IMPACT OF POLICY AND SOCIOECONOMIC FACTORS ON SPATIAL DISTRIBUTION OF LIVESTOCK PRODUCTION SYSTEMS IN RIVER NJORO WATERSHED, KENYA

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A Thesis submitted to the Graduate School in partial fulfilment for the requirements of the Master of Science Degree in Agricultural and Applied Economics of Egerton University

EGERTON UNIVERSITY

June, 2009

DECLARATION AND RECOMMENDATION

Declaration

I declare that this thesis is my original work and has never been submitted in this or any other university for the award of a degree.

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Recommendation

This thesis has been submitted with our approval as supervisors.

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DEDICATION

To Ngovi, Ndumi and Mwende

ACKNOWLEDGEMENTS

I wish to appreciate the efforts, support and encouragement from God, several individuals and organizations when undertaking this successful research work.

First, I am greatful to God, my creator, author and perfector of my faith for the grace, peace and mercies that have dominated my study period and entire life.

To my supervisors, Dr. Wilson Nguyo and Dr. Margaret Ngigi for invaluable continuous guidance during my research work, receive my gratitude. I am also extending my heartfelt gratitude to the Department of Agricultural Economics, through the able leadership of Dr. Benjamin Mutai and the CMAAE secretariat for the support that facilitated my specialized courses semester at University of Pretoria, South Africa.

To USAID, through the entire SUMAWA Global Livestock Collaborative Research Support Programme fraternity, I will forever remain grateful for the scholarship that made my studies possible and all the subsequent resource allocations towards my research work in the field and office. Personal advice and assistance from SUMAWA staff, Dr. P. Semenye, Ms. Muhia Njeri and Mrs. Mary Kyalo Ndivo is highly appreciated. Dr. Kavoi Mutuku Muendo, Dr. Victor Okoruwa, Dr. John Mburu and Mr. Eric Bett, thank you for taking your time to share pertinent ideas during the initial stages of my research work.

Finally I wish to acknowledge my parents, brother, sisters and friends, for the emotional and material support, and the patience they bestowed on me during my entire study period, may God bless you all.

ABSTRACT

Livestock production is an important contributor to rural development. In the past two decades, developing countries have experienced changes in market structures, climate and demographic characteristics. These changes have been accompanied by fast growth in demand for livestock products and the increasing dependence on livestock for sustainable livelihood systems. In response to these changes, there has been rapid land use and land cover changes, characterized by expansion of agricultural land, and land fragmentation. This has caused environmental degradation in several rural areas, including the River Njoro watershed. Policy makers and development agents are therefore, facing a dilemma on trade-offs between meeting the expanding demand for livestock products and sustainable utilization of the limited stock of natural resources. At the backdrop of this dilemma, this study sought to identify and characterize livestock production systems in Njoro River watershed using principal components and cluster analysis. A multinomial logistic regression model was then used to determine the factors that influence the spatial distribution of livestock production systems and Changes in Land Use Efficiency for Small extent (CLUE- S) model used to assess the effect of suggested policies on the spatial distribution of livestock production systems. Primary data used in the study was collected using a household survey. Data was managed and analyzed using Statistical Package for Social Sciences (SPSS) v15, STATA V9, and (CLUE-S) Modeling softwares.

Results indicate that farmers in the watershed fall under three major livestock production systems: *Intensive*, *Semi intensive,* and *Extensive*. Land size, access to extension services, age of household head, altitude of the farm, distance of farm household to the river, number of extension visits, value of physical assets, access to credit, household size, household income, and involvement in off-farm activity are the factors found to significantly influence changes in livestock production systems. It was also observed that if the current trends in land use changes continue, the production of livestock products will continue to decline in the future. This study concludes that if the growth in food production has to surpass the population growth rate, relevant policy issues to enhance sustainable livestock production have to be addressed. Policy implications drawn from this study have focused on incentives for intensification, institutional reforms, improving livestock productivity, and innovations that enhance the synergies between livestock production and the environment.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

AFC	:	Agricultural Finance Corporation
CALPI	:	Capitalization of Livestock Programme Experiences India
CEC	:	Cation Exchange Capacity
CMAAE	:	Collaborative Masters in Agricultural and Applied Economics
CLUE-S	:	Changes in Land Use Efficiency for small extent model
DFID	:	Department for International Development
FAO	:	Food and Agriculture Organization of the United Nation
G o K	:	Government of Kenya.
GIS	:	Geographic Information Systems
GL- CRSP	:	Global livestock Collaborative Research Support Programme
ICRAF	:	International Centre for Research in Agro Forestry
ILRI	:	International Livestock Research Institute
KFWG	:	Kenya Forest Working Group
LEAD	:	Livestock, Environment and Development Initiative
LET	:	Livestock and Environment Toolbox
LUCID	:	Land Use Change, Impacts and Dynamics
LULCC	:	Land Use and Land Cover Changes
MNL	:	Multinomial Logistic Regression Model
OECD	:	Organization for Economic Cooperation and Development
PSR	:	Pressure – State – Response Model
ROSCA	:	Rotating Savings and Credit Association
RRR	:	Relative Risk Ratio
SACCO	:	Savings and Credit Cooperative Organization
SLF	:	Sustainable Livelihoods Framework
SMEs	:	Small and Micro Enterprises
SPSS	:	Statistical Packages for Social Sciences
SUMAWA	:	Sustainable Management of Rural Watersheds
TLU	:	Tropical Livestock Units
USAID	:	United States Agency for International Development

CHAPTER ONE
INTRODUCTION

1.1 Background Information

Livestock production is an integral component of rural development, contributing towards enhanced agricultural productivity; improved rural livelihoods; as well as ecological services (CALPI, 2005). Integration of crops and livestock, which is an important characteristic of agricultural intensification, has been a major driver of economic growth in rural areas of many countries. Apart from food, livestock forms a major capital reserve for farming households, providing social security, fuel, transport as well as being an important basis for generating cash and value addition with multiplier effects. Furthermore, integration of livestock and crops offers opportunities for farm enterprise diversification, year-round cash inflows, in addition to spreading risk. Hence livestock production has been considered an important tool for poverty alleviation and for improving the livelihoods of resource-poor farmers (Devendra and Thomas, 2002). Indeed, livestock keeping has been considered an important indicator of household's wealth and power status especially among the pastoral communities. Finally, livestock plays an important social role as a medium for dowry payment and use in other African traditional ceremonies. However, the extent to which livestock will continue to play these important roles in development, in a sustainable way, will depend on the changes taking place in the livestock production systems.

Currently, the worlds' livestock production falls under three systems, depending on the mode of feeding, degree of market dependence and the intensity of stocking. Based on these criteria, scientists have categorized livestock production systems into grazing system, crop - livestock mixed system and the industrial system. These systems have developed and evolved over time as a result of various factors. Factors that have accelerated the development of livestock production systems include increased consumer demand for livestock products and technological advances resulting from research (Boyazoglu, 1998). Technological advancements have led to improved feed conservation, better milking and feeding techniques, and expansion of intensified livestock farming stimulated by genetic improvement. On the other hand, a global trend of increasing population and incomes, combined with expanding urbanization, has given rise to increased demands for animal products. This has in turn stimulated intensification of systems in a bid to increase production and productivity as well as to shorten production cycles. The above mentioned factors, combined with resource scarcity and declining farm sizes, continue to drive the evolution of different livestock production systems aforementioned.

Each of the livestock production systems deserves clear and in-depth understanding because these systems are the arena where livestock and the environment interact (De Haan *et al.,* 1997). The grazing systems can impact on the environment through soil compaction, overgrazing, loss of pasture biodiversity and decrease in soil fertility linked to increased soil erosion, and low water infiltration. Livestock grazing is a main cause of non-point pollution, especially to water resources. Continuous grazing on the riparian zones is a potential cause of erosion, over fertilization of the river system, and overgrazing on the lush vegetation along the (riparian) zone.

The mixed crop-livestock production system on the other hand is a closed system, the largest and the most recommended by agriculturists and environmentalists. This system facilitates proper nutrient balance and retention since all the wastes (manure and crop residues) are recycled within the system. The most commonly used method of measuring the impact of the mixed system on the environment is the assessment of nutrient balance, and we can have either a nutrient deficient or surplus system (De Haan *et al.,* 1997). The major challenge in the closed system is therefore to strike a balance between the mixed production and conservation of natural resources. The third category, the industrial system, is mainly used in the production of monogastric livestock and contributes to 43% of global meat production (FAO, 2007). The impact of the industrial system on the environment is usually directly on land, water, air and biodiversity through emission of waste, use of fossil fuels and substitution of animal genetic resources. In most cases livestock contribute to food production while at the same time causing resource degradation such as water pollution, soil erosion and deforestation (Bellaver and Bellaver, 1999). Most livestock production in watersheds depends on communal resources such as water and grazing land. Overall, degradation of communal land resources is a matter of serious concern as sustainable management of the environment is a prerequisite for sustainable development. In many watershed areas farm animals are let loose for open grazing on communal property resources without any control on resource use or any consideration of permissible stocking rates. This phenomenon leads to increased degradation and pressures on the stock of natural resources. In the Njoro River watershed for instance, there is clear evidence of environmental degradation that is attributed to expansion of crop and livestock production activities (Bett, 2006; Baldyga, 2005; Krupnik, 2005 and Shivoga *et al*., 2003). Livestock grazing along the riparian zones cause threats because they can compact the soil leading to reduced infiltration, increased runoff and erosion, and increased deposition of sediments and nutrients to the water bodies. Livestock compact soil by trampling it, making paths, or repeatedly congregating in the same areas. This reduces the ability of riparian areas to absorb and hold water, and breaks down river banks. Activities affecting watersheds or riparian zones also affect stream ecosystems both directly and indirectly, as well as cumulatively. As livestock contribute to societies' wellbeing, both positive and negative externalities can result. The integration of crop and livestock systems can provide very important sustainable advantages for the farmer through nutrient recycling and adding economic value to the system by grazing on crop residue which would otherwise be underutilized. To sustain their livestock, farmers plant nitrogen-fixing crops or forages which serve to improve soil fertility and reduce soil erosion (Seré and Steinfeld, 1995). In situations where farmers integrate livestock with crops, animals enhance soil fertility through manure production; they also feed on crop bi products and transfer nutrients from distant pastures to cropped areas.

There is an existing agricultural policy dilemma originating from the need to allow farmers to respond to the increasing demand for livestock products while at the same time utilizing the limited stock of natural resources in a sustainable way. This entails creating solutions to the issues outlined above. Towards meeting this goal, an important step would be to clearly understand the spatial distribution and characterization of livestock production systems, especially in areas of high environmental value. This study addresses this issue and proceeds to analyze the factors that influence the livestock production systems and assess the effect of suggested marketing and environmental policies on the spatial distribution of livestock production systems in River Njoro watershed.

1.2 Statement of the Problem

Njoro River watershed has experienced rapid land use and land cover changes (LULCC) in the past two decades. This has been due to increased pressure on land, caused by increased population, household partitioning and changes in consumption patterns. These demographic and economic changes have led to higher demand for high-value livestock products and have presented an opportunity for farmers to expand production. The farmers' response has taken different forms including intensification of livestock production systems. This adjustment has exerted new pressure on the environment, resulting in further degradation, which is an issue of concern for development agents and policy makers. Despite the importance of livestock in watershed resource utilization there is limited information on livestock production systems in the watershed. Also, despite the recognized role that livestock play in determining the state of the ecosystems and sustaining livelihoods within the watershed, the spatial extent and intensity of livestock production practices is yet to be assessed. Policy makers need to be informed, through generation of information regarding the spatial distribution of livestock production systems, factors determining this distribution and the possible effect of suggested alternative policies.

1.3 Objectives

The overall objective of this survey was to assess the impact of policy and household socioeconomic characteristics on spatial distribution of livestock production systems in River Njoro Watershed in the medium and short term.

Specific Objectives

1. To identify and characterize livestock production systems in River Njoro watershed.
2. To determine the factors that influence livestock production systems in River Njoro watershed.
3. To suggest alternative policy interventions and assess their impacts on livestock production systems in River Njoro watershed within a period of 20 years.

1.4 Research Questions

1. What are the main livestock production systems in River Njoro watershed?
2. How do socio-demographic and economic factors influence the livestock production systems in River Njoro Watershed?
3. How are livestock production systems spatially distributed in River Njoro watershed?
4. What are the possible effects of policy interventions on the spatial distribution of livestock production systems in River Njoro watershed?

1.5 Justification

The research was conducted in River Njoro watershed a critical watershed in Kenya's Rift valley, since it forms the collection area for River Njoro, which is a major feeder into Lake Nakuru. It has over the years experienced rapid population increase and associated land cover change that have resulted in negative impacts on water resources, human health, rural livelihoods and the local economy (SUMAWA, 2005). Livestock production is an important source of livelihood in the area, with 80 % of the households keeping animals mainly in mixed farming systems. Due to the ongoing human activities the watershed is vulnerable to more environmental degradation. Therefore given the role livestock can play in provision of environmental services, livestock production issues should be placed at the centre of the watershed development programmes.

Since livestock production is an integral part of the area's farming systems, appropriate interventions and measures for sustainable agricultural production in the watershed cannot be developed without a clear understanding of existing livestock production systems. Information generated by this study is expected to enlighten policy makers and planners of the watershed's development programmes by characterizing the area's livestock production systems and identifying opportunities and challenges that are specific to different categories of livestock producers. This can help to formulate policy interventions which will guide efforts to reverse the trends in environmental degradation and mitigate the effects of livestock on the environment. Through mapping the spatial distribution of the livestock production systems and assessing the effects of alternative policy interventions on future distribution of these systems, the study aimed at suggesting viable policy interventions that will enable farmers adopt sustainable livestock production systems.

1.6 Definition of Terms

Livestock: Within the context of this research, livestock will be limited to cattle, sheep, goats and chicken produced within the Njoro river watershed under different systems.

Farming systems: Groups of farms which have a similar structure and function and can be expected to produce on similar production functions (Ruthenberg, 1980).

Livestock production systems: This is a subset of the farming systems, which can be defined as a population of individual livestock keepers that have similar resource bases, enterprise patterns, household livelihood strategies, farming practices and constraints and for which similar development strategies and interventions can be applied.

1.7 Scope and Limitations

The study acknowledges that during dry seasons the watershed receives huge herds of migratory livestock. Evidently, such herds impact significantly on the watershed's resources including water and pastures. Besides, migratory herds increase the risk of diseases outbreaks resulting in high veterinary costs and mortality rates. Effects of migratory livestock, therefore merits keen study. However, such analysis is beyond the scope of this study. Instead the study focuses only on the livestock confined within the watershed throughout the period of the study. Further, the study is limited to smallholder farmers within the watershed. Large scale farms and institutions engaged in livestock production are not covered in the study. The study is based on simulations covering a period of 20 years, 2007-2026.

CHAPTER TWO
LITERATURE REVIEW

2.1 Characterization of Agricultural Systems

Over the years researchers have attempted to understand spatial variations in agricultural systems. A review of the literature reveals attempts to classify livestock producers into one or the other cluster. For example, Seré and Steinfeld (1995), Thapa and Rasul (2005) and Waithaka *et al.,* (2002). In their characterization of world's livestock production systems, Seré and Steinfeld (1995) classified global livestock production systems into five categories: solely livestock production systems, landless livestock production systems, mixed farming systems, rain-fed mixed farming systems and irrigated mixed farming systems. In this characterization livestock production systems were differentiated according to degree of integration with crops, relation to land, agro-ecological zone, intensity of production and type of product. Their study considers classification of livestock production systems involving cattle, buffalo, sheep, goats, pigs and chicken. However, this method is only appropriate for global level studies but not for regional or local application. To characterize dairy systems in Western Kenya, Waithaka *et al.,* (2002) used principal component, and cluster analysis based on biophysical variables and other farm specific variables such as mode of feeding, and type of livestock breeds kept. They concluded that intensification and enhancement of crop and livestock interactions are important options for increased livestock productivity. The survey however did not determine the factors behind the prevalence of subsistence systems as observed rather than market-oriented production, and specialization. The authors however did not establish the spatial distribution of the dairy systems.

Thapa and Rasul (2005) used cluster analysis to characterize the agricultural systems in the Hill tracts of Bangladesh. The study characterized the systems based on 12 variables which were: proportion of area under shifting agriculture, horticulture, paddy cultivation, annual cash crops, and average number of private trees per household, average number of fruit trees, average number of wood trees, and average number of cattle, pigs, goats, poultry, and proportion of produce used for household consumption. These variables were used to identify the patterns of agricultural systems in the study area. They also examined the determinants of these agricultural systems and discovered that even with same topographical features and climatic conditions, farmers tend to have different farming systems. They attributed these differences to land scarcity land tenure issues, household resource base, level of institutional support, and access to markets and agricultural infrastructure. However these findings differed with those of earlier work by Ali (1995) who reported that physical environment and resource base are the only major determinants of agricultural systems.

Mburu *et al.,* (2007) used principal components and cluster analysis to classify smallholder dairy farms in terms of risk management strategies, level of household resources, dairy intensification and access to services and markets in Kenya highlands. This study identified four clusters of small holder dairy systems. The following factors were used to cluster the farmers: risk strategy, access to markets, farm size, age, milk marketing channels, and on farm/ off-farm fodder production. The dairy production system that included majority of the farmers was characterized by consumption smoothing as a risk management strategy through high cooperative participation, lowest reliance on on-farm produced fodder, nearness to the market centre, lowest milk prices and small farm sizes.

There is a clear link between land use changes, agricultural intensification and changes in livestock production systems. According to LUCID (2006) there have been rapid changes in East Africa in the last decade involving expansion of mixed crop-livestock systems into former grazing and other more natural areas, and intensification of agriculture. The driving forces for land use changes have been established as social, environmental, market and demographic pressures (Bett, 2006; LUCID, 2006 and Baldyga *et al.,* 2007). However, despite the implications of changes in land management practices, most studies on land use and land cover changes (LULCC) deal only with land cover. This is because it is not possible to observe land use practices by remote sensing or other commonly used methodologies. This focus on land cover leaves out important information on changes in farm management practices over time. For farms which integrate crops with livestock, it is difficult, using remote sensing, to identify the temporal and spatial dynamics of the changes. Since changes in livestock systems are highly dynamic due to changes in consumption patterns and constantly increasing population the current study focused on livestock production systems at household level and in spatial dimensions. Studying these changes in spatial context is important due to the fact that different areas will experience different impacts due to the differences in environmental and socioeconomic factors (Verberg *et al.,* 2005). Some studies have focused on farming systems with livestock integration in spatial context and have displayed how Geographic Information Systems (GIS) based analysis can be used in mapping the farming systems. Kruska *et al.,* (2003) for instance mapped farming systems from a livestock perspective. They considered land cover, human population density and agro- climatology as factors that determine the existence of a particular livestock production system in a given area.

Conversion of Land Use and its Effects (CLUE-S) model has been used extensively since its development to study land use and land cover changes (LULCC) and the spatial distribution of farming systems. The model has two distinct modules; a non-spatial demand module and a spatially explicit allocation procedure. The non-spatial module calculates the area change for all the land use types at aggregate level, while within the second module, the demands are translated into land use changes at different locations within the study region using a raster based system. Within the raster system, all vector data is converted into grid data, allowing allocation of different attributes to each grid. Verburg *et al.,* (2005) used the CLUE- s model in Kenya, to study the spatial distribution of smallholder dairy systems in parts of Central, Rift Valley and Western Kenya. In their study, Verburg *et al.,* (2005) classified households based on decision rules reflecting market integration, intensification and livestock incorporation. The authors identified six distinct farming systems namely: subsistence farmers with no dairy, farmers with dairy activities, intensified farmers with no dairy, export oriented farmers with no dairy and export oriented farmers with dairy activities. It is however not reported what method the study used to classify the households.

2.2 The Role of Policy on Livestock Production and the Environment

Livestock and the environment interact (directly or indirectly) resulting in either positive or negative externalities. Positive externalities include enhancement of soil fertility and nutrient balance associated with the use of animal manure, improved biodiversity and potential for alternative energy. On the other hand, negative externalities include water and air pollution, trampling on the riparian zone and loss of biodiversity associated with overgrazing. Thus, through these aspects, livestock production can result in positive and negative impacts on the economy, society, environment and public health. If conditions are conducive, livestock can be beneficial to the environment. However, without proper management and coordination of livestock production the result can be negative effects on the environment (Oram, 2000). In separate studies, Gumpta (1995) and Mearns (1996) are in agreement that policy and institutions play an important role in influencing livestock-environment interactions and offering incentives for sustainable utilization of natural resources in the process of development. In areas of “high amenity and conservation value” such as wetlands, sound policy and institutional frameworks can help to mitigate the negative impacts of livestock on the environment and enhance positive impacts. In India, some of the policy and technological options used to enhance environmental protection among livestock producers include beneficiary compensation payments, taxation, insurance, credit and investments in marketing, transport and communications infrastructure to facilitate off-take of livestock (Mearns, 1996). Cornner (1996) attributed degradation of natural resources to failure of policy and institutional frameworks to coordinate resource utilization.

When the farmer is faced with increasing demand for livestock products and, at the same time, deteriorating quality and quantity of natural resource base, the tendency will be to adjust of the production system in an attempt to maximize returns. The policy makers, on the other hand, are faced with the challenge of developing policies which can enhance the interactions between livestock and natural resources, to ensure sustainable development. Government legislation can have a direct or indirect impact on the way economic agents (households, individuals, or firms) make and implement decisions. It is important to note that livestock constitute household assets which can easily be liquidated if economic incentives to keep them are lacking, *ceteris peribus* (Jarvis, 1993). Therefore the government, through policies, can strongly affect livestock production since policies can influence investment through protection of property rights (especially land ownership and use), input and output prices facing farmers development of new technologies, agricultural extension, access to and terms of credit and infrastructure.

The government, through policy interventions can enhance the adoption of sustainable farming systems and reduction of pressure on the stock of natural resources. Population pressure has been one of the driving forces of environmental degradation. However this can be addressed through alternative employment that helps to reduce agricultural population to a level that the land can sustain. Policy considerations that can help to increase agricultural productivity and intensification can help to tackle the problem of overdependence on agriculture. Pricing policy is also an important determinant of the level of flock expansion. Low purchased input prices cause definite flock expansion as farmers respond to economic signals, while fuel pricing can influence cultivation, processing, and transportation of livestock feeds.

In the past decade several research efforts have been made to understand the interactions between livestock production systems and the environment, mainly by animal production researchers using different methodologies. To study these interactions, different models have been used. De Haan *et al.,* (1997) adopted the Pressure State Response (PSR) model that looks at the driving forces for environmental degradation and how the society responds to the feedback received from the state of natural resources. The researcher developed indicators for each of the three components of the model, i.e. Pressure indicators, State indicators and Response indicators. Some of the key factors considered in the action domain under this model are: information, education, economic incentives, property rights, and institutional / regulatory factors. The indicators of the state of natural resources that have been used by the researcher include soil erosion, water quality, change in forest cover and change in plant biodiversity. As Western (1982) concludes, some of the technologies that have been adopted for pastoralists yield only short-term benefits with long-run effects of imbalances and increased environmental degradation.

To study the interactions between livestock and crop systems, Baltenwek *et al.,* (2003) used the crop–livestock interactions and intensification model and also the theory of induced innovation model developed by Hayami and Ruttan (1985). The model focuses on the household utility theory to predict the household choices in allocation of land and labour to crop and livestock production in response to changing factor and product prices. The study displays important findings: that agricultural intensification is driven by market conditions, marginal productivity of inputs, opportunity cost of labor, wage rate, and interest rates (Baltenwek *et al., 2003)*. The study identified important indicators of livestock intensification which are: feeding strategies, fodder production, purchase of concentrates, and existence of a fodder market.

The above review brings us to one agreement that the interactions between livestock and the environment within the existence of various livestock production systems are vital and need keen study. A gap exists however since there are limited attempts to study livestock production systems using an approach that integrates household socioeconomic data and biophysical data.

2.3 Conceptual Framework

This study uses the Sustainable Livelihood Framework (SLF) developed by the DFID (1999). The SLF has been used extensively in both planning new development activities and assessing the contribution to livelihood sustainability made by existing activities. It displays the relationship between people, their livelihoods and their environments and macro policies and all institutions (Neefjes, 2000). To obtain sustainable livelihoods outcomes, households pursue different livelihood strategies for which several researchers have developed categorizations (e.g. Scoones, 1998; Carney, 1998 and Ellis, 2000). The livelihood strategies fall under two broad categories: agricultural intensification and livelihood diversification, including off-farm activities.

The household lives within a vulnerability context, which frames the external environment in which people live. People's livelihoods and the wider availability of assets are fundamentally affected by critical *trends* as well as by *shocks* and *seasonality* – over which they have limited or no control. These components within the vulnerability context affect different households in different ways. Given a particular context, the household will be expected to have a combination of livelihood resources (natural, financial, human, physical and social capital). The most important aspect is the household's access to these assets either through ownership or through acquisition of the rights to use. Each household's capacity to pursue different livelihood strategies is dependent on these livelihood resources and their socioeconomic characteristics. In order to create livelihoods, therefore, people must combine the 'capital' endowments that they have access to and control over. The ownership of a certain physical asset can enable the household to reap multiple benefits. Ownership of natural assets, land for example, can empower a household to access financial assets since it can use the land for productive activities and also as collateral for loans. Livestock ownership can be a source of social capital as a sign of power, prestige, and wealth and community connectedness (DFID, 1999). Livestock can also be used as a productive physical capital (animal traction), and also as natural capital. Consequently, depending on the type and amount of livelihood resources the household or individual has, they will have an ability to follow a certain combination of livelihood strategies. These could be agricultural intensification or extensification, livelihood diversification including out migration, or a combination of two or more of these. The conceptual framework is as shown in Figure 1 below.

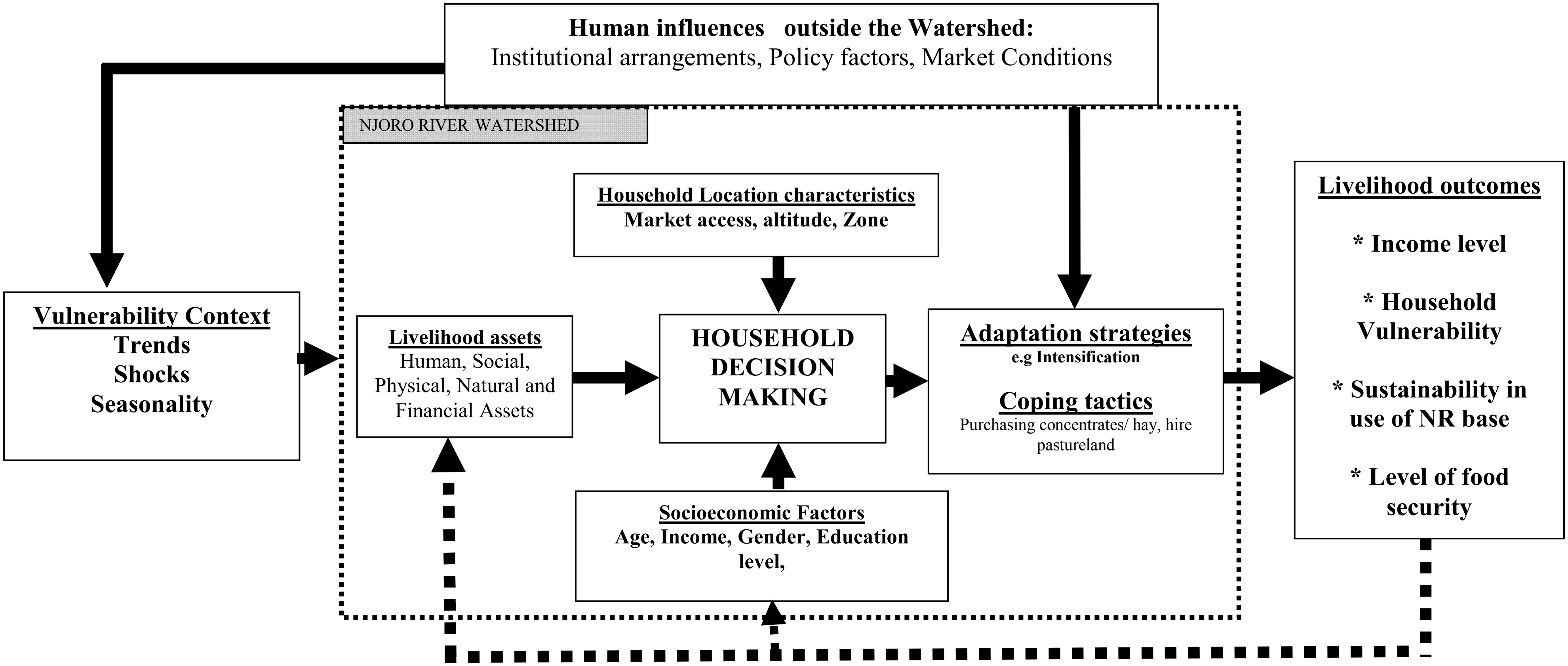

Figure 2. 1: Conceptual framework
(Source: Adapted from DFID, 1999.*)*

The combination of activities that are pursued can be seen as a 'livelihood portfolio'. Some such portfolio may be highly specialized with a concentration on one or a limited range of activities, while others may be quite diverse (Ellis, 2000). Socio-economic relationships may exist between individuals and households and these also have a major impact on the composition of livelihood portfolios. Other factors that influence the household's decision in preference of a livelihood strategy are linked to the location of the household. Distance to the market, altitude and the zone are the location factors that will be considered in this study.

The strategy or combination of strategies pursued will yield a certain livelihood outcome which may be one or more of the following: more income, improved welfare, more sustainable use of natural resources, reduced vulnerability and improved food security (DFID, 1999). The ability to achieve or not to achieve the outcomes will however depend on some institutional processes which are embedded in a matrix of formal and informal institutions and organizations acting as mediators of the ability to carry out such strategies and achieve (or not) such outcomes. They will also depend on market conditions and the underlying policy interventions. However these factors are exogenous to the household as they affect all the households within the watershed in the same way. For an individual it may be best to pursue a particular set of livelihood strategies in combination, but these may have either positive or negative impacts on other household members or the broader community. For instance, a successful agricultural intensification strategy pursued by one person may provide an opportunity for another person's agricultural processing or petty trading livelihood diversification strategy. By contrast, another type of agricultural intensification may undercut others' strategies by diverting such factors as land, labour, credit or markets. Similarly, in relation to livelihood diversification, it may make sense for individuals to specialize, while households diversify, or whole villages may specialize in a particular activity, in the context of a highly diversified regional economy. Of particular interest to the current study was to establish, given unique socioeconomic and location characteristics, how private decisions on livestock production systems are made and the resulting spatial patterns of these systems within the watershed.

Livestock have been found to be an important contributor to rural livelihoods. This study will investigate what influences the farm household to choose a particular livestock production system: intensive, semi- intensive or extensive, as a livelihood strategy and how policy can influence the future changes in these systems.

CHAPTER THREE

METHODOLOGY

3.1 The Study Area

River Njoro watershed transverses two districts, namely Molo and Nakuru, in Rift Valley Province, Kenya. It is located at 0^0 35′ South, 35^0 20′ East. The river is approximately 56 Km in length with an approximately 270 Km^2 contributing area. It originates from the Eastern Mau Escarpment at approximately 3000 Meters above sea level (m.a.s.l) flows through forested and agricultural lands before serving Egerton University and the towns of Njoro and Nakuru and finally emptying to Lake Nakuru at 1,759 m. a .s .l. The lake is enclosed in Lake Nakuru national park which is famous for its large populations of flamingoes and an internationally recognized Ramsar site. Climate in the study area is characterized by a trimodal precipitation pattern with long rains occurring from April to May, short rains occurring from November to December, and an additional small peak occurring in August. Mean annual rainfall measured at Njoro from 1949 to 2001 is 939.3 mm. Average annual minimum and maximum temperatures for the area range are 9 and 24^0C, respectively. The natural vegetation is largely moorlands and indigenous montane forest mixed with bamboo in the uppermost part of the watershed (Baldyga *et al.,* 2007). Soils in the watershed are categorized into seven types: humic acrisols, humic ferrasols, mollic andosols, vitric andosols, humic andosols, eutric leptosols and eutric regosols (Mainuri, 2006). The soil textures range from clay loams in the lower part to sandy clay loams in the plantation and indigenous forest areas at the upper part of the watershed.

The population of Nakuru district has been growing steadily since the mid 1980's. Between 1979 and 1999 the date of the last Kenya's population census, population grew from 523,000 to 1,197,000 person's, representing an approximately 129% increase (GoK, 2001). These increases are partly attributed to uncontrolled immigration programs in the forest blocks in the area. Since independence, the Mau forest complex has decreased by approximately 9 % (340 km^2) due to deforestation (KFWG, 2006). Rapid conversion from indigenous and plantation forests to small-scale agriculture have occurred in the upland region where agricultural conditions are favorable. A map of the study area is shown in Figure 3.1.

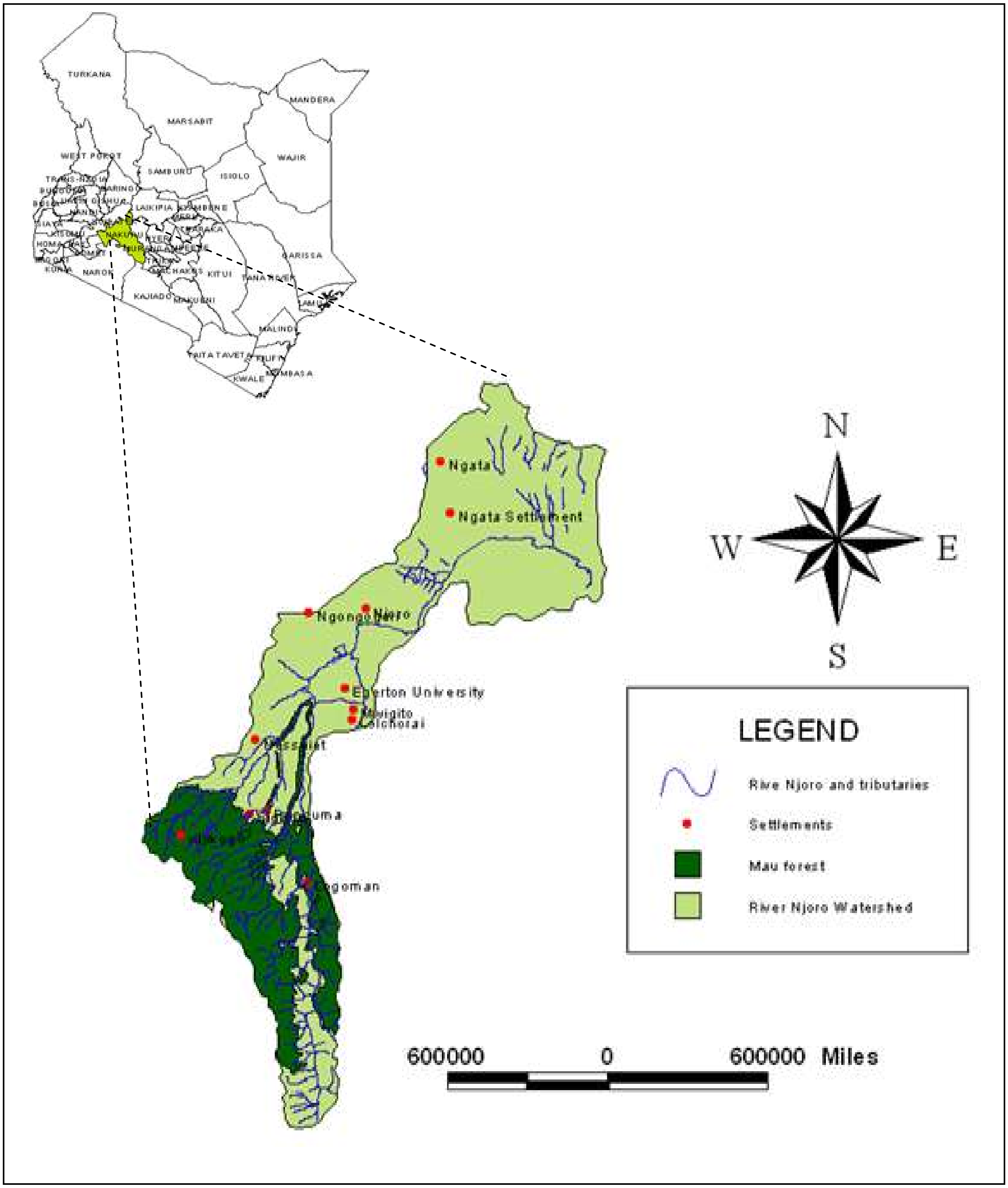

Figure 3.1: Map of River Njoro Watershed
Source: Generated by the author from the SUMAWA GIS database

Crop and livestock production are the main sources of household livelihoods in the watershed. Majority of farmers practice mixed farming, integrating crops and livestock on an average 3.5 ha land (Bett, 2006 and Muriithi, 2007). The most important crops grown in the watershed are maize, beans, wheat, potatoes, carrots, and other vegetables such as kales, cabbage and french beans. About 75% of the agricultural plots are under permanent cultivation. Livestock production is another important activity in the area. Previous surveys (Bett, 2006 and Muriithi, 2007) have shown that the most prominent livestock activity in the watershed is dairy production mainly on subsistence basis. Farmers also keep some sheep, goats, poultry and donkeys. Additional economic activities include salaried employment, small and micro enterprises (SMEs), firewood gathering and selling, charcoal burning and selling, quarrying and sand harvesting. Agricultural plots range in size from 0.1 to 12 ha. A map of the study area is as shown in Figure 3.1 (Appendix 5).

3.2 Data Types, Sources and Collection Methods

Secondary and primary data for this study were drawn from two surveys conducted in 2004 and 2007 respectively, constituting two sets of cross section data. The 2004 data was collected through a baseline survey under the socioeconomics component of the SUMAWA GL-CRSP project. SUMAWA is a multidisciplinary research project based at Egerton University, that has since 2003 been researching on the livestock, human and biophysical interactions within River Njoro watershed. In 2007 primary data was collected through follow up household surveys in three zones within the watershed: Nessuit (upper), Njoro (middle) and Ngata (lower). These are administrative zones and are distinguished based on their location within the watershed. The data was collected through personal interviews on households who had been interviewed in 2004, and focus group discussions with knowledgeable community members. A structured survey schedule and a check list were used as data collection instruments.

3.3 Sampling Design and Techniques

The sampling frame for the study was all livestock farmers in the three target zones of the watershed, with a household as the sampling unit. A stratified random sampling technique was employed to generate the sample, with the zones in the watershed forming the strata. A sample of 120 farmers was arrived at using a formula adapted from Kothari (2005).

Sample size: $n = PQ / (SE)^2$

$$n = 120 = (0.5*0.5) / (0.0456)^2$$

where:
n = sample size
P = proportion of the population containing the major attribute
Q = 1-p
SE = standard error of the proportion

3.4 Model Specification and Data Analysis Techniques

To achieve the objectives of the study, several statistical techniques and methodologies were employed. These are described in the sub-sections below.

3.4.1 Identification and Characterization of Livestock Production Systems

Principal components analysis (PCA) and two step cluster analysis were used to characterize livestock production systems. The Cluster analysis procedure attempts to identify relatively homogeneous groups of cases based on selected characteristics, using an algorithm that starts with each case in a separate cluster and combines clusters until only one is left. The variables used for Principal Components and cluster analyses were selected *a priori*. These variables were grouped into four categories: Herd structure, socioeconomic factors, management practice strategies, and farmer risk management behavior. The farmer's management behavior is reflected in his /her decisions on livestock production. Crucial decisions include feeding strategies (e.g. whether to feed wholly on forages or to mix with some concentrates), the livestock health management and breed selection. Depending on the farmers' skills and resource endowment, the management behavior may differ between farmers. Depending on how much the farmers orient their production towards the market; their commercialization index may reveal their livestock management behavior. Farmers are normally exposed to several uninsured risks such as natural disasters, demographic changes, price volatility and policy changes (World Bank, 2007). To manage the exposure to these risks, risk averse farmers may forgo activities which could yield high expected outcomes. However some farmers may adopt strategies which help them to spread risks. Such strategies include farm enterprise diversification, and hiring additional parcels of land away from their homes. Due to lack of proper methods to quantify the fodder fed to livestock within the year, the current rental value of the land dedicated to livestock production was used to compute the expenditure on fodder. The proportion of marketed milk output was used as a proxy for commercialization index. The number of enterprises and farms a farmer had was taken as an indicator of the farmers risk management and diversification behavior. However, it was recognized that this could also be an indicator of farmers' wealth status. The more risk averse farmers are expected to have more enterprises which help to spread their risk. They are also expected to have more farms spread in different parts of the watershed for the same reasons. PCA was based on the variables shown in Table 3.1.

Table 3.1: Variables used in Principal components and cluster analysis

Category of factors	Variables
Herd structure	Average number of cattle per household, average number of goats per household, average number of sheep per household, average number of poultry per household, livestock intensity[1] and main cattle breeds.
Socioeconomic factors	Age of household head and average education level for the household.
Management practice strategies	Mode of feeding, proportion of land under pastures, proportion of milk output sold per household, average milk production per cow, and expenditure on concentrates.
Farmers' risk behavior factors	Number of farms, number of enterprises, access to credit and distance to the river.

3.4.2 Assessing Factors Influencing Choice of Livestock Production Systems

To assess the determinants of the household's preference for a particular livestock production system, multinomial logitistic regression analysis was used. From the cluster analysis done in objective one, three livestock production systems were identified: *Intensive, Semi-*

[1] Livestock intensity = Total Tropical livestock Units / Land under livestock production (Ha)

intensive and Extensive. The dependent variable is therefore discrete in nature hence use of the Multinomial Logistic (MNL) a choice regression model. This model is appropriate when data are individual specific (Greene, 2003), here, the values of the independent variables are assumed to be constant among all the alternatives in the choice set. The general multinomial logistic regression model is as specified in Equation 1 according to Schmidt and Strauss (1975 a, b).

$$\Pr ob(Y_i = 1) = \frac{e^{\beta_j' x_i}}{\sum_{k=o}^{J} e^{\beta_k' x_i}}, j = 0,1,...,J \qquad (1)$$

Since we have three categories in the dependent variable, two equations were estimated providing probabilities for the J + 1 choice for a decision maker with characteristic $\mathbf{X}_i$. The β_is are the coefficients to be estimated through the maximum likelihood method.
The empirical specification was simplified as presented in equation 2.

$$\prod_{ij} = X_i \beta_k + Z_i \alpha_k + W_i \gamma_k + \varepsilon_{ik} \qquad (2)$$

where $\prod_{ij}$ is the probability that household *i* chooses to produce livestock through system *j,* X_i are the household socioeconomic characteristics, Z_i are the household location and W_i are the biophysical characteristics, β_k, α_k and γ_k are the parameters to be estimated and ε_{ik} is the error term. In this situation the parameters estimated represented the relative risk ratios.
This model can be normalized to solve a problem of indeterminacy through setting $\beta_0 = 0$. This is because the probabilities sum up to 1, therefore only J parameter vectors are needed to determine the J + 1 probability. Therefore the probabilities are

$$\Pr ob(Y_i = j \mid x_i) = \frac{e^{\beta_j' x_i}}{1 + \sum_{k=1}^{J} e^{\beta_k' x_i}} \quad for \quad j = 0, 1, \ldots, J, \beta_0 = 0. \qquad (3)$$

To give a more accurate interpretation of the coefficients, there is usually need to compute the marginal effects of the characteristics on the probabilities through the following differentiation: $\delta_j = \frac{\partial P_j}{\partial x_i} = P_j \left[\beta_j - \sum_{k=0}^{J} P_k \beta_k \right] = P_j \left[\beta_j - \overline{\beta} \right]$ (4)

In the analysis, both marginal effects and the Relative Risk Ratios (RRR) were estimated and reported. However only the RRR were interpreted. The relative risk ratios (RRR) are a transformation of the multinomial logit coefficients through exponentiation. The multinomial logit model estimates k-1 equations, where the k^{th} equation is relative to the referent group. The RRR of a coefficient indicates how the risk of the outcome falling in the comparison group compared to the risk of the outcome falling in the referent group changes with the variable in question. A RRR > 1 indicates that the risk of the outcome falling in the comparison group relative to the risk of the outcome falling in the referent group increases as the variable increases. In other words, the comparison outcome is more likely. An RRR < 1 indicates that the risk of the outcome falling in the comparison group relative to the risk of the outcome falling in the referent group decreases as the variable increases. In general, if the RRR < 1, the outcome is more likely to be in the referent group.

3.4.2.1 Variable Description

The study conjectured that the occurrence of certain livestock production system in a specific location is influenced by a number of socioeconomic, biophysical and farm location characteristics, used in this study as the explanatory variables. The basis for the assumption was theoretical considerations found in the literature. The variables used in the MNL model are summarized in Table 3. 2.

Table 3. 2: Variables in the Multinomial Logistic Regression model

Variable name	***Description***	***Measurement***	***apriori assumptions***
DEPEDENT VARIABLE			
Livsyst	Livestock production system	Categorical	
EXPLANATORY VARIABLES			
EDUCLE	Average years of completed schooling	Years	+
LNDSZE	Size of land owned	Hectares	-
ASSETV	Total value of assets	Kshs.	+
CREDIT	Access to credit	1= accessed 0= Else	+
GENDER	Gender of the household head	1=Male 0=Female	-
AGE	Age of the household head	Years	-
HHSIZE	Household size	Number	-
LIVINC	Income from livestock per annum	Kshs.	+

Table 3.2 Continued

MKTACESS	Travel time to nearest market	Minutes	+
LANDTEN	Land tenure	Dummy (1=secure, 0= else)	+
EXTACESS	Access to extension services	1=Accessed 0=Else	+
ALTDE	Altitude of the farm	Meters a.s.l	-
DSTRVE	Distance to the river	Kilometers	-
POPDEN	Population density at sub location level	Number of people / sq Km.	+
OFFINC	Off farm income	Kshs.	+
EXTVST	Number of extension contacts per year	Number	+
LIVEXPR	Years of livestock keeping experience	Years	+
CROPINC	Annual income from cropping activities	Years	+

3.4.2.2 Apriori Hypotheses

Age and years of farming experience: Age and the number of years the farmer has been keeping livestock reflect his experience, hence, might influence the type of systems adopted. The older farmers are expected to have more experience in livestock production. They are also expected to be more conservative hence maintain the local cattle breeds and be involved in the more extensive livestock production systems.

Education level: The average household education level was used as a proxy for human capital. This was computed by calculating the average years of completed schooling for all household members who had attained school going age. Human capital represents the skills, knowledge and labor ability of the household that enables it to pursue livelihood strategies. Household decision making can be influenced by the level of education, not only of the household head but also of other household members. Households with a higher level of education are expected to be more likely to adopt intensive livestock production systems.

Land size: Natural capital, which includes land, is conceptualized to be an important determinant of the livelihood outcomes of rural households whose production is natural-resource based. The size, quality, and security of tenure of land for example is expected to determine the livestock production systems that emerge. Households with larger tracts of land are expected to have larger livestock density (TLU/HA) and have extensive systems while farmers with declining farm sizes will tend to reduce their hard sizes to the extent of converting to highly intensive systems such as zero grazing.

Total household asset ownership: Physical capital comprises the infrastructure and producer assets needed to sustain livelihoods. These help people to be more productive and to meet their basic needs. At the household level physical capital was captured through the total depreciated value of household assets. The assets captured in the study were: agricultural implements, farm structures, vehicles, and other supportive assets that can enhance production and marketing of farm produce. A household with a refrigerator for example will be more likely to produce more milk while other assets like vehicles and bicycles can enhance transportation of farm inputs and output, and hence determine the kind of production.

Land tenure: This can be a limiting factor to pasture production and improvement. Farmers with insecure land tenure are discouraged from undertaking long term investments on pasture and other farm improvements such as fencing, woodlots and livestock structures. The institutions governing property rights play key roles in shaping agricultural producers' choice of production practices, outputs, and hence food security and poverty alleviation. Farmers with high tenure insecurity tend to look for component practices that give returns in the short run instead of engaging in more long term investments (Mwangi and Meinzen-Dick, 2005). When farmers gain more property rights to their land through allocation of title deeds, they invest in more long term livestock structures and engage in more intensive livestock production systems.

Biophysical factors: The probability of finding a livestock production system in a certain location can also be influenced by several other biophysical and socioeconomic factors. The distance from the market for instance is an important factor influencing the distribution of livestock production systems. The more intensive systems which depend more on purchased inputs will be located close to the markets while extensive systems, which demand more land for grazing tend to be located at zones further from the towns. The altitude will determine other biophysical characteristics such as temperature and soils types, PH and Cation Exchange Capacity (CEC), which then influence the livestock production systems indirectly through the kind of the pastures and fodder crops that can grow in a certain location.

3.4.3 Assessment of the Impact of Suggested Policies on Livestock Production Systems

Policies were suggested under three scenarios then simulations ran using the CLUE-S model to assess the impact of these policies on livestock production systems. The CLUE-S model has two modules, a non- spatial demand module and a spatially explicit allocation procedure and it links spatial patterns of environmental and socioeconomic condition to farming systems characteristics. Through this it becomes possible to identify the spatial distribution of the farming systems without extensively mapping all farming systems across a large region. The model is used for spatially explicit simulation of system changes, based on an empirical analysis of location suitability combined with the dynamic simulation of competition and interactions between the spatial and temporal dynamics of land use systems.

3.4.3.1 Input Files for the CLUE-s Model

To run simulations of spatial dynamics of the three livestock production systems, data on the spatial distribution of the systems, biophysical and socioeconomic factors which are considered to be important drivers of livestock production systems change was required. All the input files used for the CLUE- S modeling were prepared in Arc View GIS 3.2 (Appendix 4). The data was in two formats: *(1)* Vector data on attributes such as soils, altitude, precipitation and temperatures and *(2)* statistical data obtained from the household surveys. The statistical data was converted into vector formats and linked to the other spatial data through the geographical coordinates which uniquely identify each household location.

For CLUE - S to run, all input files must be communicated to the model in a consistent format (Verburg *et al., 2005*). The data was converted to ASCII raster format, such that all the files had the same grid size, extent, and projection. In the ASCII raster file format data are stored in a text file that contains all values of the individual grids stored in rows and columns and a header describing the format.

3.4.3.2 Locational Characteristics

To estimate the probabilities of finding a certain livestock production system in a certain location a binomial logit was developed, which has two choices: convert location *i* into livestock production system *k* or not. The function that relates these probabilities with the biophysical, socio-economic and location characteristics is defined in a logit model as shown in equation 5.

$$Log\left(\frac{P_i}{1-P_i}\right) = \beta + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \ldots + \beta_n X_{n,i} \qquad (5)$$

where Pi is the probability of a grid cell for the occurrence of the livestock production system on location *i* and the X's are the location characteristics. The coefficients (β) are estimated through logistic regression using the actual livestock production systems as dependent variable. Most of the location characteristics relate to the location directly, such as soils, precipitation and altitude, but others such as the socioeconomic characteristics are linked to the systems indirectly.

3.4.3.3 Alternative Scenarios for Simulating Livestock Production Systems

All simulations in this study start from 2007 as the base year. The base year data was obtained from the household survey. The main variables considered as the drivers of livestock production system changes in the watershed are locational (population density) and socioeconomic (farm size, land tenure, number of extension contacts, and livestock numbers/density. The baseline scenario was used to provide a benchmark against which the projections of the simulation scenarios can be compared and interpreted.

Scenario 1: Business as Usual

The business as usual scenario assumes that the changes in the period preceding 2007, the study year, will continue into the future. Within 10 years, between 1997 and 2007, the watershed has experienced a cumulative 4.8 % decline in the number of farmers with extensive livestock production systems. Over the same period, the number of farmers with intensive and semi intensive livestock production systems increased by 1.6 % and 2.2% respectively (Shivoga *et al.,* 2003). The trend can be attributed to increased pressure on land due to increased population and climatic changes leading to smaller farm sizes and fodder scarcity. The assumption under this scenario was that there will be no changes in the driving factors and policy environment. The driving forces under this scenario were: 2.8 % population increase, 4.5 % increase in the tropical livestock units, and 1.86% decline in farm sizes. These variables were obtained through comparisons between the baseline data (2004) and the 2007 field survey data.

Scenario 2: Market Focused Policy Scenario

Under this scenario, it will be assumed that the government will influence production and marketing through livestock input and output policies. Efficient marketing systems and a supportive policy environment are key driving factors on the development of livestock production systems. Farmers will make their production and marketing decisions in response to signals transmitted from the markets and policy environment. Since in the liberalized era price supports are not possible, this scenario considered policy interventions targeting to benefit farmers indirectly through decreasing costs of production and increasing productivity. This is because it is expected that both prices and quantities demanded for milk, meat and eggs will increase by higher rates than in the baseline scenario, and farmers need to benefit from this economic opportunity. Policies facilitating intensification conceptualized in the model are: institutional reforms to improve access to credit and extension services; targeted cost reduction strategies on livestock inputs; and land reforms. Under this scenario, it is expected that there will be a slower growth in the Tropical livestock units of 2.5 %, compared to the business as usual scenario, and farm sizes (1%). However population growth is expected to be as in the baseline scenario.

Scenario 3: Environmental Sustainability Scenario

Kenya's vision 2030 has outlined a blueprint towards better environmental management. Options considered in this scenario are based on implementation of the vision 2030. Policies in support for environmental sustainability that were considered under this scenario include a 30 meter River Njoro buffering, lower population growth (2.3%), improving pastures and farm fodder production, slowing down the rates of land fragmentation, fodder production and expanding farm forestry. From the baseline scenario, land under pastures declined by an annual average of 7.7 % implying that increasing land under pastures is not a viable option in future. Efforts should therefore be focused on increasing productivity per unit of land. Lower population growth implies lower pressure on land and demand for livestock products. It is assumed that improved fodder availability within the households will lead to a decline in the competition on pastures from the communal sources.

CHAPTER FOUR
RESULTS AND DISCUSSIONS

All results are presented and discussed in this section. The section starts with the principal components and cluster analysis results. Due to the heterogeneity nature of the sample it was necessary to first characterize the farmers to obtain homogenous categories, hereafter called the livestock production systems. This is followed by the descriptive analysis which presents the descriptive results based on the livestock production systems. Finally the Multinomial logistic regression results and simulation results are presented and discussed.

4.1 Principal Component and Cluster Analysis Results

4.1.1 Principal Components Analysis Results

Cluster analysis was preceded by factor analysis, through Principal components method which was used to identify underlying variables, or factors, that explain the pattern of correlations within each of the sets of observed variables. The objective of using factor analysis was data reduction to identify a small number of factors that explain most of the variance observed in a much larger number of manifest variables. Each of the 120 households was given a score along the new variables generated that consisted of the sum of the products of the weightings and their scores along the original variables. The components with the *eigenvalues* greater than one were selected and used in the subsequent cluster analysis. The *eigenvalue* represent the amount of variance in the original variables accounted for by each component. All the rotated factor matrices were obtained through the varimax with Kaiser Normalization method. Using the new components is preferable to using the variables which are highly correlated with the components because the components are representative of all the original variables but are not linearly correlated with each other. Although the linear correlation between the components is guaranteed to be 0, it was important to look at scatter plots of the component scores to check for outliers and nonlinear associations between the components. All the components were checked and found to display linear relationships and the outlier cases were excluded from the analysis.

4.1.1.1 Principal Component Analysis by Herd Composition

Four variables (principal components) were selected to represent the herd composition for each household. These yielded two factors with eigenvalue greater than one, hence were selected to represent the other variables. These explained 66.9 % of the variation in four original variables. The two selected variables were named large ruminants and small ruminants as shown in Table 4.1.

Table 4.1: Rotated Correlation coefficients factor patterns for herd composition

	Components	
	Large ruminants	**Small ruminants**
Number of cattle	0.731	-0.234
Number of goats	0.794	0.125
Number of sheep	0.554	0.600
Number of chicken	-0.158	0.866

Source: Author's estimations from survey data, 2007

4.1.1.2 Principal Component Analysis by Household Socioeconomic Factors

To represent the household socioeconomic factors, four principal components were selected and subjected to principal components analysis (Table 4.2). This yielded two factors with eigenvalue greater than one. These factors contribute 57.02 % of the variation in the original four variables. These variables were named experience and labor availability.

Table 4.2: Rotated Correlation coefficient factor pattern for socioeconomic characteristics

	Components	
	Experience	**Labour availability**
Gender of household head	0.356	0.716
Age of household head	-0.336	0.742
Education level	-0.637	0.081
Household size	0.747	0.091

Source: Author's estimations from survey data, 2007

Education level was computed by dividing the total number of years of schooling for all household members who have attained school age and above by the number of household members who have attained school age and above.

4.1.1.3 Principal Component Analysis by Management Practice Strategies

Six Principal components to represent the farmer's livestock management practice were selected and are as shown in Table 4.3 below. These yielded three factors which contributed to 62.12 % of the total variation. These factors are cost of concentrates, commercialization index, and cattle management.

Table 4.3: Rotated Correlation coefficients factor pattern for livestock management practices

	Components		
	Concentrates	**Commercialization index**	**Cattle management**
Cattle breed	0.161	0.069	-0.781
Proportion of land under pastures	0.322	-0.700	0.122
Quantity of milk produced /cow / month	0.743	-0.056	-0.058
Commercialization index	0.797	-0.003	0.135
Cost of fodder per Tropical livestock unit	0.255	0.037	0.677
Cost of concentrates per tropical livestock units	0.175	0.839	0.069

Source: Author's estimations from survey data, 2007

4.1.1.4 Principal Component Analysis by Risk Management Factors

The last category of variables represented the farmers' risk management behavior. The five variables used yielded one factor with an eigenvalue greater than one which was arbitrarily named Risk index. This factor contributed 48.9 % of the variation in all the five variables. Since one factor cannot be rotated, only the component score coefficient matrix is presented (Table 4. 4).

Table 4. 4: Component score coefficient factor patterns for risk management behavior

	Components
	Risk index
Risk index	.508
Distance to River	-.288
Diversification index	.193
Credit access	.316
Distance to the market	-.474

Source: Author's estimations from survey data, 2007

4.1.2 Cluster Analysis Results

The study identified three major livestock production systems through Principal components and cluster analysis. Automated cluster selection was used in SPSS. From the auto clustering statistics, three was the number of clusters that had a small Schwarz Bayesian Criterion Information (BIC) value and also a small change in BIC between adjacent number of clusters. The three clusters yielded three livestock production systems: Intensive, Semi intensive and Extensive livestock production systems.

4.1.2.1 Intensive Livestock Production System

Cluster one was the intensive production system, which was characterized by highly diversified and commercial oriented farmers. Farmers in this livestock production system constituted 34.7 % of the entire sample. These farmers were spread over the three zones in the watershed with Njoro, Nessuit and Ngata having 50.0 %, 21.4 % and 28.6 % of the households respectively. Compared with the farmers in the Extensive livestock production system, farmers in this system had a relatively lower number of male household members. The mean land holding was 3.9 Ha, which was lower than in the extensive production system. Farmers within this system were closest to the river, (Mean = 1.11 Km) and had the highest expenditures on concentrates. Production in this system is mainly through stall feeding (zero and semi zero grazing). Feed sources are mainly from purchases and own fodder production, with an average 14% of their land under fodder crops. Farmers under this system kept mainly cross breed cattle and some pure breeds. The tropical livestock units and number of milk cows were also lower than those of farmers the extensive livestock production systems but lower than those in the semi intensive livestock production system.

4.1.2.2 Semi Intensive Livestock Production System

The second cluster was the semi-intensive livestock production system. Farmers in this cluster are found mainly in the lower river Njoro watershed (Ngata and part of Njoro) and constitute the lowest number of households, 19.0 %. However, farmers within this system have the lowest number of livestock holding (Mean TLU = 1.065 and milk cows = 0.17). With the lowest land holding, farmers in this system were also located furthest from River Njoro. Their expenditure on concentrates and acaricides was lower than those in the intensive system.

4.1.2.3 Extensive Livestock Production System

The last system, the extensive system had the highest number of households, 46.3 % spread over the study area. Majority of farmers in this category are found in Ngata (41.1 %) while the rest are distributed between Njoro (39.3 %) and Nessuit (19.6 %). Farmers in this cluster have relatively higher number of livestock holdings (Mean TLU = 5.216). This livestock production system displayed the highest number of male household members, and also land holdings. About 23% of these farmers' land is under pastures and they also own larger parcels of land compared to the farmers under the intensive livestock production system. Having the highest number of milk cows, these farmers also were located further from the river compared to those in the intensive livestock production system. Descriptive statistics for some selected variables across the three livestock production systems are as shown in Table 4.5, with a test whether the mean differences are statistically significant.

Table 4.5: Descriptive statistics by different livestock production system

Variable description	Livestock production system				
	Intensive	Semi intensive	Extensive		
				T- stat	*p*
% of farmers overall	34.7	19.0	46.3	25.769	0.000
				F- stat	LSD
Number of milk cows	1.33	0.17	2.45	16.619	I-S (1.16*) I-E (-1.12*) E-S (2.28*)
Number of male household members	2.833	3.045	3.667	2.185	I-E (-0.833*)
Tropical Livestock units	3.042	1.605	5.216	10.065	I-E (-2.1923*) S-E (-3.6125*)
Expenditure on concentrates/ TLU/YR	13207.89	11091.12	6168.74	2.95	I-E(7039.15*)
Proportion of land under pastures	0.1447	0.1588	0.2308	2.766	I-E (0.0861*)
Distance to the River	1.1076	2.2391	2.1102	5.729	I-S(-1.1315*) I-E (-1.0026*)
Mean land owned (Ha)	3.9	2.02	6.17	5.891	I-E(-2.1923*) S-E(-4.146*)
Cost of acaricides per year	1912.38	300	1828.00	6.511	S-I (1528.0*)

***Means differences are statistically significant, at 0.05 level of significance, 2-tailed (*$p<0.05$*)**

Livestock production systems: I = Intensive; S = Semi intensive and E = Extensive

Source: Author's survey, 2007

4.2 Descriptive Analysis Results

4.2.1 Household Socioeconomic and Demographic Characteristics

Household headship was male dominated, 79.2 % of the households being male-headed. Results indicate that the mean age of the household heads was 52.3 years. Most of the heads are therefore within the active working age category. Majority of the household heads (44.2%) had attained eight years of education and below, 30.0 % had on the other hand attained twelve years of education and below, while 16.7 % had acquired some professional skills from either tertiary colleges or universities. A substantial percentage, 9.2 % had no formal education. Many households pursue alternative livelihood strategies to diversify their income generating options. It was found that 92.5 % of the household heads were involved in at least one off - farm activity. The main types of off-farm activities observed included salaried employment, casual employment (agricultural and non agricultural) and businesses. Majority of households (87.4 %) satisfy their domestic food demand from own production. However, some households (11.8 %) reported that they were net food buyers, depending on the market for food supplies. The household head socio-demographic characteristics are summarized in Table 4.6 below.

Table 4.6: Descriptive statistics for household heads' socioeconomic characteristics

Variable	Category	Percentage
Level of education	No formal education	9.2
	Primary	44.2
	Secondary	30.0
	Tertiary college	14.2
	University	2.5
Gender	Female	20.8
Marital status	Single	5.0
	Monogamously married	87.5
	Polygamous	4.2
	Widowed	3.3
Involvement in off-farm activity	Yes	92.5
Mode of acquisition of land	Inheritance	19.5
	Purchase	51.7
	Government allocation	28.0
	Rental	0.8
Source of food	Own farm production	87.4
	Purchased	11.8
	Remittances	0.8

Source: Author's survey, 2007

Household income in the watershed is drawn from three main sources namely: off- farm sources, crop production, and livestock production. Figure 4.1 below shows the percentage contribution of different sources to the total annual household cash inflow. Livestock plays an important role in sustaining livelihoods in the watershed. Across the four income categories, livestock income remains the third largest provider of household income, after off-farm income. From Figure 4.1 below, it can be seen that livestock provides 26 % of total annual household cash inflow. The low contribution from crop production implies that a larger proportion of on farm food crop production is consumed within the household.

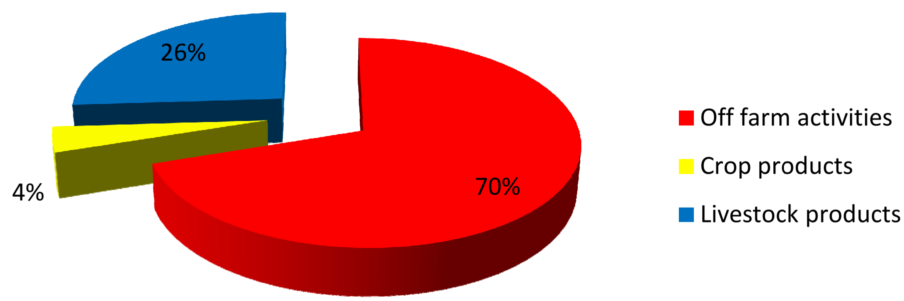

Figure 4.1: Main sources of household cash inflows

The total household income was however not well distributed. Due to this skewness, a categorization was developed by the author, by putting the sample into quartiles. Each of these quartiles represented an income category. There was a big gap between the households in the lower income category and those in the upper income category. Majority of the households were within the lower middle income category with a mean annual household income of Ksh. 169,430 (US$ 2726) and per capita income of Kshs. 93 (US$ 1.44)[2] per day. This was followed by 30.8 % households falling in the lower income category earning an average Kshs. 26,216 (US$ 403.32) per annum, with a per capita income of Kshs.25 (US$ 0.38) per day. Against the prior expectations, the last category had the highest number of household members and household adult equivalents too (Table 4.7). This is because though their nuclear families may be small, households who are well off tend to host

[2] Exchange rate: 1 US $ = Ksh. 65.7

some members of the extended families and have resident farm and households workers. Overall, 55.8 % of the households were below the UNDP poverty line of US$ 1 per day.

Table 4.7: Household income and sources by income category

Variable description	Income category				F-stat	LSD
	Lower	Lower Middle	Upper Middle	Upper		
Annual household income (Ksh)	48095	169430	311816	643103	447.2	1-2(-121334.9*) 1-3(-263721.5*) 1-4(-594918.8*) 2-3 (-142386.6*) 2-4(-473583.9*)
Annual off-farm income (Ksh)	26216	131402	219891	476052	83.88	1-2(-78214.3*) 1-3(-176071*) 1-4(-474439.7*) 2-3 (-97857.1*) 2-4(-396225.5*)
Annual livestock income (Ksh)	18666	42472	105545	182017	13.35	1-3 (-84729.8*) 1-4 (-170381.7*) 3-4 (-85654.9*)
Income per capita per day (Ksh)	25	93	148	278	21.61	1-3 (-166.26*) 1-4 (354.7*) 3-2 (300.8*) 3-4 (188.48*)

* Mean differences are statistically significant, at 0.05 level of significance, 2-tailed (*$p<0.05$)*

Income categories: 1= Lower; 2=Lower middle 3=Upper middle 4=Upper

Source: Author's survey, 2007

4.2.2 Household Composition

The average household size was 6.26 members, constituting an average adult equivalent of 5.4 (Table 4.8). Contrary to expectation, there has been a marginal decline in household sizes by 5.1 % from the 6.6 average household membership reported in 2004. However it is still higher than the national average of 4.5 persons (G.o.K, 2001). The average dependency ratio in the watershed was 1.17. This implies that there is a burden on the working household members. The household composition presented in Table 4.7 below indicates 50.4 % of the population is within the productive age between 19 and 55 years. Children and young adults within school going age of less than 18 years formed about 40.3 % while the rest, 9.2 % are the aged. The mean number of years of schooling was 8.66 years, therefore, on average the household heads had attained primary level of education.

Table 4. 8 : Household composition in River Njoro watershed

Variable	ZONE							
	NESSUIT		NJORO		NGATA		ALL	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Number of males	4.4	2.5	3.0	2.0	3.09	1.7	3.3	2.0
Number of females	3.7	2.5	2.8	1.6	3.38	2.5	3.2	2.1
Adult equivalents	6.8	3.1	5.1	2.7	5.29	2.8	5.4	2.8
Dependency ratio	0.61	.40	1.3	1.3	1.19	1.2	1.2	1.2

Source: Author's survey, 2007

4.2.3 Land Ownership and Use

Land ownership in the watershed ranged between 0.17 Ha and 36.75 Ha, with a mean of 7.86. This indicates a decline in farm size by 5.6 % between 2004 and 2007. This decline in farm size can be attributed to population increase and household partitioning. As indicated in Table 4.9, land size varies across the farmers with different livestock production systems. Farmers with extensive livestock production systems had the largest farm sizes (9.58ha) followed by the ones with intensive livestock production systems (7.33).

Table 4.9 : Land ownership and land use in River Njoro watershed (Hectares)

Variable	LIVESTOCK PRODUCTION SYSTEM							
	Intensive		Semi intensive		Extensive		ALL	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Mean land owned	7.33	3.93	5.05	1.56	9.58	3.25	7.86	6.54
Land rented in	7.01	2.54	3.55	0.45	5.2	1.25	5.65	3.46
Rented out	7.76	1.87	1.22	0.12	5.8	2.89	5.90	5.1
Land under cultivation	9.15	2.15	4.50	1.25	7.7	1.36	7.48	3.56
Land under pastures	2.24	0.62	1.78	0.63	3.5	1.26	2.77	1.72
Homestead	0.84	0.42	0.71	0.21	0.95	0.15	0.86	0.56

Source: Author's survey, 2007

Land use in the watershed is mainly on crop production, pasture and settlement. As shown in Table 4.9, Njoro has larger averages of land allocated to pasture and fodder production. The proportion of land allocated to crop production is highest in Nessuit, followed by Ngata and Njoro in that order. It was however noted that between 2004 and 2007, the land under pastures had declined by 7.7 % annually.

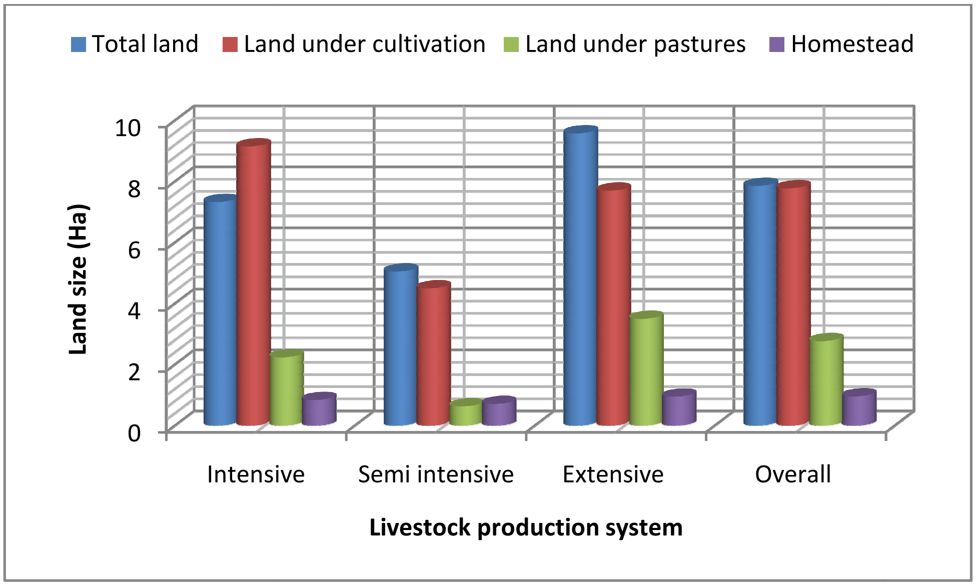

Figure 4.1: Land ownership and use (size) in the study area

4.2.4 Property Rights and Livestock Production Decisions

In the survey it was found that 69.5 % of the farmers had secure land ownership with title deeds as indicated in Table 4.10. However land ownership for 29.5 % of the households in the watershed is insecure since they had no land title deeds.

Table 4. 10: Land tenure in Njoro River watershed

Type of land tenure	Percent
Freehold with certificate/title deed	69.5
Freehold without certificate/title deed	29.5
Gift/ Land owned by another individual	1.0
Total	100.0

Source: Author’s survey, 2007

4.3 Livestock Production in River Njoro Watershed: Current Status and Trends

Livestock production in the watershed involves mainly cattle, (mainly cross breeds), sheep, goats and chicken. These livestock are produced through different systems, which may change with time due to a number of reasons. As indicated in Table 4. 11, the change in livestock feeding strategies which are indirect indicators of livestock production systems has been due to pastures scarcity (34.6%), decrease in farm size/ decline in grazing land (19.6%), increased market demand leading to changing into systems with high productivity (19.2%) and changes in land tenure (22.8%).

Table 4. 11: Reasons for changing the livestock feeding strategies

Reason	Percentage of farmers
Decline in the size of grazing land	19.6
Change of land tenure	22.8
Shortage of pastures	34.6
Shortage of labor	3.8
To increase production/ productivity	19.2

Source: Author's survey, 2007

4.3.1 Cattle Herd Size and Distribution

Cattle herd size and distribution was as indicated in Table 4.12. Cows, which are considered an important productive natural asset, formed a larger percentage of the herds in the watershed. Under the calves category, female calves formed a larger percentage, indicating that farmers kept the female calves and disposed the males as part of replacing the producing stock and also sell as heifers at a later date.

Table 4. 12 : Herd structure in the three livestock production systems in the watershed

	ZONE							
Livestock type	**Intensive**		**Semi intensive**		**Extensive**		**ALL**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Cows	1.5	0.77	1.1	0.62	2.55	2.1	2.3	1.7
Bulls	1.6	0.89	1.0	0.00	1.67	1.1	1.63	0.92
In-calf heifers	1.43	0.53	1.5	0.25	1.14	0.36	1.24	0.44
Female calves	1.06	0.25	1.0	0.00	2.17	1.4	1.70	1.22
Male calves	1.22	0.44	1.0	0.23	1.67	1.5	1.52	1.25
Castrated male calves	1.0	0.00	0.0	-	1.86	1.5	1.55	1.29

Source: Author's survey, 2007

Most of the cattle produced in the watershed are cross breeds of Friesians and local cattle breeds. However, there were some local breeds and few exotic breeds. The local breeds are mainly found in the upper watershed, which borders Maasai land. The middle watershed had mainly cross breeds and some pure exotic breeds. Friesians were the main breed both for the crosses and the exotic breeds (Table 4.13).

Table 4.13: Holding of cattle breeds within the three zones of the watershed

	ZONE		
	Nessuit	**Njoro**	**Ngata**
Friesian cross	25.0	46.3	48.6
Jersey cross	0	4.9	2.7
Guernsey cross	5.0	7.3	5.4
Ayreshire cross	35.0	29.3	21.6
Local breed	35.0	2.4	13.5
Pure Breed	0	9.8	8.1
Total	100.0	100.0	100.0

Figures are percentages of farmers owning the particular cattle breeds
Source: Author's survey, 2007

Goats, sheep and chicken were the other livestock kept by the farmers. As shown in Table 4.14 below, chicken formed the largest number followed by sheep and goats. However due to the varying sizes of the livestock in terms of body weight, it was important to compute a standard measure for the herds in the watershed. The Tropical Livestock Unit (TLU) has been extensively used for this purpose. From the study it was established that Nessuit zone had the highest TLUs and herd sizes per household. Nessuit is closer to the catchment area for River Njoro and also has expansive land for grazing. The current situation on livestock numbers poses a threat to the natural resources especially the Mau forest. Njoro, which has the largest number of farmers with intensive systems, had the lowest TLUs per household.

Table 4.14: Small livestock inventory and Tropical Livestock Units (TLUs)

	LIVESTOCK PRODUCTION SYSTEM							
	Intensive		Semi intensive		Extensive		ALL	
Variable	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Number of goats	4.0	1.25	3.80	2.16	5.36	1.36	4.67	3.54
Number of sheep	8.37	2.50	6.50	2.85	9.77	1.58	8.60	6.44
Number of chicken	24.26	6.56	24.17	10.66	18.32	11.59	21.35	17.47
Tropical Livestock Units[3]	2.82	1.50	2.17	0.85	4.51	2.65	3.48	3.44

Source: Author's survey, 2007

A comparison between livestock feeding strategies between 1997 and 2007 revealed some changes which have been taking place in these strategies. Farmers in the Njoro river watershed have been changing their livestock feeding strategies as indicated in Table 4. 15. It was noted that there has been a movement from extensive methods of livestock feeding such as pure grazing towards more intensive methods (Zero grazing). The percentage of farmers using only stall feeding and stall feeding with some grazing has been increasing between 1997 and 2007.

Table 4. 15: Livestock feeding strategies between 1997 and 2007 (% number of farmers)

	YEAR			
STRATEGY	**1997**	**2002**	**2005**	**2007**
Only grazing	37.9	30.8	24	19.7
Mainly grazing with some stall feeding	20.7	26.2	26.7	27.6
Mainly stall feeding with some grazing	25.9	27.7	32.0	34.2
Only stall feeding (zero grazing)	15.5	18.5	17.3	19.7

Source: Author's survey, 2007

On the other hand farmers who have been doing open grazing have declined within the same period of 10 years from 37.9 % to 19.7 %. The semi intensive methods of livestock feeding: namely mainly grazing with some stall feeding and mainly stall feeding with some grazing has also been

[3] **1 TLU** = {1.0 * Local Cows + 1.05 * Cross cows + 1.1 * Grade cows 1* Bulls + 0.3 * Calves + 0 .1 * Goats + 0.1 * Sheep + 0.01 * Chicken + 0.05 * Ducks + 0.03 * Rabbits}

increasing. The implications for these changes on the environment are many. Due to the increase in the number of farmers using only stall feeding, there is a tendency to have more own farm production of fodder and increased use of concentrates. Farmers with this system also display a great extent of crop and livestock integration hence can better replenish the nutrients in their farms through application of manure and growing of the nitrogen fixing leguminous fodder.

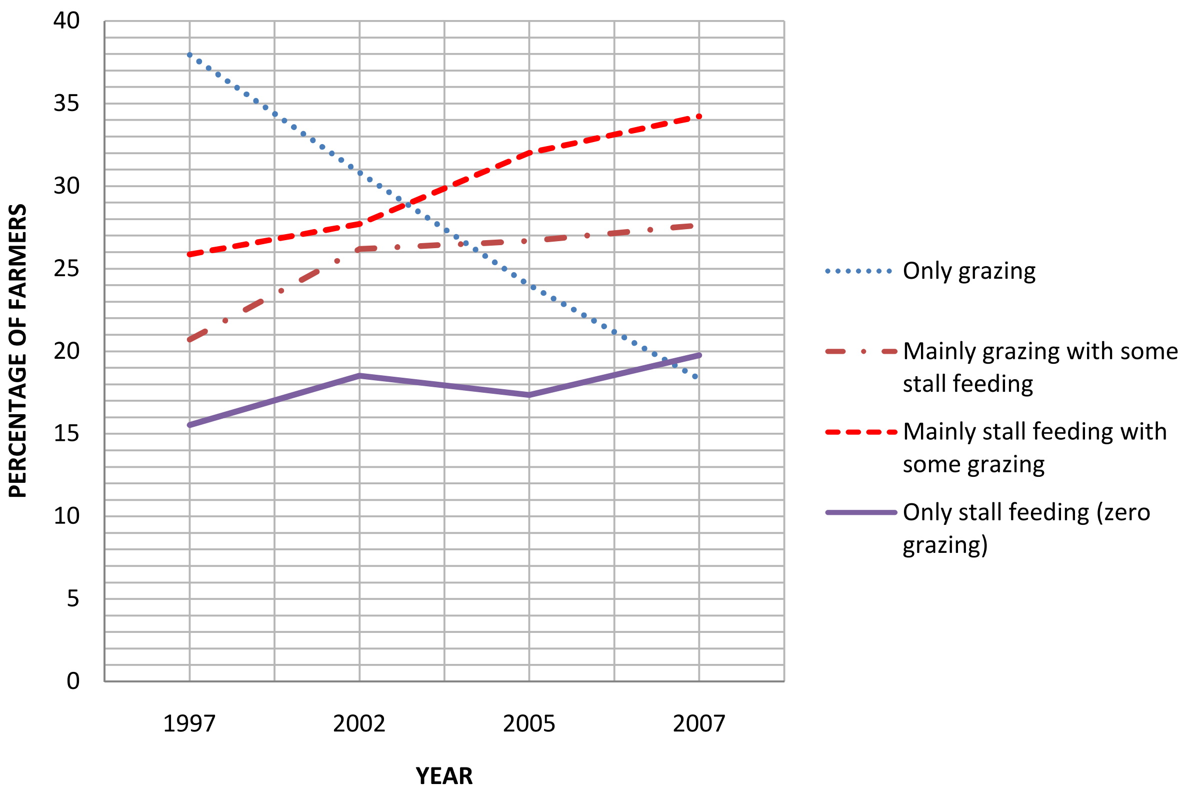

Figure 4.2: Trends in livestock feeding strategies (1997-2007)

4.3.2 Cattle Breeds

The changes in livestock feeding strategies have also been accompanied by changes in cattle breeds. Table 4.16 indicates that between when the farmers started keeping cattle and 2007, there has been a 55.2 % and 33.3 % decrease in local breeds and pure breeds respectively. Changes from pure to cross breeds have been driven by factors such as disease prevalence and poor breeding services. Farmers who changed from local to cross breeds did so to meet an objective of increasing milk production and others were acting on advice from extension officers. It was noted that as farmers move towards intensive systems, they are likely to replace their less productive breeds (local), to more productive ones like the cross breeds.

Table 4.16 : Changes in cattle breeds kept by the farmers (percentages)

	Cattle breed when Farmer started keeping livestock	**Cattle breed kept by the farmer 2007**	**Percentage change**
Cross breed	55.4	77.6	+25.16
Pure breed	10.7	7.1	-33.3
Local breed	33.9	15.2	-55.2

Source: Author's survey, 2007

4.3.3 Livestock Production Support Services and Inputs

The livestock support services play an important role in determining the quality of the animals kept by farmers, hence the quality and quantity of livestock products. These services include credit, extension services, livestock health (veterinary and ethno veterinary) services, and breeding services.

4.3.3.1 Credit and Extension Services

This study noted a slight increase in the number of farmers with access to extension and credit facilities between 2004 and 2007 by 12% and 5% respectively. As shown in Table 4.17 most of the farmers who accessed credit used it for household goods (18.2%), school fees (37.1%), and business purposes (34.5%). Only 10.2 % indicated that they used credit directly on agriculture to purchase inputs. However, it is expected that due to the fungibility nature of credit, there are some indirect benefits to agriculture associated with the increased access to credit.

Table 4.17: Farmers access to credit, credit sources and uses

Variable	Category	Percentage
Access to credit	Yes	10.8
Source of credit	SACCO	61.5
	Commercial bank	23.1
	ROSCA	7.7
	AFC	7.7
Use of credit	School fees	37.1
	Business	34.5
	Household goods	18.2
	Buy agricultural inputs (crops)	10.2

Source: Author's survey, 2007

Table 4.18 below shows that only 17.5 % of the farmers had received extension services within a period of two years. Majority of these were in Njoro and Ngata, the zones which is more accessible to the divisional agricultural offices. Proximity to the offices has an impact on the rate and efficiency of disseminating appropriate extension messages.

Table 4.18 : Access to extension services in the last two years

Accessed extension services?	**ZONE**			
	Nessuit (%)	**Njoro (%)**	**Ngata (%)**	**ALL (%)**
Yes	15.0	16.4	20.0	17.5
Total	100.0	100.0	100.0	100.0

Source: Author's survey, 2007

Livestock production seems to have received limited attention by the extension staff, as indicated in Table 4.19, where 84.2 % of the respondents had received extension information on crop agronomy and husbandry. Among those who had received extension services on livestock production issues, 1.67% had received information on fodder production, 1.67% had received information on livestock health management while 4.96 had acquired information on reproductive management. There is therefore a great need to focus extension services on livestock production related issues especially livestock health and nutritional management.

Table 4. 19: Main type of extension advice acquired

	%
Growing forages (Napier and other grasses)	1.67
Reproductive management	4.96
Feeding of the dairy cow	2.5
Health management	1.67
Breed selection	1.67
Milking	0.83
Farm management/ economics/records	2.5
Crop agronomy and husbandry	84.2
Total	100

Source: Author's survey, 2007

4.3.3.2 Breeding Services: AI and Bull Service

As indicated in Table 4. 20 farmers in the watershed do not carefully select the breeding material (indiscriminate breeding). About 78.7% of the farmers used "other farmers" bulls for breeding. Consequently sometimes it is difficult for farmers to have a control in choosing the type of males that serve their animals. Where Artificial insemination (A.I) services and good quality local bulls are lacking, quality breeding attempts have largely failed, leading to the extinction rather than conservation of useful local livestock species as well as stagnation of breeding improvement.

Table 4. 20: Sources of breeding service in the watershed

	ZONE			
	Nessuit (%)	***Njoro (%)***	***Ngata (%)***	***ALL (%)***
Own Bull	16.7	2.7	2.8	5.3
Other farmer's Bull	78.7	40.5	69.4	58.5
Private A.I	5.6	56.8	25.0	35.1
Cooperative / SHG A.I	0	0	2.8	1.1
Total	100.0	100.0	100.0	100.0

Source: Author's survey, 2007

4.3.3.3 Livestock Health Services

The role of livestock production in rural livelihoods can be enhanced through proper access to livestock services including pest and disease control and management. Good breeding and health makes livestock require less investment and fetch good prices (CALPI, 2005). When there are no proper services, livestock farmers will tend to overstock so that they can break even on their enterprises thereby increasing the pressure on natural resources. From the study it was reported that east coast fever and foot & mouth diseases, are the most common livestock diseases and are more prevalent in the months of January, March, August and November. The most commonly used sources of livestock health services were private veterinarians and para-workers (including Traditional herbalists). Even in cases where the farmers received the services from the government veterinary officers, they were mostly on private duty. Proper delivery of livestock health services, including ethno - veterinary services can help to decrease the threat of zoonotic animal diseases, communicable to human beings being more widespread.

4.3.4 On-Farm Fodder Production

The commonly used fodder sourced on-farm was dry maize stover, followed by Napier grass as reported by 91.7 % and 75.0 % of the farmers respectively. Results indicate a large extent of crop-livestock integration as indicated by the variety of crop residues used as livestock feeds. These ranged from dry and green maize stover to banana stalks and sweet potato vines. Majority of the farmers do not preserve cut grass, but rather graze their livestock directly on the pastures. About 24.2 % of the farmers indicated that they do so as indicated in Table 4.21.

Table 4.21: On-farm fodder production by type

	Percentage of farmers producing type of fodder
Napier grass	75.0
Dry maize Stover	91.7
Green maize Stover	24.2
Cut grass	24.2
Trees fodder	19.2
Sweet potato vines	21.7
Banana Stalks	31.7

Source: Author's survey, 2007

4.4 Multinomial Logistic Regression Results

4.4.1 Model Fit

The log likelihood of the fitted model was -79.69, and from this value we can reject the null hypothesis that all the regression coefficients are simultaneously equal to zero. The likelihood ratio on the other hand was 89.05 (*degrees of freedom = 36*) and the p value is 0.0000. These two statistics help us to reject the null hypothesis that all regression coefficients across both models are simultaneously equal to zero. Lastly the McFadden's pseudo R^2 was 0.3585.

This is within the highly satisfactory range of 0.2 – 0.4. Table 4.22 shows the results obtained from the analysis on the multinomial logistic regression model. The Relative risk ratios and the marginal effects are presented.

4.4.2 Relative Risk Ratios (RRR) Interpretation

A number of socioeconomic, biophysical and location characteristics were found to significantly influence the likelihood of a household being in a certain livestock production system. The relative influence of these factors varied between the different livestock production systems. The relative risk ratios and marginal effects were estimated as shown in Table 26. The RRR of a coefficient indicates how the risk of the outcome falling in the comparison group compared to the risk of the outcome falling in the referent group changes with the variable in question. The marginal effects on the other hand indicate the change in predicted probability associated with percent changes in the continuous independent variables and in the case of dummy explanatory variables, the marginal effects indicate the effect of a discrete change from 0 to 1. In the rest of this subsection, the results are interpreted with respect to the relative risk ratios.

Size of land: The relative risk ratio for a unit increase in the natural capital measured by the size of land was 0.895 in the semi-intensive system relative to extensive system model. This implies that if a farmer increases his land size by one hectare, the relative risk of preferring the intensive livestock production system to the extensive system decreases by this magnitude when other variables in the model are held constant. Generally, as the farm size increases the farmers relative risk of falling in the extensive livestock production system relative to the intensive system will decrease by a 0.895 factor.

Table 4. 22: Multinomial Logitistic regression estimates

Independent variables	LIVESTOCK PRODUCTION SYSTEMS					
	INTENSIVE			SEMI – INTENSIVE		
	RRR	P > | z |	dF/dx	RRR	P > | z |	dF/dx
Education level	0.854 *(0.103)*	0.191	-0.33	0.923 *(0.130)*	0.572	-0.000
Size of land (Natural capital)	0.954 *(0.028)*	0.166	-0.010	0.895*** *(0.059)*	0.095	-0.002
Total value of assets (Physical capital)	1.000 *(7.3e-07)*	0.281	1.7e-07	0.999*(1.9e-06)*	0.221	-5.3e09
Access to credit	8.338 *(11.28)*	0.117	0.464+	49.003* *(070.29)*	0.007	0.028+
Male gender	0.535 *(0.359)*	0.352	-0.187+	7.9e+08* *(7.2e+09)* +	0.023	0.165+
Age of the household head	1.033 *(0.031)*	0.261	0.007	0.979*(0.0.035)*	0.552	-0.000
Household size	0.922 *(0.944)*	0.427	-0.017	0.754*(0.128)*	0.96	0.0006
Income from livestock per annum	1.000 *(3.4e-06)*	0.346	6.8e-07	1.000*** *(4.0e-06)*	0.08	1.5e-08
Income from crops per annum	1.005 *(0.000)*	0.116	0.000	1.000** *(0.000)*	.0125	1.1e-07
Travel time to nearest market	1.006 *(0.018)*	0.744	0.001	0.959*(0.026)*	0.131	-0.000
Access to extension services	135.478** *(298.60)*	0.026	0.802+	47.13*** *(105.78)*	0.086	0.002+
Altitude of the farm	0.996 *(0.003)*	0.204	-0.001	0.996*(0.004)*	0.343	-6.85e-06
Distance to the river	0.484* *(0.123)*	0.004	-0.154	1.252*(0.310)*	0.364	0.001
Income from off-farm activities	1.000*** *(2.4e-06)*	0.085	-8.82e07	1.000*(3.2e-06)*	0.638	7.1e-09
Number of visits by extension staff	0.087** *(0.103)*	0.040	-0.516	0.281*(0.278)*	0.200	-0.001
Years of livestock keeping experience	0.954 *(0.031)*	0.157	-0.01	1.001*(0.042)*	0.975	0.000
Land tenure dummy	3.817*** *(2.85)*	0.073	0.249+	1.287*(0.993)*	0.744	-0.000+
Population density (sub location)	0.999 *(0.002)*	0.945	-0.000	0.999*(0.002)*	0.990	1.6e-08
Number of obs =120 ; LR chi2(36) = 89.05 ; Prob > chi2 = 0.0000 ; Log likelihood = -79.6874 ; Pseudo R^2 = 0.3585						

Figures in parentheses are the standard errors.
***, ** and *** Significant at 0.01, 0.05 and 0.1 levels respectively.**
RRR = Relative Risk Ratio

Extensive is the referent livestock production system
+ dF/dx is for discrete change of dummy variable from 0 to 1.

Access to extension: The relative risk ratio comparing farmers who accessed extension services to those who did not for preferring intensive livestock production system to the extensive livestock production system was 135.478 in the intensive system relative to extensive system, holding other variables in the model constant. In the other model, the RRR value was 47.125. This implies a strong positive relationship indicating that farmers who had access to extension services were more likely to adopt intensive livestock production systems compared to those who did not access the services.

***Distance to the river**:* The RRR for a unit increase in the distance from the household to the river was 0.484 for intensive relative to extensive livestock production system. Increasing the distance by one kilometer holding other variables in the model constant would cause a farmer to prefer the intensive livestock production system over the extensive ones. The extensive livestock production systems are likely to be found in households who are closer to the river. Although this finding is contrary to expectations, it has important implications on the potential impact this system has on the environment. The extensive system is associated with overgrazing on the riparian zone and other public grazing lands.

Off farm income coefficient: This is the RRR for a one unit increase in off farm income for intensive livestock production system relative to the extensive system, given that the other variables in the model are held constant. If a farmer were to increase his off-farm income by one shilling, the relative risk for intensive relative to extensive production system would increase by a factor of 1.00, given all other variables in the model are held constant. Similar results were obtained for incomes from livestock and cropping activities.

Access to credit: This variable was found to positively influence intensification. The relative risk of semi-intensive relative to extensive livestock production system would increase by a 49.004 comparing those who accessed credit to those who did not, given all other variables are held constant. Credit eases the cash constraint in the household and can be used for long term investment in farm structures.

Male gender: This is the RRR comparing males to female for semi-intensive relative to extensive livestock production system, given other variables in the model are held constant. For males relative to females, the relative risk for intensive relative to extensive livestock production system would be expected to increase by a factor of 7.9 e+08, given the other variables are held constant. In other words, males are more adopters of intensive livestock production systems.

Land tenure: This variable was found to positively influence intensification. As the farmers land tenure becomes secure, such a farmer is more likely to have an intensive livestock production system, relative to the extensive livestock production system.

4.5 Simulation Results

Figures 4.4 shows the spatial distribution of livestock production systems in 2007, the baseline year.

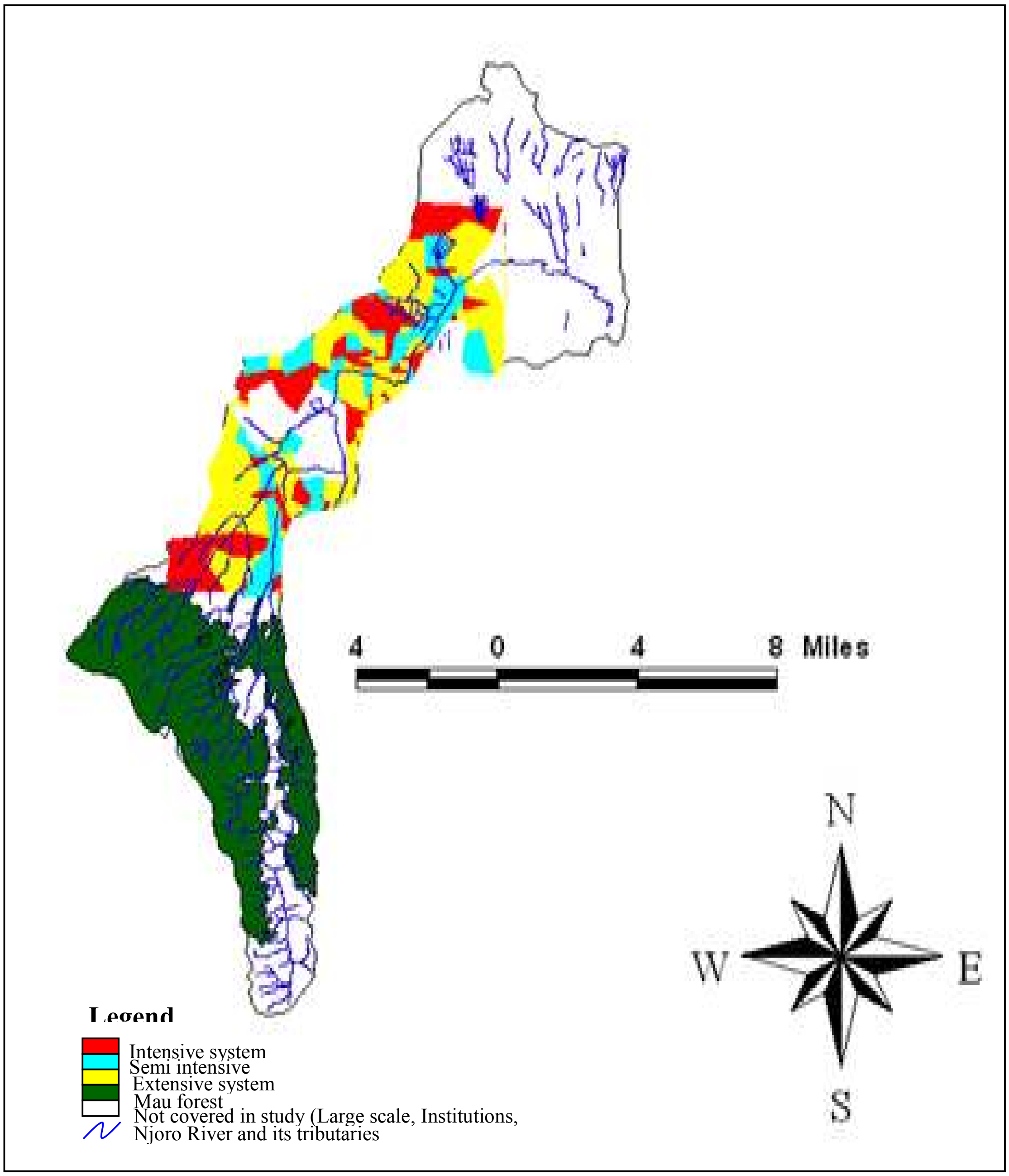

Figure 4.3: Spatial distribution of livestock production system in 2007 (*Benchmark*)

The baseline systems were projected for 2026, under different assumptions, which were specified within three scenarios: *business as usual*, *market oriented* and *environmental sustainability.* Under the business as usual scenario, it was assumed that trends observed within 10 years preceding the base year (2007) will continue. The projections for 2026 under this scenario indicate that there will be a gradual system transition, with the semi intensive system, an intermediate system occupying several areas previously occupied by the extensive system. However by 2026, the intensive systems will be covering greater spatial extent than any other system. These changes will be driven by decline in farm sizes, population pressure and shortage of pastures. The results are as shown in Figure 4.5 below

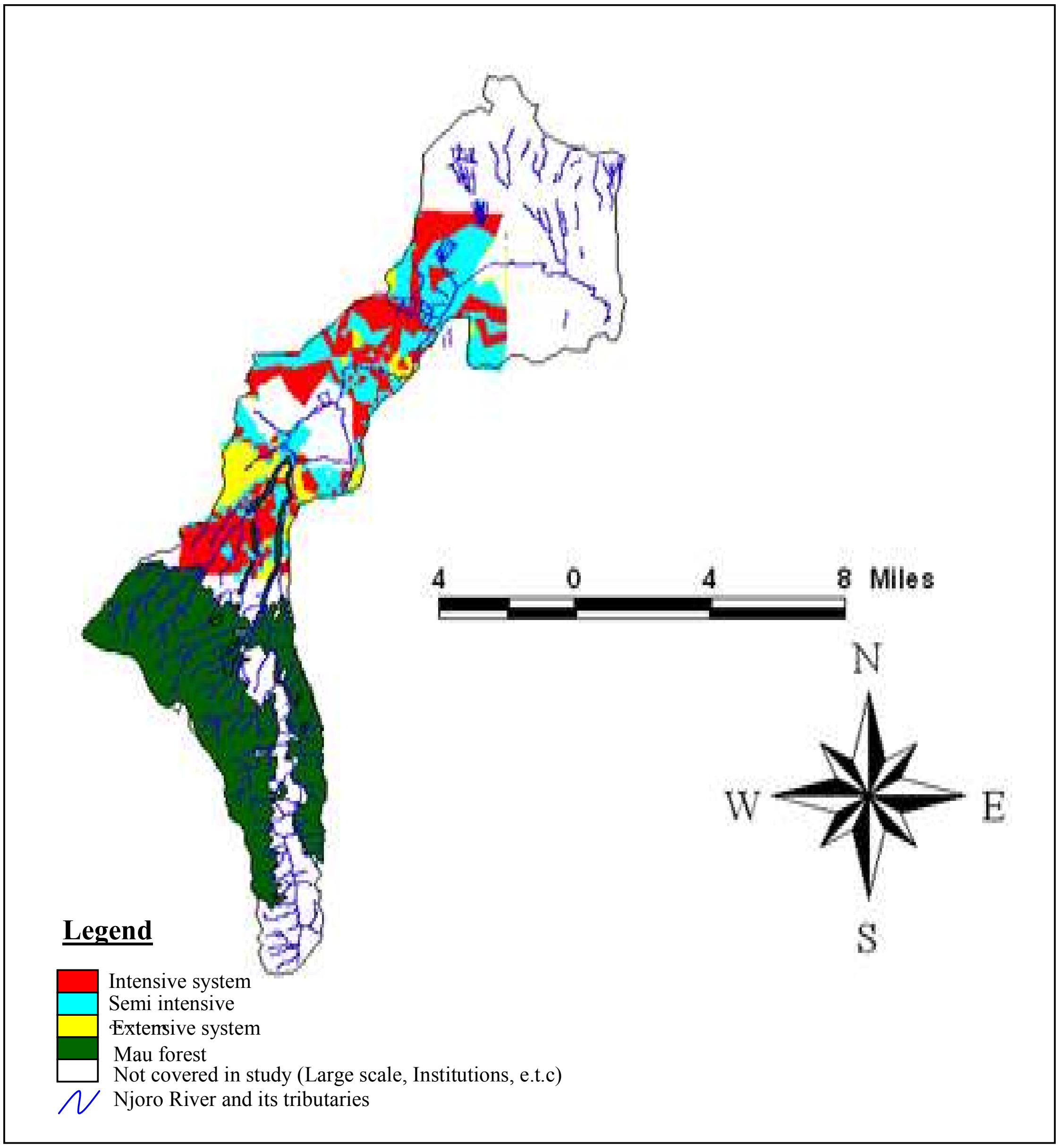

Figure 4.4: Baseline projections for 2026 in the *Business as usual* scenario

Results from the market oriented scenario, which assumed a policy mix in support for intensification verify the hypothesis that government policy can influence the livestock production systems. As shown in Figure 4.6, there will be more intensification especially in areas close to the main urban centers of Nakuru and Njoro. Results indicate all the systems will grow at the baseline rates between 2007 and 2010, to allow for systems to respond to policy changes. However between 2011 and 2026, the intensive livestock production system will be expected to expand at an average annual rate of 1.87 % while the extensive livestock production system will be expected to decline at an average annual rate of 5.49 %. The semi intensive production system will be expected to grow at 2.1 % rate at a decreasing rate and start declining in 2025. However these changes can only take place if farmers will positively respond to the economic signals generated by the policy mix.

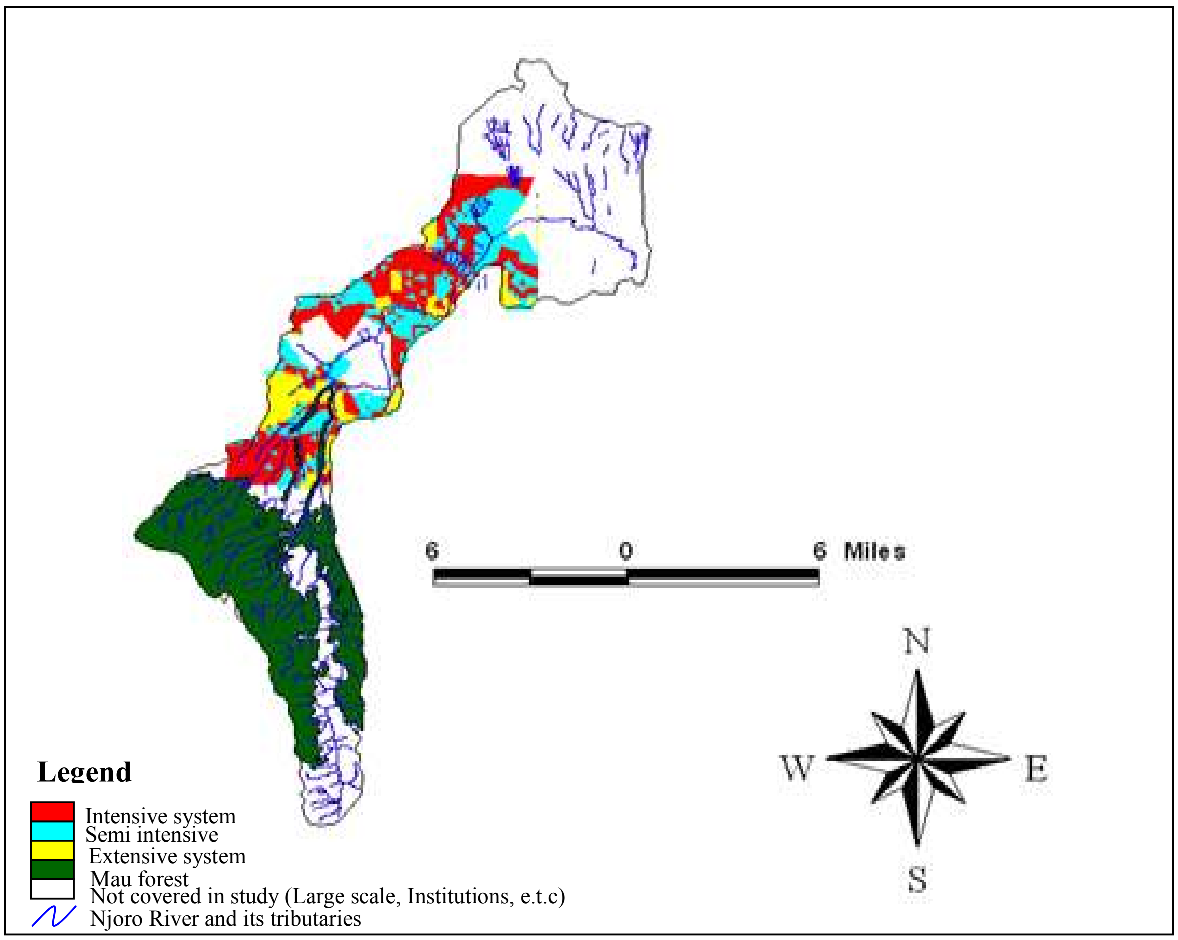

Figure 4. 5: Baseline projections for 2026 in the *market oriented* scenario

Finally, environmental sustainability policies will go a long way into easing the pressure on natural resources. As seen in Figure 4.7, following the implementation of the policies outlined under this scenario (section 3.4.4), the extensive systems will decline at a lower percentage (4.3 %) than in the baseline scenario. This is because improvement of farm fodder and increased intensification will ease the pressure on the communal grazing and water resources. The intensive system is assumed to expand at the same rate in the baseline scenario while the annual growth rate of the semi intensive system is expected to be 1.83 % on average. The slower decline in the extensive livestock production system will have an implication on preservation of traditional breed diversity that is threatened by intensification of livestock production systems.

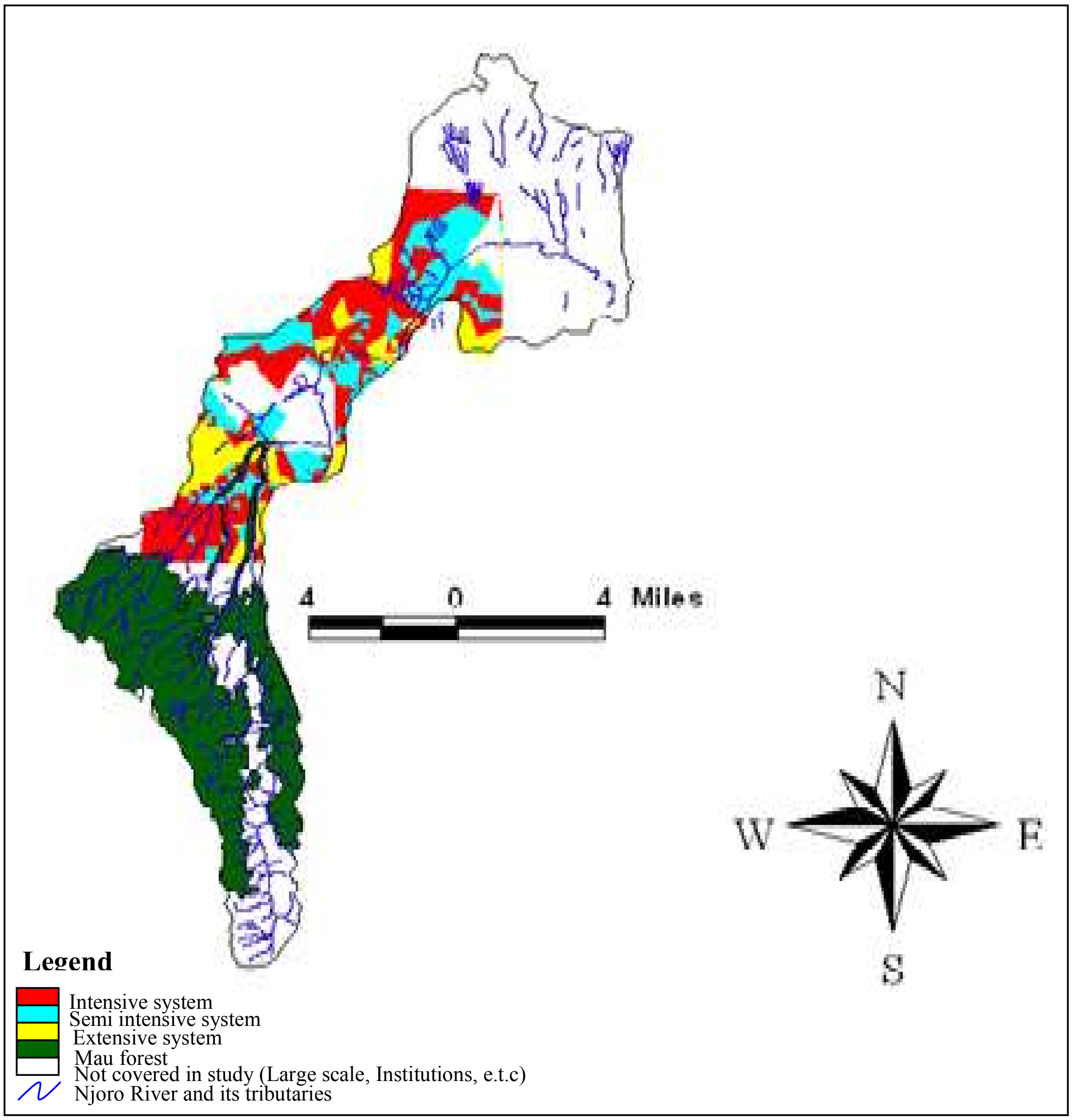

Figure 4.6: Baseline projections for 2026 under the *environmental sustainability* scenario

CHAPTER FIVE

CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Conclusions

The study characterized and classified livestock farmers within river Njoro watershed into three major production systems, intensive, semi intensive and extensive. Majority of the farmers were in the extensive and semi intensive livestock production systems, which are mainly land based systems. This study therefore ascertained that, land based systems are mainly used to produce a large share of livestock products within the study area. However, there is a moderate transition into the intensive systems, driven by policy, socioeconomic and biophysical factors. The spatial distribution of these livestock production systems was found to be influenced by socioeconomic factors (size of land, gender, income from crops and livestock) and policy related factors (access to credit, access to extension services, and distance to the river and land tenure). Based on simulations, the study reveals that transition of livestock production systems is an inevitable trend to be observed in the short and long term future. Livestock producers will continue to transit from extensive production systems into extensive and semi extensive systems, driven by changes in the environment, population increase, increasing incomes and urbanization. This expansion of livestock production systems will take place amidst declining quality and quantity of natural resources in the watershed and the climate change crisis. However, policies addressing marketing of livestock inputs and outputs, and also environmental sustainability can be used to influence the transition of livestock production systems. Some imperative implications for sustainability of livestock production systems can be drawn from the findings of this study.

5.2 Policy Implications

Livestock producers in river Njoro watershed are in three distinct production systems. Therefore, development planners and policy makers need to develop unique interventions targeting each specific group, since blanket policies are not appropriate in such a situation. Across the three systems, policy needs to encourage interventions that can enhance sustainability and productivity of livestock production systems. This can be addressed through reforms on institutions governing land tenure and fragmentation within the watershed. More secure land ownership can influence intensification of livestock production systems. Intensive livestock production systems are associated with high productivity and can help to reduce the burden of livestock production on the environment. Since the farm sizes within the watershed have continued to decline, putting pressure on livestock producers in terms of availability of on-farm livestock feed. There is also need to use policy instruments that can discourage land fragmentation and resolve land ownership issues, especially on the catchment area in the upper watershed. Besides land tenure and sizes, interventions leading to more access to extension services and credit can be used to enhance sustainable livestock production systems. Through increased extension access and refocusing extension messages, farmers can improve their livestock management practices towards more sustainable systems. Extension can be used to help farmers increase productivity on their resources, enabling them to have lower livestock densities, hence lower pressure on natural resources.

Finally, the government can allow livestock production in the watershed and other similar areas to continue business as usual. However, the consequences of this policy alternative will be more environmentally destructive production, which is a threat to sustainability and will be a drawback towards achievement of the Vision 2030 and the Millennium Development Goals (MDGs).

5.3 Suggestions for Further Research

This study focused only on the resident small scale livestock producers within the watershed. However as indicated earlier, there are a number of large scale livestock producers within the watershed, which are believed to be impacting on the environment. There are also migratory livestock, which frequent the watershed during certain periods in the year whose impact on the environment cannot also be ignored. It will be important to carry out studies on these two groups of livestock and develop strategies for improving the interactions of these systems with the environment.

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APPENDICES

Appendix 1: Spearman Correlations for Variables Used in MNL Model

	LIVSYST	ACCRED	GENDER	LANDTEN	ZONE	EXTACESS
LIVSYST	1	-.175	.167	.126	.086	.013
ACCRED	-.175	1	.034	-.147	.087	.066
GENDER	.167	.034	1	.127	-.016	-.034
LANDTEN	.126	-.147	.127	1	-.276(**)	.056
ZONE	.086	.087	-.016	-.276(**)	1	.052
EXTACESS	.013	.066	-.034	.056	.052	1

** Correlation is significant at the 0.01 level (2-tailed).

Appendix 2: Main Parameters Used in the CLUE – S Model

Line	Parameters	Description
1	3	Number of livestock production systems
2	1	Number of regions
3	3	Maximum number of explanatory variables in the equation
4	10	Total number of explanatory factors
5	65	Number of rows in cov_all.0 and all other ASCII raster files
6	62	Number of columns in cov_all.0 and all other ASCII raster files
7	6.25	The cell area in Ha (250 m grid size)
8	819179.532076	Xll coordinate of grids
9	9953834.261698	Yll coordinate of grids
10	0 1 2	Number coding of the livestock production systems
11	1 0.2 0.8	Codes for system conversion elasticity
12	1 20 50	Iteration variables for livestock production systems, which determine the criteria for model convergence.
13	2007 2026	Start and end year of simulations
14	0	Number and codes for the dynamic explanatory variables
15	1	Out pit file choice (Arc View GIS)
16	0	Region specific regression choice
17	1 15	Default initialization of land use history
18	0**	Neighborhood calculation choice
19	0*	Variables for location specific preference addition

** Feature not used due to lack of spatial data to support it.*
*** Feature not used due to lack of sufficient data describing the neighborhood effects.*

Appendix 3: Pearson Correlation Coefficients for Variables Used in the MNL Model

	HUMCAP	NATCAP	PHYCAP	FINCAP	AGE	HHSIZE	LIVINC	HHINC	MKTACESS
HUMCAP	1	-.101	.150	.191(*)	.028	-.138	.113	.362(**)	-.272(**)
NATCAP	-.101	1	.252(**)	-.050	.330(**)	.109	.172	.033	.153
PHYCAP	.150	.252(**)	1	.050	.256(**)	-.028	-.003	.376(**)	-.159
FINCAP	.191(*)	-.050	.050	1	.015	-.073	.077	-.026	-.135
AGE	.028	.330(**)	.256(**)	.015	1	-.069	.068	.023	-.093
HHSIZE	-.138	.109	-.028	-.073	-.069	1	-.132	.134	.063
LIVINC	.113	.172	-.003	.077	.068	-.132	1	.482(**)	.024
HHINC	.362(**)	.033	.376(**)	-.026	.023	.134	.482(**)	1	-.186(*)
MKTACESS	-.272(**)	.153	-.159	-.135	-.093	.063	.024	-.186(*)	1

Appendix 4: Input Files Used in CLUE- S Simulation Model

File name	Description
Main. 1	The main parameters file specifying all the important parameters that determine the configuration of the simulation. Detailed description presented in appendix 4
Alloc1.reg	Regression parameters. This file displays the logistic regression model results which relate the probabilities to the location characteristics.
Allow.txt	This file contains the conversion matrix, which has rows and columns equal to the number of livestock production systems. It indicates the allowed livestock production systems conversions. The values in the matrix are either 0 (conversion not allowed) or 1 (conversions allowed). E.g. in this study conversion of intensive system into an extensive system was not allowed
Region_*.fil	Area restriction files, showing areas where changes cannot occur due to spatial policies or tenure status. E.g. where the livestock production systems cannot be allowed to expand into a protected forest or land occupied by an institution.
Demand .in*	This file contains different system demands calculated at the aggregate level. For every year, the demands by the three systems must equal the total area occupied by the systems in the watershed.
Cov_all.0	This is the initial livestock production systems. It is a grid of all livestock production systems at the start of the simulations (year 0).
Sc1gr*.fil	These files are the grids for the explanatory variables used in the model. * represents the number of the variable ranging from 0 to 10.
Sc1gr#.*	Grid files for the dynamic explanatory factors such as population density.

Appendix 5: Survey Instrument

EGERTON UNIVERSITY /SUMAWA-GL-CRSP
RIVER NJORO WATERSHED LIVESTOCK PRODUCERS SURVEY, 2007

"We are part of a team at Egerton University, who are trying to design policies to improve sustainable utilization of watershed resources. This is a follow-up of a previous survey we carried out in April-June 2004. Your help in answering these questions is much appreciated. Your participation is voluntary. Your response will be confidential and will be pooled with those of other households and analyzed together.

QUESTIONNAIRE IDENTIFICATION

Farm Household No _________________ (to be filled by the supervisor at the time of issuing the questionnaire to enumerator)

Date (day/month/year) ____/___/2007

Respodents' name:	_______________________	**HMNUM***	__________
Enumerator name:	_______________________	**ENUMCODE****	__________
Location:	_______________________	**LOC****	__________
Sublocation:	_______________________	**SUBLOC****	__________
Village:	_______________________	**VILL****	__________
Study zone	_______________________	**SZONE****	__________

GPS location of the household

UTM ……………………………………Longitude…………………………….…….

Latitude………………………………Altitude…………..

(Enume: Fill at the start or the end of the interview)

Starting time ________

Ending time _________

***(Enum: Fill the HMNUM after completing the demog table)**

***** Codes for Loc, Subloc, Vill and Szone provided in a separate sheet**

SECTION A: BACKGROUND INFORMATION/ FARM ACTIVITIES AND FACILITIES

1. When did you start keeping livestock? (year) **Yrstart**__________

(a)Which **cattle breed(s)** did you keep first **breedkp**_____ **breedkp**_____ **breedkp**_____

1= Cross breed 2= Pure breed 3= Local breed 4= Other specify____________

(b) Have you ever **changed the breed(s)** since you started keeping livestock? **livecng**______

1=yes 0=No

(c)If yes, which breeds are you **keeping now**? **bred1now**_______ **bred2now**_____**bred3now**_____

(d)What are the **reasons for the change**? **rsn1cng**_____ **rsn1cng**_____ **rsn1cng**______

1=to increase milk production 2=Due to disease prevalence 3=Lack of labour 4=Shortage of feeds 5=Advice /education from extension officers 6=Other (specify)________________

2. What is the **main source of food** for your household? **fdsrc**__________

1= own farm production 2= purchased 3=from other family members 4=other (specify)________

3. (a) **Total farm** area **owned** in acres (all parcels within the **watershed**) **totfarm** [_____]

(b) Area **rented in** (acres) (within the **watershed**) **ldrentin** [_____]

(c) Area **rented out** (acres) (within the **watershed**) **ldrentot** [_____]

(d)Area accessing **freely** / **gift** (within the **watershed**) **ldgift** [_____]

(e) How much of **your** land ***(Enume: Ask for owned, rented or free access land)*** is under

(i)Cultivation______acres (ii) Pasture______acres (iii) Homestead______acres (iv) Others (specify____________ _______ Acres

(f)For **all the parcels** of **land owned**, please indicate the following details

Parcel number	acreage	Year acquired	Mode of acquisition(**see codes below)**	Tenure(**see codes below)**
parcnum	**acrege**	**yracq**	**modeacq**	**tenure**

Land tenure type 1= Freehold with certificate/title deed 2 = Freehold without certificate/title deed

3 = Rented from another individual 4 = Informal and not paying rent (e.g. roadside/public land held informally

5 = other (specify) ________________

Codes for acquisition: 1=inheritance 2=Purchase 3= Government allocation 4=Loan 5=other(specify)

(e) Did you access any **communal/public land within the watershed** in the last 12 months? 1=Yes, 0=No

Type of **public land (Codes below)**	Purpose(s) **(codes below)**	Mode of access 1=free 2=payment	Amount paid **(Kshs.)**	Payment per? **(Codes)**
typplnd	**pldpurp**	**modeacss**	**amtpaid**	**pmtprd**

Types: 1= Road researve 2= Riparian zone 3=Public grazing land 4=Government forest 5=Public Spaces 6=School compound 7=other (specify) __________

Purpose(s) 1= crop production 2= Livestock grazing 3=Cutting fodder 4= Other (specify)__________

Payment per? : 1= Acre 2= Month 3= Day 4=Year 5= Other (specify)_____

4. What are the **main farm enterprises**? Please **rank them** and mention **two main purposes** of having them (**Jun 06 – jun07)**

Enterprise *(Probe for each)*		**Rank**	**Purpose 1**	**Purpose 2**	**Purpose codes**
Milk	**1**				1 = income 2= production of Breeding and slaughter stock 3= Manure 4 = Social prestige and status 5 =Food source/ security 6= production of livestock feed 7 = Draught 8=other (specify)_________
Eggs	**2**				
Other livestock products	**3**				
Maize	**4**				
Wheat	**5**				

Horticulture	**6**				
Other 1 (specify)	**7**				
Other2 (specify)	**8**				

SECTION B: LIVESTOCK INVENTORY

5. Did you have **any livestock in your farm** in the **last one year** (**Jun 06 –Jun 07**)? **liveown** ____________
(1= yes 0= No)

6. If **yes** in 5above indicate the **details on** livestock (**except cattle**) inventory within the **last one year.**

Livestock **livetype**		Number owned by the household Jun 2007 **Numj07**	**Number sold** **numsale**	Unit selling price(Kshs) **selprc**	Number purchased **numprch**	Purchase unit price **Kshs.** **purprc**	Number **consumed at home** **numcon**	Num. **died** **numdie**	Number **stolen** **numstl**	Donations **out**	Donations **in** **numdon**	Number kept **for** others **kepfor**	Num kept **by** others **kepby**	Number owned by the household Jun 06 **Num j06**
Goats														
Local goats	1													
Toggenburg	2													
Saanen	3													
Anglonubian	4													
Sheep (Local)	5													
Cross goats	6													
Sheep (exotic)	7													
Indig chicken	8													
Broilers	9													
Layers	10													
Ducks	11													
Geese	12													
Turkey	13													
Donkeys	14													
Pigs	15													
Rabbits	16													
Beehives	17													

7. Indicate the numbers of **cattle** for the different **breeds** owned at **present** on the farm

Breed **breed**	Female calves still suckling or not weaned **femcalf**	Female calves weaned but maiden **femcwen**	Incalf heifers **incheif**	Cows **cows**	Male calves still suckling or not weaned **malcwen**	Castrated male calves (Steers) **castmcf**	Bulls **bulls**	**Breed codes** 1=Frieshian cross 2= Jersey cross 3=Guernsey cross 4= Ayrshire cross 5=Local breed 7= other (specify)___ ________________

Codes for tables below.

Animal type 1 = Female calves still suckling or not weaned 2 = Female calves weaned but maiden 3 = Incalf heifers 4 = Cows 5 = Male calves still suckling or not weaned 6= Castrated male calves (Steers) 7 = Bulls
Reason for purchase: 1= Replacement of old animal 2 = Obtain more manure 3= Increase social prestige 4 = Increase milk production 5= Replace animal that died suddenly 6 = for animal draft 7 = Other (specify)_____________

Purchased/Obtained from who/ Source of animal: 1 = Bought from government farm 2 = Bought from smallholder farm 3 = Bought from individual trader/broker 4 = Loan from project/ co-operative society 5 =Gift from relatives/ others 6= Obtained as dowry 7= Reared on farm 8= Kept but not owned 9=Bought from large farm 10=Other (specify) ___________
Season 1 = Long dry**(Sept-March)** 2 = Long rainy**(March-July)** 3= Short dry**(July-Aug)** 4= Short rainy **(Aug-Sept.)**
Reason for selling 1 = for cash or income 2 = Old age 3 = Disease 4= Poor performance 5= Slaughtered for meat 6 = Unwanted (e.g. bull calves) 7 = Ritual / ceremony 8 = Other__________
Cause of death: 1 = Old age /natural death 2 = Died due to disease 3 = Died due to injury/ accidents 4= Died due to poisoning (acaricide, snake bite, bracken fern, etc) 5 = Died due to bloat 6 = Died due to starvation 7 = Stolen 8 = Neglect (e.g. bull calves) 9= other (specify)____________
Buyer type: 1=Broker 2=Butcher 3= Small scale farmer 4=Large scale farmer 5=Large company (e.g KMC) 6= Other(specify)

8. Indicate **individual details** on all **cattle that were purchased/ obtained/ sold / Died in the last 12 months**.
(*Number of calvings and State refer only to cows)

(a)CATTLE PURCHASED OR OBTAINED (use separate row for each animal)									
Animal type **codes above)**	Reasons for purchase **codes above)**	Breed **(Use codes above)**	Age (Yrs)	Number of calvings *	State* **1=dry 2=pregnant 3=lactating**	Season **codes above)**	Cost (Kshs)	**From whom** **codes above)**	**Place** Where Bought from

(b)CATTLE SOLD or SLAUGHTERED (separate row for each animal)									
Animal type **(codes above)**	Reasons for selling **(codes above)**	Breed **(Use codes above)**	Age (Yrs)	Number of calvings *	State* **1=dry 2=pregnant 3=lactating**	Season **(codes above)**	Price sold (Kshs)	To whom **(codes above)**	**Place where** sold

(c) CATTLE that DIED or were STOLEN (separate row for each animal)							
Animal type	Cause of death/loss	Source of animal	Breed	Age (Yrs)	Number of calvings *	State* **1=dry 2=pregnant 3=lactating**	Season

SECTION C: LIVESTOCK FEEDING AND LABOUR INPUTS.

9. Indicate who in the household is **primarily responsible** for carrying out the following tasks (**Jn 06–Jun 07)**

CATTLE ACTIVITIES		Activity done 1=Yes 0=no	**Main people** doing the work are: **(see codes below)**	Number of **people** involved	Number of **hours** per person per day	**Season** when activity is intensive
liveact		**actdne**	**mpleact**	**numple**	**hrdday**	**sesact**
Grazing animals	**1**		[__] [__] [__]			
Tethering	**2**		[__] [__] [__]			
Cut and carry of feed/fodder	**3**		[__] [__] [__]			
Planting, weeding and manuring forage	**4**		[__] [__] [__]			
Milking	**5**		[__] [__] [__]			
Marketing milk	**6**		[__] [__] [__]			
Spraying/Dipping	**7**		[__] [__] [__]			

Cleaning animal shed or boma	**8**		[__] [__] [__]			
Obtaining AI/ Veterinary Services	**9**		[__] [__] [__]			
Fetching water for animals	**10**		[__] [__] [__]			
Taking livestock to the watering point	**11**		[__] [__] [__]			

1 = Household head 2 = Adult Males (other than HH head) 3 = Adult Females (other than HH head) 4 =Spouse 5 = Any Household member 6 = Children 7 = Long-term labourers 8 = Casual labourers 9 = Any Adult in Household 10=Other (specify)_________________

10. If Permanent and **Casual labourers** above indicate

(a) **Monthly salary** for permanent labour (Ksh) **salary**__________

(b) **Daily wage rate** for casual labour (Ksh) **wage**__________

11. (a) What is your **main system for keeping your livestock now** and what was it in the **past** (e.g. 5- 10 years ago), if the farm was established then?

Livestock		System presently	System in the past **(1-2 yrs ago)**	System in the past **(3-5 yrs ago)**	System in the past **(5- 10 years ago)**	**Reason(s) For changing (at least 2)**
livtyp		**syspre**	**syspst2**	**syspst5**	**syspst7**	**rsncge**
Pure breed cattle	**1**					
Cross breed Cattle	**2**					
Local breed cattle	**3**					
Local Goats	**4**					
Exotic goats	**5**					
Sheep	**6**					
Chicken	**7**					

Systems: 1 = Only grazing (free-range or tethered) 2 = Mainly grazing with some stall feeding 3 = mainly stall feeding with some grazing 4 = only stall feeding (zero grazing) 5=Deep litter 6= scavenging 7=Free range 8= other (specify)_____________

Reasons: 1= sold part of the land 2=Amount of grazing **3**=change of land tenure 4= Shortage of pastures Five=Acquired exotic animals 6=To increase production/ productivity 7=other (specify) ______

12. (a) **If GRAZING** in Q 11 **above,** indicate below which types of land are accesed in different seasons, in order of importance.

Season **sngraz**		First source	Second source	Third source	Fourth source
		Src1	**Src2**	**Src3**	**Src4**
Long dry season	1				
Long rainy season	**2**				
Short dry season	**3**				
Short rainy season	**4**				

Sources: 1= Own pasture/uncropped land 2=Own post harvest cropped 3=Neighbours post harvest cropped 4=Public land 5= other (specify)_____________

13. (a) Do you usually **experience a shortage of feeds**? (1=Yes =No) **fedsttg**__________

(b) If **Yes** indicate in the table below **when the shortages are experienced** ***(If No Skip to Q14)***

Period		**Long dry season**	**Long rainy season**	**Short dry season**	**Short rainy season**	**All year round**
Now	**1**					
5 years ago (skip if farm not established then)	**2**					
10 years ago (skip if farm not established then)	**3**					

(c) **Rank** the seasons depending on when the **shortages are severe**.**Rank1**____**Rank2**_____**Rank3**_____

1= Long dry season 2= Long rainy season 3= Short dry season 4= Short rainy season 5=All year round

(14) Incase you have excess **feeds** what do you do to the **extra feeds**? **extrfed**______**extrfed**_______

1=make hay 2= Sell in raw form 3= Make silage 4=Compost manure 5= Preserve in the field as pasture 6= other (specify)________

15. What difficulties do you experience **when sourcing animal feeds**? **Prob1____ prob2_____prob3_____**

0= None 1= Poor quality 2= Irregular supply 3= Seasonal shortages 4=High cost 5=other (specify)________

16. (a) Have you recently **sought for new feed sellers**? (1= yes 0=No) **newsalr______**

(b). If **yes in 16(a) above give reason**(s)? Rsn1 ___________ rsn2 _________ rsn3 _______

1= Find a better price 2= Find a single seller of larger quantity 3 = Want more sellers
4 = Find a more reliable seller 5 = Find a better quality 6= Sellers stopped selling 7= other (specify) _

(c) **If yes** in 13(a) above **Rank the 3 major strategies** (**in terms of importance**) you apply during these **periods of feed shortage** and what you did in the past.

Strategy **RANK: First=1, second=2 Third=3**		Now	5 Years ago **(skip if farm not established then)**	10 Years ago **(skip if farm not established then)**
Strtgy		**strnow**	**Srt5yrs**	**Srt10yrs**
Use standing mature fodder (napier or other)	**1**			
Use cut and stored forages (stover, hay, other crop residues, – NOT purchased)	**2**			
Feed less to all animals	**3**			
Feed less to certain categories of animal	**4**			
Feed silage (specify forage type________)	**5**			
Rent grazing land	**6**			
Take cattle to search for pasture elsewhere	**7**			
Reduce herd size	**8**			
Purchase fodder	**9**			
Purchase concentrate feed	**10**			
Feed tree leaves/forage not normally used	**11**			
Others (specify) ____________________	**12**			

(d) **Indicate** details for the **own production and sales of fodder in the last 12 months (Jun 06–Jun 07)**

Fodder type		Quantity produced	Quantity units	Quantity Fed to livestock	Quantity sold	Area	Quantity stored	Livestock fed **(codes pg 7)**	Buyer **(Codes below)**
fodtyp		**fqtyprod**	**fqtyunt**	**qtyfed**	**qtysld**	**fdarea**	**fdstre**	**livfder**	**Buyer**
Nappier grass	**1**								
Cut grass	**2**								
Green Maize stover	**3**								
Forage legumes	**4**								
Dry maize stover	**5**								
Banana Stalks	**6**								
Sweet potato vines	**7**								
Straw from wheat	**8**								
Fodder from trees	**9**								
Other crop residues	**10**								

Buyer: 1= Small scale farmer 2= Large scale farmer 3=other(specify)____________________

(e) (i) If using fodder from trees above. How many **fodder producing trees** do you have of each type?

		Number of trees			**Number of trees**
tretyp		**trenum**	**tretyp**		**trenum**
Leucaena	**1**		Calliandra	**4**	
Sesbania	**2**		Indigenous trees	**5**	
Grevillea	**3**		Tithonia	**6**	

(ii) **Since when** have you **had fodder** trees? [__ ___ ___] **(year)**

(iii) **From whom** did you get the **information** on **fodder trees**? [___] [___]

1= Extension service agents/project 2= Co-operative 3= Neighbours 4 = University 5 = Others (specify)________

17. (a) Have you planted **forage legumes in your farm?** (1= yes 0=No) **forleg _____**

(b) If **Yes**, which **forage legumes**? (use codes) [___] [___] [___]

1 = Desmodium 2 = Lucerne 3= Alfa alfa 4=Other (specify)__________

(c) **Since when** did you start growing forage legumes [__ ___ ___] **(year)**

(d) **From whom** did you get the **information** on legumes? [___] [___] **(use codes above)**

18. (a) Indicate for **each item** the quantity of **inputs purchased** and **expenditure** for the stated period and the unit cost of each item. If the quantity and cost are not known, **indicate the total amount** (KSh).

Period: **Jun 06 – Jun 07**

Item		Animal types fed **(Codes below)**	Season(s) mainly offered **(Codes below)**	Quantity purchased	Quantity Unit **(Codes below)**	Main **seller/service** provider **(Codes below)**	Mode payment **(Codes below)**	Distance to seller **(Kms)**	Mode of tspt	Transport cost per unit **(Ksh)**	**Interval of purchase Code (Codes below)**	Cost per unit **Kshs.**
livinput		**anityp**	**season**	**qtpur**	**qunt**	**seller**	**pymd**	**dist**	**tspmd**	**tstcst**	**intev**	**ctunt**
Napier	1	[__][__][__]	[__][__]									
Dry Maize Stover	2	[__][__][__]	[__][__]									
Green maize stover	3	[__][__][__]	[__][__]									
Hay	4	[__][__][__]	[__][__]									
Straw	5	[__][__][__]	[__][__]									
Fodder trees	6	[__][__][__]	[__][__]									
Other crop residues	7	[__][__][__]	[__][__]									
Forage legumes	8	[__][__][__]	[__][__]									
Cut grass	9	[__][__][__]	[__][__]									
Dairy meal	10	[__][__][__]	[__][__]									
Bran	11	[__][__][__]	[__][__]									
Maize germ meal	12	[__][__][__]	[__][__]									
Pollard	13	[__][__][__]	[__][__]									
Cakes/husks	14	[__][__][__]	[__][__]									
Cow/pigeon peas	15	[__][__][__]	[__][__]									
Poultry waste	16	[__][__][__]	[__][__]									
Molasses	17	[__][__][__]	[__][__]									
Broiler starter mash	18	[__][__][__]	[__][__]									
Broiler finisher	19	[__][__][__]	[__][__]									
Chick and duck mash	20	[__][__][__]	[__][__]									
Growers mash	21	[__][__][__]	[__][__]									
Layers mash	22	[__][__][__]	[__][__]									
Poultry litter	23	[__][__][__]	[__][__]									
Mineral salts		[__][__][__]	[__][__]									
Block	**24**	[__][__][__]	[__][__]									
Powder	25	[__][__][__]	[__][__]									
Stone	26	[__][__][__]	[__][__]									
Acaricides	27	[__][__][__]										
Dewormers	28	[__][__][__]										
Vet. Treatment	29	[__][__][__]										
Vaccines	30	[__][__][__]										
Service bulls	31	[__][__][__]										
A. I	32	[__][__][__]										
Water	33	[__][__][__]										
Fuel for **brooding**	34	[__][__][__]	[__][__]									

Buying units:1 = 90 kg bag 2 = 50 kg bag 3 = gorogoro 4 = kg 5 = Numbers 6 = wheel barrow 7 = debe 8 = tray 9 = litre 10 =bunches 11 =crates 12 = pickup 13 = donkey cart 16=40 kg bag 17= 20 kg bag 18= 70 kg bag
Interval1 = daily 2 = weekly 3 = monthly 4 = quarterly 5 = semi-annually 6 = yearly 7 = other (specify)
Animal type codes: 1= Lactating cows 2= Shoats 3= Chicken 4= Pigs 5=Bulls 6= Calves 7= Draught bulls 8=All 10=other (specify)_______
Seasons: 1=Long dry season 2=Long rainy season 3=Short dry season 4=Short rainy season 5=All year
Mode of payment: 1 = Cash sale 2= On credit sale 3 = Exchange for goods (specify)______________4 = Other (specify) ___
Main seller: 1= Neighbour (farmer) 2=Veterinary shop 3= Private vet. Technician 4= Hardware shop 5= Feed manufacturer 6= Large scale farmer 7=Government vet. 8=self with professional advice 8=traditional herbalist/quack 9=other (specify)_____

(b) Incase livestock were **vaccinated** in 18(a) above against **which diseases were** the **Vaccinations done**? **dis1______ dis2 ______ dis3 _____ dis4______**

1= Foot and Mouth Disease (FMD) 2= Rinderpest 3= C.B.Pleuropneumonia (CBPP) 4= Anthrax
5= Black quarter 6= Haemorrhagic septicaemia 7= Lumpy skin disease (LSD) 8 = Brucellosis
9 = Rift Valley Fever 10 = ECF infection & treatment 11= Don't know 12 = other (specify)________

SECTION D: MILK AND OTHER LIVESTOCK OUTPUT PRODUCTION AND MARKETING

19. (a) **When** did you **first get a local cow**? **(Year)** [___ __]

(b) **How** did you get your **first local cow? (see codes below)** [_____]
(c) **When** did you **first get a crossbreed cow**? **(Year)** [___ __]
(d) **How** did you get your **first cross breed cow**? **(see codes below)** [__ ___]

(e) **When** did you first **start selling milk? (year)** [___ __]

Mode of acquisition: 1= Purchased cow from neighbour farmer/ market/ development project
2= Obtained cow from a development project as gift/ loan etc. 3= Through purchased bull on Heifer/cow. 4= Through AI on heifer/ cow 5= through borrowed/rented bull on heifer/cow 55
6= As a gift from relatives /friends 6= As a loan from relative/friend/ neighbour 7 = Dowry payment
8 = Other (specify)__________

20. (a) Do you **plan to increase the amount of milk** you produce? 1=yes 0=No **incmlk______**

(b) If **yes, how do you plan to do it?** **Incmlk1_______ Incmlk2 _______**
1= improve the grade of animals 2= produce more feed 3= buy more feed 4= increase number of dairy cows 5= increase number of dairy goats 6= spend more on controlling animal disease 7= depends on extensionist's advice 8 = better management and feeding practices 9= don't know10 Other______

(c) If NO, why not? **Coninmlk1_______ Coninmlk1_______**
1= My animals cannot produce more 2 = Not enough feed available for increasing production
3= Lack of credit to buy animals/feed 4 = Buying more feed would be too expensive
5= I cannot use more milk 6 = Dairy animals have poor health 7= The price of milk is too low
8 = I cannot sell more milk 9= Lack of labour 10= There is not enough reliable water available
1 1= other specify _____

21. (a) Indicate the details on Manure production, sales and usage within the last one year.

Quantity produced	Quantity units	Quantity used on crops*(**use prod. units**)*	Quantity sold*(use prod. units)*	Sales price per unit	Quantity stored*(**use prod. units**)*	Buyer type codes	Place where sold
qtyman	**qtyunt**	**qtycrp**	**qtysld**	**saprc**	**qtyst**	**buytyp**	**placesel**
Unit codes: 1= 90 kg bag 2= 50kg bag 6= wheelbarrow 7= Debe 12= Pick up 14= lorry 15= Hand cart 16=Tractor trailer 20= other (specify)_____ 25= canter. **Buyer: 1= Small scale farmer 2= Large scale farmer 3=other(specify)________________________**							

(b) What are some of the **other uses of manure** in your farm?
manothr1___________________________________
manothr2___________________________________
manothr3___________________________________

22. **For each COW in the herd up to 3, fill a row**. [If number of cows is more than 3 then **select your best 3.**

COW		Cow **Age** (Years)	Number of **Calvings**	**Age at 1st calving** (Months)	**Pregnant Now?** 1=Yes 2=No	**Last service** date MM/YY **(most recent)**	**Source of last service**	**Last calving** date MM/YY	Second last calving date MM/YY	**TOTAL DAILY MILK PRODUCTION (Morning plus evening milk)** MILK QTY UNIT_______			Average length of **Drying period**	**MOST RECENT CALF**		
Name	Breed (code)									At Calving	Yesterday	When **stopped milking**		Sex 1=M 2=F	Where is calf?	Age of calf when disposed of **in months**
	Breed	**agecw**	**numcal**	**age1cal**	**preg**	**sersrc**	**lserdt**	**lstcvdt**	**slcadt**	**mlkcav**	**mlktest**	**mlkstop**	**dryprd**	**sexcf**	**wreclf**	**agecalf**

Breed: 1 =cross breed 2= local
Source of service: 1 = Own bull 2 = Other farmer's bull 3 = Government AI 4 = Private AI 5 = Coop / Self Help Group 6= Project AI 7 = Project bull 8 = Unknown bull 9 = Other (specify)________________
Where is calf: 1= Present on farm 2 = Died 3 = Slaughtered 4 = Sold 5= Given out 6 = Aborted / still birth 7 = Other (specify) _
Milk units: 1= Litre 2= Kg 3= 4= Treetop bottle (750ml) 5= "Pint" or Large Cup (500 gm) 6= Small Cup (350 gm) 7= Other (specify

23. How much milk, on average, does this household **consume per day**, whether from **own production, purchases or receipts** (litres)? **mlkcon______**

24. How many cows on average were being milked at any one time over the past year, **Jun 06 – Jun 07**? **Cowmlk___________**

25. Please tell us about the livestock products produced during the past year. **Jun 06 – Jun 07**

Livestock Product		Number of **months** of **production** per year	**Average** production/ month	**Unit** of Production. 1= Litres 2= Kgs 3=Trays 5=Numbers 6=750ml bottle 7=Big cup 8=Small cup 9=500 ml bottle	Number of **months** of **sales** per year	Average Amount **sold** /month	**Price** received **per Unit (Kshs) on the largest sale**	Nature of payment **(Codes below)**	Mode of transport to market. **(codes below)**	Transport cost to market per unit **(Kshs.)**	**Buyer** type of **largest sale** 1=Cooperative societies 2=K.C.C. 3=Private processors/traders 4=Hawker 5=Institutions/Hotels 6=Consumer/Neighbor/Farmer 7=Other (specify)	Was the **milk checked** **1=Yes** **2=No**	**Mode of checking (cpdes below)**
liveprod		**mprod**	**Avpmon**	**Untprod**	**Mnsal**	**Avsld**	**Price**	**Ntpmt**	**Mdtrs**	**Trcst**	**bytype**	**mlkch**	**mchk**
Fresh Milk	**1**												
Sour milk	**2**												
Eggs	**3**												
Ghee	**4**												
Honey	**5**												
Hides and skin	**6**												
Fish (if have fish Ponds)	**7**												
Goat milk	**8**												
Other(Specify)	**9**												

Mode of transport: 1= on- foot 2 = draft animals/ carts 3 = bicycle 4 = public vehicle/ matatu/ bus 5 = private pick-up, van, truck 6= other (specify)

Nature of payment: 1 = Cash sale - single sale 2 = Cash sale – verbal contract 3= on credit sale- single sale 4 = on credit sale- verbal contract 5 = on credit sale- written contract 6 = Exchange for goods 7 = other (specify) ____________

Mode of checking: 1 = Not checked 2 = Lactometer 3= Smear test 4 = Smell test 5 = Colour check 6= Match check 7 = Alcohol gun test 8 = Thermometer test 9=Strip cup 10=Other (Specify)_________________

SECTION E: LIVESTOCK MANAGEMENT AND HEALTH SERVICES

26. (a) How do you **feed milk** to your **calves**? **calsuck**_____________
1 = Let it suckle all day 2 = Restrict the suckling 3 = Bucket feeding
4= other (specify)___________

(b) If you let them **suckle**, **how long** do they **continue suckling**? Give a period in **months** [___]
(c) At what age in **months** do you **wean** the calves and **at what age** are they **sold?**
(Average of last 3 calves) (**put 0 if slaughtered before weaning)**

Calves	Age at weaning (months)	Age if sold (months)
Females	[___.__]	[___.__]
Males	[___ .__]	[___ . __]

(d) Do you **castrate male calves** not selected for breeding? (1= Yes 0 =No) _______
(e) How many **times a day do you milk** your cows? Tick where appropriate 3 times [___]
2 times [___]
Once [___]

27. (a) Do you **confine** your animals? (1= Yes 0 =No) **confliv**___________
(b) If **Yes**, where? **wrecon1**_____ **wrecon2**_____
1= Stall 2 = paddock 3= Tethering 4 = other (specify) _______
(c) Roofing material for livestock house **roof**___________
1= without roof 2= under semi-permanent roof 3= under permanent roof
(d) Floor material for livestock house **floor**_____________
1= Soil 2= Concrete 3 = Stone 4 = other (specify) _______
(e) Wall material for livestock house **wall**_____________
1= Mud 2= Wood 3= Concrete 4= other (specify)__________
(d) How do you **treat your stall floor** for collection of **manure**? [___][___]
1 = Clean dung and urine alone regularly 2 = Add feed refusals to dung and urine before Cleaning regularly 3= Collect slurry in pit 4 = Deep litter (let dung, urine, refusals pile in stall for a while before cleaning 5 = Other (specify) _______

28. (a) Is **water always available** to your animals **throughout the day** (1=yes2=No)_______

(b) If **No**, how **frequently do you water** your cows? [___]
1= Once a day 2= Twice a day 3= Three times a day 4= other (specify)____
(c) Are all **your livestock provided water** with the **same frequency? (1= Yes 2= No**)_______

(d) What are the main **source(s) of this water?** **wtsrc1**____ w**tsrc2**____ w**tsrc3** ____
1= Carted to farm 2= On-farm well / bore hole 3 = Rain catchment 4 = Piped public Water supply 5 = Closest river/stream 6 = Bought from vendors
e) If you have to **collect water** what is the **distance** to the source? (Kms)_________
(f) If **carted to** the farm or **bought from vendors**, what is the average **water usage for your cattle** per **day**? **pwtamt_______Litres**
(g)If water is **bought** what is the **amount paid** per **20 litres can**? (Kshs.) **wtamt**________

(h) Please give an **estimate of the daily water intake** for the following **livestock types**

Livestock types		**Daily intake(Litres)**
livetype		**wtinday**
Sheep	**1**	
Cattle	**2**	
Goats	**3**	
Poultry	**4**	
Donkeys	**5**	
Other (Specify)	**6**	

29 (a) How often do you **feed minerals and/or salt**? **minfre**___

1=Ad lib in mineral box 2= only through concentrate mix 3=Only as salt at weekly/ monthly interval 4=Very occasionally 5=. None 6= other specify ______

30. What are the 3 **worst animal health problems** affecting your herd in order of the **most frequent**?

	Disease 1	Disease 2	Disease 3
Which disease? (**codes below**)	[___]	[___]	[___]
Why is this disease a problem? **(list)**	[___] [___] [___]	[___] [___] [___]	[___] [___] [___]
Clinical signs **(list)**	[___] [___] [___]	[___] [___] [___]	[___] [___] [___]
Date when last case occurred (**mm/yy**)	[__ __/___ __]	[__ __/_ __ __]	[__ __/_ __ __]
Breed of animal when last case occurred	[_____]	[_____]	[_____]
Which **animal type** is **mostly infected** by the disease? (**codes below**)	[___ ___]	[___ ___]	[___ ___]
Treatment provider of last case **(code)** **Specify name**_______________________	[_____]	[_____]	[_____]
Source of livestock service of last case **(code)**	[_____]	[_____]	[_____]
Outcome 1 = Died 2 = Survived 3= slaughtered	[_____]	[_____]	[_____]
Total number of **disease events** in last 12 months Total **cost for full treatment of this disease**	[_____]	[_____]	[_____]

Diseases: 1 = East Coast fever 2 = Anaplasmosis 3 = Respiratory / Pneumonia 4 = Diarrhoea 5 = Intestinal worms 6= Trypanosomes 7= Lumpy skin disease 8= Other skin problems9= Mortality in calves 10= FMD (Foot & Mouth) 11 = Mastitis 12 = Milk fever 13= Reproduction (abortion, fertility) 14 = Foot problems 15= Tick burdens 16 = Poisoning (acaricide, snakebite, bracken fern etc.) 17 = Anthrax 18 = Black quarter 19 = other (specify)____________

Why a problem: 1 = Highest cause of sickness 2= Causes deaths 3 = decreases milk yield 4 = Affects milking cows 5 = Expensive to prevent 6 = Expensive to treat 7 = Other (Specify) _____________

CLINICAL SIGNS: 1 = Diarrhea 2= Cough 3= Fever 4 = Lack of appetite 5 = Skin problems 6 = Swollen lymph nodes 7 = Weight loss 8 = Lameness 9 = other (specify) ________

TREATMENT PROVIDER OF LAST CASE: 1 = None 2= Veterinarian 3 = Animal Health Assistant AHA) 4 = Local traditional herbalists/ quack 5= Local informal service provider 6 = Neighbour 7 = Self 8 = Other 9=(specify)___

Source of livestock service: 1 = Government vet dept (on official duty) 2 = Government vet dept (on private duty) 3 = Private vet practice 4 = Local traditional herbalists/ quack 5= Co-operative 6= Agrovet shop 7 = Chemist 8 = General shop 9= Other (specify) __________

Animal type codes: 1= Lactating cows 2= Shoats 3= Chicken 4= Pigs 5=Bulls 6= Calves 7= Draught bulls 8=All 10=other (specify)_______

31. (a) When your **animals need health treatment, are services available**? (1= Yes 2= No) **srvav**____

(b) What **tick control** practices do you use? **tkcntr**______

1= None 2= Hand spraying 3= Grazing restriction 4= Hand picking 5= Traditional treatments 6 =Dipping Other ____

(c) If **acaricide** is used**, how is it applied**, and how frequently?

	Adults: indicate frequency	**Young stock**: indicate frequency
Dipping	[___]	[___]
Hand spray	[___]	[___]
Hand wash	[___]	[___]
Pour-on	[___]	[___]
Other specify______	[___]	[___]

FREQUENCY OF ACARICIDE USE: 1=Twice a week 2=Weekly 3=Fortnightly 4=Monthly 5=Irregularly or occasionally 6=Other (specify)_______

(d) Do you have a **trypanosomiasis** disease problem?______ 1= yes 0= No 2= Don't know.

If **yes**, which control measure do you apply for **trypanosomiasis**? [___][___]

1 = No control 2 = Control of Tse Tse flies (traps, etc...) 3= Use of drugs/chemo-therapeutics
4 = Bush clearing 5 = Use of pour-on, etc (vector control) 6 = Other (specify)

(e) If **Trypanosomosis** is present but **no control measure is employed**, why? [___] [___]

1 = Do not know where to get drugs 2 = Drugs do not work 3= Do not now how to control
3= Drugs are expensive 4 = other (specify) _______

SECTION F: ACCESS TO EXTENSION SERVICES AND CREDIT

32. (a) Indicate the use and availability of the following services in your area

Note: tick if **available**, even if not used.

	Available in your area? (1=yes 2=No)	**Number of visits in last 12 months**	Type of **livestock** extension messages received(**at leatst3**) **see codes below**
AI SERVICES by:			
Government			
Project or NGO's			
Private Practitioners			
Cooperative/farmer group			
EXTENSION SERVICES by:			
Government			[___] [___][___]
Project or NGO's			[___] [___][___]
Private Practitioners			[___] [___][___]
Cooperative/ farmer group			[___] [___][___]

1= Growing forages (napier and other grasses) 2 = Reproductive management3 = Feeding of the dairy cow 4= Health management 5= Milk processing 6= Breed selection 7= records 8= Milking
9 = Farm management/ economics/records 10 = Gender awareness 11= Credit 12= Fodder legumes or trees 13 = Food crop management 14 = Calf rearing 15 = Cash crop management 16 =soil and water concervation 17= Farm judging 18=Others specify)________

(b)Did you **apply** the **skills learned from the extension officers** in your **farm**? **Extaply______**

1=Yes 2=No

(c) How many times in the **last 5 years** has any member of this **household** attended a **dairy field day/seminar**? **dsematt** ____________

(d) How many times in the **last 5 years** has any member of this household attended a **general farmer field day/seminar**? **gensemat** ___________

33. (a)Did any member of this **household** borrow any **credit** (**cash or in-kind**) in the last one year? **(1= yes 2=No)** **creditbor** __________

(b) If yes please fill in the following details

Source of credit *(see codes below)*	Form of credit *1= cash 2= kind*	Amount of credit requested (Kshs)	Granted ? *1= yes 2= No*	How did you use the credit *(see codes below)*	Repayment period *(See codes below)*	Interest rate(pa)	If Not granted give reasons *(see codes below)*
cdtsrc	**crdfm**	**amocrd**	**crdgra**	**crduse**	**crdrpy**	**intr**	**rsnogra**
				[___] [___][___]			
				[___] [___][___]			
				[___] [___][___]			

Source of credit: 1= SACCO 2= Commercial bank 3= Microfinance institution 4= ROSCA 5=AFC 6=ASCAs 6= Empoyer/ company 7= Informal money lenders 8=FBOs 9=CBOs 10=NGOs 11= other (specify)___________
Use of credit: 1= Business 2= School fees 3= Household goods 4= Medication 5=Buy agricultural inputs (crops) 6= Buy livestock inputs 7= Build livestock structure 8=Buy livestock (Specify) ____________9=other (specify) ________
Repayment period: 1= Monthly 2= Weekly 3= Fourtnightly 4=Quartelly 5=annually 6=Semi annually 7=0ther (specify)**Reasons for not being granted loan**: 1= had outstanding loan 2= No securities 3= No enough savings 4= Defaulted previous loan 5= other (specify) _____________

SECTIONG: HOUSEHOLD ASSET OWNERSHIP AS A MEASURE OF WELFARE.

35. Please tell us about the **assets** that you own **at the moment**

Item		Current number	*Unit value*	*Total current value*	Item		Current number	*Unit value*	*Total current value*
item		**cnum**	**Untval**	**totval**	**item**		**cnum**	**Untval**	**totval**
Cow shed (s)	**1**				Farm house(s)	**18**			
Ox plough	**2**				Furniture	**19**			
Food store	**3**				Panga	**20**			
Water trough	**4**				Jembe	**21**			
Milking shed	**5**				Vehicle(s)	**22**			
Fence for paddocks	**6**				Tractor	**23**			
Chuff cutter	**7**				Tractor trailer	**24**			
Wheel barrow	**8**				Water tank	**25**			
Sprayer pump	**9**				Posho mill	**26**			
Donkey/ox cart	**10**				Cereals Sieve	**27**			
Feed troughs	**11**				Well	**28**			
Milk Buckets	**12**				Power saw	**29**			
Bicycle	**13**				Mobile phone	**30**			
Television	**14**				Fixed land line	**31**			
Radio	**15**				Irrigation equip.	**32**			
Spade/shovel	**16**				Borehole	**33**			
Solar pannel	**17**				generator				

SECTION H: HOUSEHOLD DEMOGRAPHIC INFORMATION

36.Indicate the following details for **all the household members** who **were home** for **atleast one month** within the **last one year** **(Jun 06-Jun 07)**

House hold member number **HMNUM**	First Name	Sex 1=Male 0=Female	Year of birth	Relationship to head 1=head 2=spouse 3=Child 4= Parent 5= Niece 6= Nephew 7= Worker 8= Grand child 9=Brother/sis.inlaw 10=Bro./sis 11=Other	Number of months living at home in the last 12 months	Marital status 1=Single 2=Monogamously married 3=Polygamously married 4=Divorced 5=Windowed 6=Separated 7=Other	Education level **Level of education** 0= none 1= Primary 2=Secondary 3= Tertiary college 4= University	Was this person involved in any **Income earning** activity in the past **12 months** ***1 = Yes*** ***2 = No (got to next member)***	If yes, Which **Income earning activity (main)?** ***(See Activity Code below)***		Months involved in the activity in the last 12 months		What was the range of monthly estimate of income from this activity (Shs) **1=<5000 2=5001-10000 3=10001-15000 4=15001-20000 5=20001-25000 6=25001-40000 7=>40000 range**	
									IGA1	IGA2	IGA1	IGA2	IGA1	IGA2
1														
2														
3														
4														
5														
6														
7														
8														
9														

Income generating activities	11=Curio trader	22 =Driver	33=Engineer	43=Secretary
1 =Charcoal burning	12=Lumbering/wood cutting	23= Doctor	34 =General farm worker	44=Shop keeper/attendant
2=Selling firewood	13=Pit sawing	24=Tea picker	35 =House help	45=Subordinate civil services
3=Timber /poles trading	14=Mining	25=Teacher	37=Lab attendant	46=Surveyor
4 =Brick making	15=Tree seller, commercial	26=Veterinary doctor	38=Lecturer/tutor	47=Trading in agric produce
5=Boat making	16=Selling tree seedlings/seeds	27=Waiter/cook	39=Herbalists	48=income from sale of agric produce from another farm
6 =Carpentry	17=Manager	28=Watchman	40=Policeman/woman	49=Other (specify)_____
7=Industrial worker	18=Mechanic	29=Building/Mason	41=Road constructor	**Note: IGA =Income generating activity 1.**
8=Pension	19=Messenger	30=Chain Sawing (power saw	42=Sales person	
9=Remittance	20 =Nurse	31=Tailor		
10=Subordinate staff	21=Pastor/religious services	32=Electrician		

Note: The household includes all people eating from the same store plus unmarried members such as students who live elsewhere but are still dependent on the household for income and food,, and permanent labourers who eat and live with the family.

SECTION I: LIVESTOCK MIGRATION AND MOVEMENT WITHIN THE WATERSHED.

37. (a)Do you ever take your livestock to areas **outside your village** for **grazing**? **liveout**_____
1=yes 0=No

(b). If yes name the areas **aregrz1**___________ **aregrz2**__________**aregrz3**________

(c)Which months of the year do you take your livestock outside the village for grazing?
mongrz1________ **mongrz1**________ **mongrz1**________ **mongrz1**________
(Codes, 0=throughout 1= Jan, 2=Feb, 3=March,……..)

38 (a) Do you ever see livestock **brought into your village** form other areas for grazing?
1= yes 0=No **livmigr**__________

(b) If yes **where** do these livestock **come from? Name of the area.**
migarea1________________ **migarea2**______________ **migarea3**_____________

(c)**When** do these livestock usually come? **igmon1**___**migmon2**___**migmon3**___**migmon4**____
(*Enume: Rank the months starting with the more frequent/ intensive)*
(Codes, 1= Jan, 2=Feb, 3=March,……..)

(d) Please indicate how the trends have been presently and in the past.

Period		Frequency of migratin **into the watershed**	Frequency migration **out of the watershed**	
Presently	1			**Frequency codes** **0= Never** **1=Rarely** **2= Somehow frequently** **3=Frequently** **4=Very oftenly /throughout**
1-2 years ago	2			
3-5 years ago	3			
5-10 years ago.	4			

SECTION J: OPINION OF THE FARMER.

39. Please indicate whether you agree or disagree with the following statements

Statement		**1=Agree** **2= Disagree** **0=Neutral**
Livestock **from other areas** usually **compete with our livestock** for **feeds** and **water**.	**1**	
Livestock production brings **negative impacts** to the environment.	**2**	
It is not good to **graze along the river bank**	**3**	
It is **not good to farm along the river banks**.	**4**	
The **soil fertility** in **my farm** has been declining	**5**	
Livestock **migration into** this location has always been in existence	**6**	
Livestock production **promotes the conservation of natural resources**	**7**	
The **number of trees** in my **village** has been **declining** for as long as I can remember	**8**	

SECTION K: INFRUSTRUCTURE (DISTANCES IN KILOMETERS)

(a) What is the **distance** from your home to the nearest **shopping centre? distshop**_____
(b) What is the **distance** from your home to the nearest **tarmac road? disttmk**______
(c) What is the **distance** from your home to the nearest **health centre? disthc** ______
(d) What is the **distance** from your home to the nearest **public telephone services? dtel**____
(e) What is the **distance** from your home to where you can **tap electricity? dstelec** ______
(f) What is the **distance** from your home to where you can get **piped water? dstpipe**_____
(g) What is the **distance** from your home to **public/private extension services**? **dstext**_____
(h) What is the **distance** from your home to **the nearest river/stream**? **dsrver**_____

General comments from the respondent concerning the survey:………………………………