062	.034	-.217	-1.823	.073	.833	1.201
	LANDSIZ	.022	.019	.367	1.163	.249	.118	8.447
	ARABLE	.002	.039	.016	.051	.959	.122	8.206

Dependent Variable: crop profit
R^2=0.294; Adjusted R^2= 0.199; DW = 1.602
***Significance at 10%**
****Significance at 5%**

The analysis shows that regressing farmers' perception about crop profit on demographic and socio-economic characteristics does not help a great deal in clarifying the picture. The results show that the only significant variable in this analysis was age of the household head (p=0.001), while very little of the total variations is explained by the model which shows R^2 of 29% and adjusted R^2 of 20%, despite a fairly acceptable Durbin Watson statistics of 1.60.

4.11 Results of the Logistic Regression Analysis

A key objective of this study was to determine the major factors influencing the decision of the households to engage in crop-livestock integration and what obstacles they confront in the process. Given the dichotomous nature of the dependent variable in this case, this required that a binary logistic regression model be fitted alongside the other analyses already undertaken and discussed. The results of the analysis are presented in Table 4.17. The procedure began with the inclusion of all the variables identified in the correlation analysis and follow up multiple linear regressions as potentially key explanatory variables. The initial runs exhibited very high levels of insignificance. As a result, the variables were deleted by backward elimination to achieve parsimony in the model. All 70 cases were included in the analysis. The Nagelkerke R Square value of 0.50 shows that about 50% of the variation in the outcome variable (integration of crops and livestock) is explained by this logistic model with the Cox & Snell R square indicating that this is not likely to fall below 35%. These indications in respect of the model adequacy are supported by the results shown in Table 4.17 for both the Wald estimates and the p-values. For instance, p-values of 0.002, 0.049, 0.07 and 0.049 are associated with the variables age, perceptions of high milk and meat yield and total income, respectively (Table 4.17). Interestingly, the Total Income predictor which was hardly helpful in the linear model came out to be highly significant in the binary choice model which may reflect the non-linearity of this particular variable rather than a reflection of the nature of the overall model fitted.

Table 4.17: Effect of socio-economic factors on participation in the integration of crops and livestock

Variable	B	S.E.	Wald	Sig	Exp (B)	95% C.I. for EXP(B)	
						Lower	Upper
Constant	-12.517	3.901	10.296	0.01	0.000	-	-
Age	0.140	0.045	9.705	0.002**	1.151	1.053	1.257
Arable land	-0.157	0.296	2.386	0.122	0.633	0.355	1.131
Meat	0.483	0.246	3.859	0.049*	1.622	1.001	2.627
Milk	0.621	0.231	7.218	0.007**	1.861	1.183	2.928
Manure	0.207	0.299	0.481	0.488	1.230	0.685	2.210
Total Assets	0.786	0.497	2.501	0.114	2.195	0.828	5.814
Total income	0.001	0.000	3.887	0.049*	1.001	1.000	1.001

Overall, of the seven variables hypothesized to explain the farmers' adoption behaviour of an integrated livestock and crop farming system, four were found to be significant at 5% probability level. There are a few interesting implications that can be drawn from these results. Taking the continuous variables first, the evidence from the values of the odds ratios can be examined in the case of age and total income. In the case of age, there is the suggestion that the odds of a farmer adopting crop-livestock systems are 1.151 times higher for older persons than for one who is younger. This implies that the older a person is, the more likely s/he will adopt crop-livestock integration. According to the values shown in Table 4.17, an increase in age by one year can produce a positive response towards adoption by as much as 15% on the average, with a 5% probability that this such a response can range from as low as 5% to nearly 26% (95% CI 5.3% to 25.7%) of adopting integrated livestock and crop farming system.

The odds ratios can also be interpreted in a straightforward manner in the case of the total income predictor. According to Table 4.17, the odds ratio associated with this variable is 1.001. Since this is a positive value greater than 1, there is an implication of an increase in the odds of the respondent adopting crop-livestock integration for every one unit increase in total income. Such a result is consistent with the expectation that smallholder farmers will be less eager to adopt a practice with uncertain outcomes when they have difficulty financing the initial investment in the first place. Households with higher income and existing wealth are undoubtedly more likely to take risks and embark on exploratory investments than those households with weaker resource bases, all things being equal. It must be noted however that in this case, the range over which the income predictor influences adoption decisions is quite narrow when assessed at the 5% alpha level (95% CI 0.0% to 0.1%). This result with respect to the rather narrow confidence interval in the smallholder setting being evaluated in this study probably reflect the multiple influences that these farmers are subject to, including cultural considerations which can sometimes exert stronger influences on the decision process than other factors.

For the variables that have been based on the 5-point Likert Scale, namely the farmers' perception of the importance of meat and milk as motives for integration, the interpretation is similar to the case of categorical variables with more than two categories, in this case five categories. The perceptions of respondents in this respect have been ranked according to the strength of their perceptions from weak (ranked 1) to very strong (ranked 5). In the case of the respondents who are of the opinion that more meat production is a reason for integrating, the results suggest that the odds of a household integrating crops and livestock increases the stronger the views of the respondent in respect to the meat value of the farming approach. Thus, households whose heads think that crop-livestock integrated system yields higher meat output are more likely to adopt the approach than households whose heads hold less strong views in that regard. The stronger the perception of the household the more likely is the household to adopt crop-livestock integration. In numerical terms, the results suggest that the odds of adopting integrated crop-livestock system is 1.6 times higher between successive ranks on the scale as we move from the weakest viewpoint of 1 to the strongest viewpoint of 5, all things being equal (i.e. if farmers' perception were the only determinants of adoption of crop-livestock integration). Given the results, it seems that this influence of perception may be even stronger at higher rankings of the perception in view of the relatively wide range of values indicated at 95% confidence interval (95% CI 1.0 to 2.6). The results in the case of the perceptions about the contribution of crop-livestock integration to milk production lead to similar conclusions, with the likelihood of integration being estimated at 1.9 times higher for those with stronger views compared to those with less strong view. Again, in the case of milk, there seems to be a possibility that stronger views will elicit much larger responses in terms of the adoption of the practice than weaker views given the observed confidence interval (95% CI 1.2 to 2.9).

4.12 Summary

This chapter has presented the results of various analysis carried out as part of this study. At the outset, the results of the descriptive analysis are presented and discussed to profile the demographic and socio-economic characteristics of the farming households enumerated as part of this study. The gender distribution of the sampled farmers shows that more men than women are involved in farming. For married couples, even women usually take care of the daily operations of the farms, the main decisions regarding the farm activities are usually made by men. The results related to age show that older people are more interested in the farming business than the younger people. It was revealed that the educational level among the sampled farmers is generally low, with quite a number of the farmers never having completed primary schooling. Without a doubt, the low educational levels among the farming households present a challenge to development programmes in the area.

The results of the inferential analysis regarding the determinants of household's decision to integrate and their perceptions about the relative value of the practiced are also presented and discussed. The indication is that is possible to improve the welfare of the farmers by integrating crop and livestock enterprises. The evidence for this is that strong associations were established between the perceptions that integrated systems is crucial for enhanced food security and also for adequate access to field for livestock. Food security programmes linked to such practices therefore have a very good chance of succeeding than other schemes. Even though farmers are aware of the importance of integrating crops and livestock, they still face some challenges when integrating. Therefore, ways of improving the crop-livestock integration system need to be developed and made available to the farmers. The farmers are likely to obtain greater benefits from crop-livestock farming and their livelihoods are likely to be improved, and sustainability of the farms is also likely to be improved.

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The Eastern Cape has immense potential for the integration of livestock and crops in the farming system in view of the rainfall patterns and soil conditions which permit such enterprise combinations. But households whose means allow only small-scale operations are highly vulnerable to a wide range of other factors, including their own perceptions about the relative profitability and sustainability of the systems and this can often become a binding constraint to adoption of good agricultural practices. Again, while integration of livestock and crops could be the only means for achieving food security and improvement of overall livelihoods for the generality of rural dwellers, available arable land is continually being depleted as a result of population growth and competition with other economic activities. Urbanization is also contributing to the decline in the stock of available land.

This chapter therefore gives the summary of the study as well as strategies for improving the productivity of the integrated crop and livestock farming system. A brief conclusion is also part of this chapter. Finally, the chapter identifies and presents areas for further research on the integration of crops and livestock in the smallholder communal agriculture.

5.2 Summary

The main body of thesis is divided into 4 chapters which covered the introduction and background of the study, the literature review, methodology and area of study, and the presentation of results of the research. In this section, each of the foregoing chapters will be summarized, highlighting the main issues covered and how that links to the overall theme of the thesis. These summaries are presented in the next several sub-sections.

There is no need to for sub-sections in this part.

5.2.1 Introduction and Background of the Study

The increasing pressure on land and the growing demand for livestock products makes it more and more important to ensure the effective use of feed resources, including crop residues. The necessity of integrating livestock and crop husbandry is becoming more pronounced due to deterioration in soil fertility, high cost of inorganic fertilizers and scarcity of fodder for livestock particularly during the dry season. The purpose of this study is to gain deeper understanding of the farming systems as it pertains to the integration of crops and livestock. The main objective of the study is to investigate the farmer's perception of the relative importance of crop-livestock integration in the small holder farming systems. This entailed the assessment of farmers' perception regarding the relative value of crop-livestock integration and the extent to which they consider that it can be a viable path out of poverty for them. The main hypothesis of the study is that there are significant variations in farmer's perception of the relative importance of crop-livestock integration in the small holder farming systems in the former Ciskei. Thus, it is hypothesized that farmer's decision about whether or not to integrate crop and livestock enterprise on their small farms is influenced by their perception about relative profitability and other attributes of the system. The research fits well into current policy focus on black economic empowerment in Agriculture, agricultural restructuring, integration of the black population in the agricultural economy of South Africa, poverty reduction, as well as sustainable natural resource management.

5.2.2 Literature Review

According to the literature, crop-livestock integration is an effective means by which waste can be recycled rapidly. Same/higher level of output can be achieved with integrated farming, using relatively less inputs. The yield would be inherently more sustainable because the waste of one enterprise becomes the input of another, leaving almost no waste to pollute the environment or to degrade the resource base. Farming with both crop and livestock permits wider crop rotations and thus reduces dependence on chemicals. Since mixed systems is viewed to be closer to nature and allows diversification for better risk management, it is considered sustainable. Integration of crop and livestock has tended to intensify over the years and has been adopted by both smallholder farmers and commercial farmers. The combination of Livestock and Crop activities had helped small-scale farmers from almost all over the world, to use manure as fertilizer for crops, and the crop residues as feed for livestock. Mixing crops and livestock on the same farm has both advantages and disadvantages. The importance of these advantages and disadvantages differ according to the socio-cultural preferences of the farmers and to the biophysical conditions as determined by rainfall, radiation, and soil type and disease pressure. The main drawbacks associated with integrated farming include that nutritional values of crop residues are generally low in digestibility and protein content and chemical fertilizers are easy to use and act faster than manure.

According to the contemporary literature, the renewed interest in crop-livestock integrated farming is a response to the disappointing results of the specialization approach and is motivated by a belief that the system improves the output of both crops and livestock products. In other words, in situations where the approach has been adopted within a systematic setup, the main goal has been to improve the efficiency of the farming systems. However, in order to optimise productivity, crop-livestock interaction needs to be enhanced through development and dissemination of appropriate crop-livestock conditions and technologies that take account of the technical, economic, social and environmental dimensions.

There are also differences in the extent to which different groups of farmers benefit from integrated farming systems. According to a number of research studies in comparison to commercial farmers, it is often argued that the poorest smallholders benefit the most from integrating livestock with crops because the extent of reduction in the vulnerability to risk is greater for smallholders than for commercial farmers and because of the much greater opportunities created for recycling and maintaining soil productivity. As already noted, the integration of crop and livestock production into the same farming unit is an evolutionary process principally determined by differences in climate, population densities, disease, economic opportunities, and cultural preferences. These factors were divided into external and internal factors. External factors have been identified clearly as weather patterns, market prices, political stability and technological developments, among others. Internal factors, on the other hand include such factors as local soil characteristics, composition of the family and farmers' ingenuity.

Several practices of integrated crop-livestock systems have been noted throughout the world. For example, farmers in Ghana defoliate maize tops and cut leaves from standing maize before grain harvest to feed animals. Feeding animals in such a way helps to alleviate feed stress during the late wet season/early dry seasons, where there is restricted animal movement and people are busy with cropping. A clear advantage of this method is that the animals benefit from the more nutritious green material. Animals can also be used as a form of transport, labour and can reduce postharvest losses from pests by allowing timely removal of crops from the fields. Animal transport can also be used to move crop produce to the market, increasing the chances of selling crops at desired prices. Literature shows that small-scale farmers with a cart and animals can get a higher price for their goods since they can sell directly to markets. Farmers using animal power also find it easier to move manure and fertilizer to the field.

Literature reveals that Crop-Livestock Integration is a conceptually vast subject which embraces several conceptual and theoretical issues. Some of the most common conceptual and theoretical issues include food security, commercialization, agricultural intensification, sustainability, intra-household bargaining and resource allocation, technical efficiency, gender, among others. Several studies on crop-livestock integration have approached the subject from an adoption perspective, looking at the determinants of household decision to adopt practices that optimize a wide range of household objectives. For these reasons, the agricultural economics literature presents a wide diversity of models that look at different aspects of crop-livestock integration some of which will be briefly reviewed in this section.

To a large extent, the bulk of the recent literature on the subject has reflected a huge intellectual interest in the aspect of the role of crop-livestock integration on sustainable natural resource management. In the research carried out by the Future Harvest Centres around Africa and Asia, there has been considerable interest in exploiting the high degree of interdependency inherent in the system whereby products and by-products are recycled internally, thus promoting resource use efficiency.

The chapter reviewed the literature on Crop-Livestock Integrated Systems as an option to improve productivity among small-scale farmers. It has been highlighted that if properly managed, these integrated farming systems can be a powerful tool for poverty reduction and socio-economic empowerment of the rural population. Also, Crop-Livestock integration systems have been identified in the literature as being sustainable because they promote the interaction of animals and plants in as natural condition as possible. The advantages associated with this system have been identified as an improvement in productivity and increased incomes, in addition to a range of benefits that include agronomic, ecological, economic and social sustainability. The disadvantages of the system have also been identified. The main constraints faced by small-scale farmers who integrate crop and livestock are reduction in yields both for crops and livestock. For example in crops use of manure as a substitute of fertilizers reduces yield as manure acts more slowly and is not rich in nutrients compared to chemical fertilizers. For livestock, nutritional values of crop residues are generally low in digestibility and protein content and this in turn reduces body condition and height of livestock than using concentrate feeds. Finally, the review examined the conceptual and analytical framework employed in the large number of research conducted on the subject matter of crop-livestock integration, showing that the bulk of these studies have assumed a modified household model and have employed diverse statistical and econometric procedures for analyzing the resulting data.

5.2.3 Area of Study and Methodology

The research was conducted in three towns of the Nkonkobe Local Municipality. Stratified random sampling method was applied in order to select 70 small scale and emerging farmers. A semi-structured questionnaire was the major tool used for data collection and was administered through face to face interviews. The questionnaire was designed to capture data on production, marketing and farmers perceptions factors that influence household decision to integrate crops and livestock in the farming system. The variables that were to be used in the models were described and divided into continuous and categorical variables.

Data analysis was performed using SPSS version 18. Descriptive statistics were applied on the basic characteristics of the demographics and socio-economic backgrounds of the sampled households. Following these, the study carried out several inferential analysis, including correlation model, a series of multiple linear regression analysis in which total assets are used as the dependent variable to identify the perception of farmers on integration crops and livestock and three diagnostic tests to detect used; the serial correlation, heteroskedasticity, and the multicollinearity and to determine the factors influencing choices of crop-livestock integration. A binary logistic regression equation was also fitted to determine the factors influencing farmers' perception and how these in turn contribute to the decision to adopt or not to adopt crop-livestock integrated farming system in Nkonkobe municipality.

5.2.4 Presentation of Results

In respect to these, the descriptive analysis made use of means, standard deviation and measures of skewedness. The descriptive results provided information related to the demographic and socio-economic profile of the sample, looking specifically on variables such as gender, age, educational level, reported income and revenue earned, an asset index derived from household assets owned, and livestock ownership. The most interviewed farmers about 71% were married men and had at least primary education. Fifty percent of the farmers fall in the age range of between 50 and 59. The majority of the respondents (59%), regard farming (includes both crop and livestock farming) as their main source of income. The idea of integrating livestock and crop on the same farm has been fairly accepted where 45% of the respondents integrate. The most common mixes between the crops and the livestock were maize, cattle, goats and sheep. Most of the farmers indicated that crop-livestock integration was a more profitable venture than specializing in either crops or livestock. The main constraints identified by the farmers include the creation of competition on resources, for example competition for land.

Correlation analysis is described as one of the most common and useful statistics employed to determine the extent of linear association between two independent variables. The measure of the degree of correlation is the correlation coefficient. A correlation coefficient is a single number that measures the degree of relationship between the two variables. The results this study enumerated the farming households in the study area with respect to range standard perceptions associated with crops and livestock integration. These perceptions were grouped into nine distinct cases namely, source of milk production, production of meat, source of income, wealth or status symbol, food security, cultural reasons, draught power, source of manure and making feed more available for cattle. The analyses show that at 5% level, farmers' age has a positive impact on food security, suggesting that the probability of adopting integrated farming system for the sake of boosting food security is higher among older farmers than among younger farmers.

The level of education was significant at 10% implying that educated farmers also adopt crop-livestock integrated farming system to boost food security. It was also revealed that household size, land size and size of arable land are each strongly correlated with food security. The implication of these results is that adoption of crop-livestock integration in the farming system is dependent on the opinion held by the farm in respect to relative value of the practice. It is therefore crucial that farmers are very conversant with the very good quantities of the practice so that they make their decisions on the basis of knowledge. A significant relationship was found between the perception of crop-livestock system as a rich source of feed for livestock and the four demographic and socio-economic characteristics: four variables, gender, household size, land size and size of arable land. This implies that decision whether or not to integrate crop and livestock could be influenced by household's need for animal feed. A significant positive relationship between both gender and household size and the feed perception scores implies that female household heads are more likely to adopt pushed integrated farming systems to meet animal feed requirements whilst larger households are also more likely to behaviour in a similar manner. Both land size and total size of arable land negatively influence the perception that integrated crop and livestock farming helps as a source of animal feed.

An important specific objective of this study is to assess the extent to which farmers' perception influences the adoption of crop-livestock integration among smallholder farmers. An impact of farmers' perception on the adoption of crop-livestock integration, using variations of Total Assets from one household to the other is explained by the demographic and socio-economic characteristics of the household head interviewed in this study. According to the results show that the most important determinants of the level of Total Assets could be gender of the household heads and their land holding. As the results indicate that male farmers were more numerous in the sample, this result suggests that men were likely to command more assets in the area than women which is also consistent with most viewpoints on the impact of gender on livelihoods in the area. The tests of model adequacy confirm that the regression analysis throws reasonable light on the determinants of wealth differences among households.

The results of the inferential analysis regarding the determinants of household's decision to integrate and their perceptions about the relative value of the practiced indicate the possibility of improving the welfare of the farmers by integrating crop and livestock enterprises. The evidence for this is that strong associations were established between the perceptions that integrated systems is crucial for enhanced food security and also for adequate access to field for livestock. Food security programmes linked to such practices therefore have a very good chance of succeeding than other schemes. Even though farmers are aware of the importance of integrating crops and livestock, they still face some challenges when integrating. Therefore, ways of improving the crop-livestock integration system need to be developed and made available to the farmers. The farmers are likely to obtain greater benefits from crop-livestock farming and their livelihoods are likely to be improved, and sustainability of the farms is also likely to be improved.

5.3 Conclusion

From all indication, the sustainability and contribution of integrated crop-livestock farming system can be enhanced by breaking the barriers to adoption of the practices as well as addressing the constraints faced by the farmers who have already adopted in order to improve the efficiency of the system. In South Africa, the integration of grains and livestock constitutes a new paradigm for agriculture and animal husbandry. There are benefits in terms of productivity and resource use efficiency. Without a doubt, the diversity of farming activities may increase the stability of the production of the farm and reduce risks for resource-poor households, whereas integration of activities using the outputs of one activity as input in another activity may reduce dependency on external resources. These systems have the potential to increase grain, meat and milk productivity and to reduce the risks of degradation of natural resources.

The results of the study reveal that small farmers in the Nkonkobe municipality have the possibility of realizing immense benefits from the integrated systems which also have the potential to lead to substantial improvements of the physical, chemical and biological soil properties. There is clear evidence of widespread interest to experiment with the practices based on the strong positive perceptions that a majority of the survey farmers exhibited during the course of the survey. But the farmers are facing challenges in coping with the associated complexities of competition on land, and management skill which are often in limited supply. It seems also that there is reduction in crops yield due to use of manure as a substitute of fertilizer.

5.4 Recommendations

For a number of farmers food security is the crucial role which motivated them to practice crop-livestock integration. If farmers can be educated this will increase the rate of adoption of crop-livestock farming system. The implication is that adoption of crop-livestock integration in the farming system is dependent on the opinion held by the farm in respect to relative value of the practice. It is therefore crucial that farmers are very conversant with the very good qualities of the practice so that they make their decisions on the basis of knowledge.

Through government policy of land redistribution, small scale farmers who will be using their land more efficiently must be given more land if they are not satisfied with the size of land they currently own. Also the provision of title deeds in order for farmers to manage to motivate farmers to practice more farming related activities. Constraints to integrating crops and livestock include the competition for resources, especially land. Managing two types of farming on the same farm was perceived as difficult and many respondents held the view that use of waste of one enterprise as input to the other enterprise can reduce productivity. For example some farmers considered that the use of manure to improve soil fertility may not lead to output growth to the same extent as the use of fertilizer.

Complementation of inputs rather than substituting inputs is required to render the system more productive and sustainable as costs are minimized and output is boosted. Animal manure alone cannot meet crop requirements, even if it does contain the kind of nutrients needed. This is because of its relatively low nutrient density and the limited quantity available to small-scale farmers. Alternative sources for the nutrients need to be found. Growing fodder legumes and using them as a supplement to crop is the most practical and cost-effective method for improving the nutritional value of crop residues. This combination is also effective in reducing weight loss in animals, particularly during dry periods. External sources of nutrients (such as nitrogen and phosphorus fertilizers, and feed supplements) are required to render the system more productive and sustainable.

5.5 Suggestions for further research

A cost benefit analysis of crop-livestock integration has to be conducted on a bigger scale in most developing countries that are practicing this farming system against those that are practising either crops or livestock farming system. In addition the profitability has to be compared between commercial and small scale farmers and also across regions as this will give us a clear picture of whether or not to advise farmers to adopt this farming practice. A more elaborate research is necessary to accurately quantify the effects of these constraints to small scale farmers adopting crop-livestock integration has to be contacted in other parts of South Africa as region might be having an effect on importance, constraints and opportunities for crop and livestock integrated farming system. On station research have to be done to determine the best livestock and crop combination that yield the highest economic returns from the limited resources that small scale farmers have access to.

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APPENDICES

Appendix 1: Questionnaire

Integrated Crop-Livestock Farming System for Sustainable Economic Empowerment of Small-scale and Emerging Farmers in the former Homeland of the Eastern Cape Province of South Africa.

All information provided by interviewee will be treated as STRICTLY CONFIDENTIAL for mutual benefit of both the researcher and the respondents.

Questionnaire number…………………… Enumerator name………………...…

Municipality Name…………………….. Community name…………………...

Name of respondent…………………….. Date...……………………………….

A. HOUSEHOLD DEMOGRAPHIC INFORMATION				
1. Head of household				
a. Sex	Male			
	Female			
b. Marital status	Married	Single	Divorced	Widowed
c. Age				
d. Highest level of education				
e. What is your principal occupation?				
f. What is your religion	Christianity	Traditional	Muslim	Other (specify)
g. What is the size of your household?			Adults	Children
		Male		
		Female		

B. LAND OWNERSHIP AND USE
1. How much land do you own (ha)?
2. How much land is arable (ha)?

3. How much land is used for grazing (ha)?		
4. Is grazing communal? *(If not specify):*	Yes	No

5. What crops/Tree did you grow last season? (Rank 1 as the most commonly grown)				
Crop	Rank	Area (ha)	Purpose of production	
			Consumption	Sale

6. What type of livestock species do you keep? (Rank 1 as the most important specie)						
	Class	Cattle	Goats	Sheep	Chickens	Other (specify)
	Number					
	Rank					

B. PERCEPTION ASSESSMENT

1. What are your sources of income? (Rank 1 as the most important source of income)

	Source	Amount raised	Rank
	Crops/Trees		
	Livestock		
	Salary/wages		
	Pension		
	Other (specify)		

2. For how long have you been involved in cattle production (nearest year)	
3. For how long have you been involved in crop/tree production (nearest year)	

4. Indicate how important each of these items is (scale of 1-5 with 1= least important, 5= most important) reason for integrating crop-livestock Why do you keep livestock?

Scores	1	2	3	4	5
Profcrop					
ResMeat					
ResMilk					
ResDraftpower					
ResManure					
ResSales					
ResCulture					
ResConsumption					
ResFeed					

6. Are you affiliated to farmer organization	Yes	No
7. What are your reasons for the answer given?		
8. If yes, which one(s) are you affiliated to?	Crop	Livestock

9. What are the benefits of being a member of this organisation?		
10. Have you ever applied for credit?	Yes	No
11. What are your reasons for the answer given?		
12. Do you integrate crop and livestock?	Yes	No

D. PRODUCTION RELATED PROBLEMS		
1. What problems are you facing in raising your livestock		
Problem	Rank	Possible solution
Shortage of feed resources		
Shortage of water		
High mortality		
Parasites and disease		
Lack appropriate skills for livestock production		
Poor extension		
Veterinary services		
Stock theft		
Other (specify)		
2. What problems are you facing in growing your crops/trees		
Problem	Rank	Possible solution
Lack of capital to purchase inputs		
Labour shortage		
Shortage of tillage equipment		
Poor soil fertility		
Shortage of water		
Equipment		
Disease		

	Lack appropriate skills for crop production		
	Poor extension		
	Theft		
	Other (specify)		

E. LIVESTOCK MANAGEMENT							
1. What is the condition of your animal? (Scale 1-5. 1 for poor and 5 for exellent) and How many provide draught power?							
Class	Cattle	Goats	Sheep	Pigs	Chickens	donkeys	Horses
Condition							
Number							

2. What are the sources of feed for your livestock? (Tick 1 or more)

	Source	Cattle	Sheep	Goats	Pigs	Chicken
	Veld					
	Pasture					
	Conserved feed					
	Own Crop residues					
	Bought-in feed					
	Food left over					
	Grain					

3. How do you describe the condition of your grazing lands?

Condition	Tick	Condition	Tick
Extremely deteriorating- Very Poor Condition		Good - Plenty Grass	
Deteriorating -Poor Condition, but Some Grass		Very Good-Improving	
Fair - Reasonable Amount of Grass		I don't know	

4. What are the reasons that have led to the current state of rangelands?

	Poor grazing management	Fire	Poor soils	Low rainfall	Bush encroachment	Other

5. Do you provide supplementary feeding to your livestock? (Y- Yes and N for No)

Goats	Sheep	Pigs	Chickens	Other (specify)

6. What are the most prevalent diseases in your area? (Rank 1 as the most common) State season of high prevalence and control measures for the named diseases and parasites.

Diseases	Rank	Season of high prevalence	Animals affected	Control

7. What are the most common livestock predators in your area?

8. Do you keep livestock records	Yes	No

9. Give reasons for the above

F. CROP MANAGEMENT

1. How do you describe the condition of your arable lands?

Class	Very Poor	Poor	Fair	Good	Excellent	Don't know
Condition						

2. What are the sources of inputs you use?

	Source	Seeds	Herbicides	Labour	Equipment	Fertilizers
	Government					
	Buy from Shops					
	Given by friends					
	My last year harvest					
	From a donor					
	Belong to a project					

	From the household					
	Hired					
	Other					

3. What do you use to improve soil fertility? (you can mark more than one)	fertilizers	manure	nothing
4. What agricultural equipment do you own	Tractor		
	Plough		
	Sprayer		
	Cart		
	Hoes		
	Draught power		
	Other (Specify)		
5. Are your fields fenced?	Yes		No
6. How far are your fields from your homestead? (specify)			
7. Do you irrigate your crops	Yes		No
8. If yes, when? If no, why?			
9. Do you keep crop records?	Yes		No
10. Give reasons for the above			

G. MARKETING				
1. Which markets do you usually use for selling your produce?				
	MARKET	Crop	Livestock	Tree
	Formal markets			
	Informal markets			
	I do not sell			
For crop and tree farming only				

2. Approximately, how much produce did you sell in the previous season?	Crop/tree	Quantity	Price

3. Where do you sell most of your produce to?	Place	Tick as appropriate	Reason
	Farm gate		
	Around the village		
	Road side		
	Nearest town		
	Other countries(export)		
4. Do you always find a market for all the goods you produce?		Yes	No

5. If NO, what happens to the unsold produce? Mark with an X.	Use as feed	Throw away	Eat	Reduce price	Proces s

For livestock farming only

6. How many livestock did you sell between 2008 and 2009 and where?	Species	Market	Distance

All enterprises

7. How difficult is it to look for buyers?	Easy	Fair	Difficult

Mark with an X.			

8. Which marketing systems are available in your area?

	Crops	Livestock	Trees

9. Which marketing systems are you not satisfied with?	Market	Reason

10. How is your produce moved to the marketing points? (Tick as appropriate)

	Crop	Livestock	Tree	Distance	Cost
Own transport					
Hired vehicles (individual)					
Hired vehicle (group)					
Public transport					
Buyers transport					
Move animals by foot /head balancing crops					
Other (specify)					

11. What general problem do you experience in moving your produce?

	Small size of transport	Lack of transport	High transport cost	Other (Specify)

12. When selling, do you combine with other farmers?

	YES	Reason	NO	Reason
		It lowers costs		You don't sell at the same time
		Increases bargaining power		You don't sell at the same market

		Share market knowledge		You have a conflict
		Other (Such as:)		They will degrade your produce
				Other (Such as:)

13. Before selling your produce what value adding activities do you perform? (tick as appropriate)

	Livestock	Crop

H. INSTITUTION CONSTRAINTS					
1. What institutional problems are you facing?					
	Problem	Livestock		Crops	
		Rank		Rank	
	Shortage of input suppliers				
	Lack of training institutions				
	Lack of marketing agencies				
	Lack of extension services/vet services				
	Poor access to credit				
	Lack of police services				
	Poor transport services				
	Other institution problems (specify)				

I. ADDITIONAL COMMENTS

THANK YOU

Appendix 2

Table 1. Livestock units coefficients that be used for international comparisons

Region	**Cattle**	**Buffalo**	**Sheep**	**Goats**	**Pigs**	**Asses**	**Horses**	**Mules**	**Camels**	**Chickens**
Near East North Africa	0.70	0.70	0.10	0.10	0.20	0.50	0.40	0.60	0.75	0.01
North America	1.00		0.15	0.10	0.25	0.50	0.80	0.60		0.01
Africa South of Sahara	0.50		0.10	0.10	0.20	0.30	0.50	0.60	0.70	0.01
Central America	0.70		0.10	0.10	0.25	0.50	0.50	0.60		0.01
South America	0.70		0.10	0.10	0.25	0.50	0.65	0.60		0.01
South Africa	0.70		0.10	0.10	0.20	0.50	0.65	0.60		0.01
OECD	0.90	0.70	0.10	0.10	0.25	0.50	0.65	0.60	0.90	0.01
East and South East Asia	0.65	0.70	0.10	0.10	0.25	0.50	0.65	0.60	0.80	0.01
South Asia	0.50	0.50	0.10	0.10	0.20	0.50	0.65	0.60		0.01
Transition Markets	0.60	0.70	0.10	0.10	0.25	0.50	0.65	0.60		0.01
Carribbean	0.60	0.60	0.10	0.10	0.20	0.50	0.65	0.60		0.01
Near East	0.55	0.60	0.10	0.10	0.25	0.50	0.56	0.60	0.70	0.01
Other	0.60	0.60	0.10	0.10	0.20	0.50	0.65	0.60		0.01