# ECONOMIC ANALYSIS OF THE FACTORS THAT INFLUENCE THE BEEF CATTLE MARKETING BEHAVIOUR IN PASTORAL AREAS OF KENYA:

*CASE STUDY OF THE IMPACT OF LIVESTOCK MARKET INFORMATION IN GARISSA AND ISIOLO DISTRICTS*

It has already been used.

**KOMEN K.M.**
**REG.NO. A/56/8108/2003**



**A thesis submitted to the University of Nairobi in partial fulfillment of the requirements for the degree of Master of Science in Agricultural Economics,**

**May 2010**

**DEDICATION**

To my parents Job Komen Cherutich and Martha Komen for their prayers and sacrifices

## DECLARATION

This thesis is my original work and has not been submitted for a degree in any other university

Signed ---------- Date 31st MAY 2010

Candidate: Mathew K. Komen, Bachelor of Agribusiness Management (Hons)

This thesis has been submitted for examination with our approval as supervisors:

Signed ---------- Date 3/6/10

1. Dr. Kimpei Munei.[1]

Signed ---------- Date 4/6/10

2. Prof. Stephen. G. Mbogoh[1]

Signed ---------- Date 3/6/2010

Dr. Robert Kaitho[2]

[1]Department of Agricultural Economics, University of Nairobi, P.O. Box 29053 Nairobi

[2] Department of Rangeland Ecology and Management, Texas A& M University, 2125 TAMU, College Station TX77843

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ADC | Agricultural Development Corporation |
| ALRMP | Arid Lands Resource Management Project |
| ANOVA | Analysis of Variance |
| ASAL | Arid and Semi- Arid Lands |
| CBS | Central Bureau of Statistics (Kenya National Bureau of Statistics) |
| GL-CRSP | Global Livestock -Collaborative Research Support Program |
| DFID | Department for International Development |
| ERSWEC | Economic Recovery Strategy for Wealth and Employment Creation |
| GDP | Gross Domestic Product |
| GOK | Government of Kenya |
| GTZ | *Gessellschaft Für Technische Zusammernarbeit* (German Technical cooperation Agency) |
| HELB | Higher Education Loans Board |
| ICT | Information and Communication Technology |
| IFPRI | International Food Policy Research Institute |
| ILRI | International Livestock Research Institute |
| KACE | Kenya Agricultural Commodity Exchange |
| KBC | Kenya Broadcasting Corporation |
| KMC | Kenya Meat Commission |
| KLMC | Kenya Livestock Marketing Council |
| KSH | Kenya Shilling |
| KG | Kilogram |
| LEWS | Livestock Early Warning System |
| LINKS | Livestock Information Networks and Knowledge Systems |
| LMD | Livestock Marketing Division (Currently Livestock Marketing Service Division) |
| LMIS | Livestock Marketing Information System |
| MDG | Millennium Development Goals |
| MOLD | Ministry of Livestock Development |
| Msc | Master of Science |
| NCPB | National Cereals and Produce Board |
| NGO | Non Governmental Organization |
| ODA | Overseas Development Administration |

| | |
|---|---|
| PMIDS | Price Monitoring and Information Dissemination Services |
| PRSP | Poverty Reduction Strategy Paper |
| SAPs | Structural Adjustment Programs |
| *SMS* | Short Message Service |
| SNV | *Schweizerische Normen-Vereinigung* (Netherlands Development Organization) |
| SPSS® | Statistical Package for Social Science |
| SRA | Strategy for Revitalizing Agriculture |
| SSA | Sub- Saharan Africa |
| TLU | Tropical Livestock Units |
| UNDP | United Nations Development Program |
| USAID | United States Agency for International Development |
| VOK | Voice of Kenya |
| VSF | *Vétérinaires Sans Frontiérés* (Veterinarians Without Borders) |

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## ABSTRACT

The pastoral areas of Kenya comprise over 80 % of the country's land area. These areas are inhabited by over 10 million people whose livelihoods mostly hinge on livestock. The area hosts over 70 percent of the national cattle herd; with an annual slaughter of over 1.6 million total livestock units. However, above 70 % of the population in these areas live below the poverty line. Available literature has revealed little knowledge on the factors that influence marketing behaviour of beef cattle producers in pastoral areas of Kenya. The purpose of this study was to carry out economic analysis of the impact of livestock market information and its influence on beef cattle marketing behaviour among other factors and to identify important attributes used in beef cattle valuation by producers and how these attributes affects price differential from the traders perspective.

The study employed a combination of purposive and random sampling in a survey of market sheds in two districts of Kenya's rangelands, namely Garissa and Isiolo. This survey generated primary data from 135 respondents. Secondary data was sourced from LINKS website and statistical abstracts from Central Bureau of Statistic and FAO yearbook. Regression methods of analysis using Nerlove Supply Response model (NSR) and the Consumer Goods Characteristics Model (CGCM) were employed to explore the stated objectives.

The study findings were: One, that beef cattle sector in Kenya has low response to price, this response is negative for the current price and positive for one year lagged price. Two, livestock market information does not influence beef cattle household off-take decision, these decision are rather influenced by calving rate, purchase rate, off-pastoral income and dependency ratio. And three, that animal attributes such as animal class, grade, sex, and other variables like market location and volume were important determinants of beef cattle price. These attributes show significant price differentials between each other and within each other. The attributes were ranked as important by livestock producers when determining which animal to sell.

From these findings, the following conclusions were drawn; firstly, that beef cattle sector in Kenya has responded in an economical manner to changes in beef cattle prices. This response

was initially, in a perverse manner, explained by the treatment of cattle as capital goods and eventually in a positive manner. Secondly, that livestock market information does not influence producer off-take decision; a plausible explanation could be that pastoral households based their decision on household needs which accounted for 91 % of the reasons why households sell their livestock. This could also be attributed to the fact that disseminated livestock information reached the isolated villages too late when it was no longer relevant or accurate. Thirdly, that there was a well differentiated pricing system for beef cattle based on animal attributes such as animal class, grade, sex and that these attributes are used both by the livestock traders and producers in valuation.

The following recommendations are deduced from the study. One, that a framework for reporting market information needs to be established to take into account the standardization of reporting based on animal attributes. Secondly, on factors influencing beef cattle off-take, the study proposes the improvement of breeds in order to minimize their calving intervals; this should be coupled with investment in infrastructure, access to extension service including veterinary services. Further, an expansion of source of income for pastoral households will be achieved through increase investments in other sectors in pastoral areas.

In conclusion, the study extends analysis of the factors influencing beef cattle marketing behaviour to variables hitherto unexplored in the literature. It uses market transactional data to provide a body of empirical verifiable research results regarding attributes that are important in beef cattle market information packaging. These findings provide important insights into the ability of market information to accomplish its intended goal of enhancing efficiency of livestock price discovery. And wealth of information to guide the policy maker as regard interventions needed to spearhead development in the pastoral communities of Kenya and beyond.

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# CHAPTER ONE

## *INTRODUCTION*

### 1.1 Background

The Arid and Semi Arid Lands (ASALs) of Kenya comprise over 80 percent of the country's land area. Over 10 million people (30 percent of the Kenya's population), inhabit these rangelands. The rangelands are characterized by poor soils, and low and highly variable rainfall patterns (Barrett *et al.*, 2003). Given the adverse climatic conditions, the rangelands are mainly suitable for livestock production (GoK, 2004a). Over 50 percent of the households' gross revenue in the ASALs of Kenya comes from livestock or livestock related activities (Bonfiglioli, 1992). The rangelands hold over 50 percent of beef cattle resources. These areas are host to over 70 percent of the national cattle herd, with an annual slaughter of over 1.6 million tropical livestock units (TLU)[1].

The livelihood of the people living in these areas hinges on livestock, and it is generally believed that whatever affects livestock affects pastoralists (Ndikumana *et al.*, 2000). Consequently, the livestock industry is seen as an important vehicle for the development of the pastoral areas, and generally towards the overall development of Kenya. This is because the industry contributes about 10 percent of the total Gross Domestic Product (GDP) and employs over 50 percent of the labor force in agriculture (GoK, 1999), of which 75 percent comes from the ASAL areas. The pastoralist households derive as much as 70 percent of cash incomes at household level from the sale of milk, meat, wool, hair, and animal traction services (Ndikumana *et al.*, 2000; GoK, 2004a). Besides, livestock serves as a store of wealth, a form of insurance against risk, an important status symbol, a means of securing access to land, and an instrument of establishing social relations including marriage (Barrett *et al.*, 2003).

In the livestock industry, the beef-cattle sector is the largest single segment commanding over 17 percent of the overall livestock population of 60 million (Mbogoh *et al.*, 2005). This has been attributed to the fact that beef-cattle are kept in all agro-ecological zones of the country. The sector therefore contributes significantly to the sustenance of pastoral populations. However, inappropriate policy designs with little regard for the unique features

[1] One TLU is equivalent to one head of cattle, 10 goats, 11 sheep or 0.7 camels (Osterloh *et al.*, 2003)

of livelihood systems in the ASALs have contributed to the failure of governance and institutional structures. These inappropriate policies have failed to engender pro-pastoral development and this explains why most of the pastoral areas of Kenya have the lowest development indicators and the highest poverty incidence (Omiti and Irungu, 2002). Over 70 percent of the population in the ASALs lives below the poverty line - defined as the boundary for the household whose members live on an average of less than a dollar per day (GoK, 2001). With proper policy and support, pastoral areas can be used to meet the growing demand for livestock and livestock products and considerably reverse the poverty situation (Mbogoh *et al.*, 2005; Omiti, and Irungu, 2002; Nyariki, and Munei, 1993).

The Millennium Development Goals' (MDGs) concept recommends policies directed to address marketing efficiency, especially for those commodities which are vital for the livelihoods of the poor. One suggestion is opening up these areas through provision of adequate market information to boost market integration and increased access to markets (UNDP, 2003). These sentiments are also reflected in other policy documents, such as the Poverty Reduction Strategy Paper (GoK, 2001), Economic Recovery Strategy for Wealth and Employment Creation (GoK, 2003) and the Strategy for Revitalizing Agriculture (GoK, 2004b). These policy guidelines have pointed to the huge untapped potential of the pastoral areas, and the need to open them to the rest of the economy, especially through well functioning markets.

In attempts to address the needs of pastoralists, various studies (Mbogoh *et al.*, 2005; GoK, 2004b; Ndikumana *et al.*, 2000; Mbogoh, 1997) have indicated the need to improve beef cattle production and marketing in Kenya. The major recommendations include: increasing livestock off-take rate and raising livestock producer prices. These parameters form the principal determinants of incomes of pastoral communities and the overall growth of the ASAL areas. As noted by Pingali (1997), the future emphasis of agricultural policy ought to be in maximizing farm household incomes from surpluses rather than aiming at food for self-sufficiency. Therefore, for the livestock sector to fulfill its important economic and food security role, mechanisms need to be put in place to strengthen its income generation capacity.

This necessity has spurred international and non-governmental organizations (NGOs) to expand activities in the pastoral areas. For example, in the Northeastern parts of Kenya, there

have been efforts to explore high impact interventions with the aim of bringing change in the standards of living of the ASAL inhabitants. Notably, the United States Agency for International Development (USAID), Global Livestock Collaborative Research Support Program (GL-CRSP) is supporting Livestock Information Networks and Knowledge Systems (LINKS) project with the objective of empowering the pastoralists to make better marketing decisions, through the provision of livestock market information. It provides them with improved livestock market information on prices based on: animal class, grade, sex, breed and markets. A combination of market reporting with cell phones and simple e-mail or web entry into a software system is used by LINKS, which allows traders, pastoralists and other interested parties to request on demand market information.

The LINKS project has brought with it new challenges to all participants in the livestock marketing industry. These challenges include its sustainability and whether it augurs well with the traditional marketing system. For example, the acceptance of, and adherence to, harmonized grades and standards of reporting that will provide basis of quality assurances to all stakeholders in the industry. To tackle these challenges, knowledge of the current role of market information in pastoral areas is necessary. Equally critical is the knowledge of the important attributes used when assessing the condition of the animals for sale by beef cattle producers, and how they influence prices.

An important tool that policy focus should be directed to in the pursuit of increasing saleable output of any agricultural commodity is the pricing. In order to come up with interventions which will achieve such an objective, the livestock producer's behavior should be considered. The usefulness of livestock market information system (LMIS) will largely depend on the response of livestock producers to price information. For this reason, the estimation of the extent to which price acts as an economic incentive is undertaken. For example, if price information system is operated for producers who do not respond to prices changes, then funds are obviously being wasted if the sole objective was to induce a higher household livestock off-take rate.

Some studies have reported that, following information explosion and the development of new information technology, a completely new conscious knowledge based economy is bound to come (McCalla, 1997; Wang *et al.*, 1999). This new consciousness could only be captured through thorough research. In this study particular attention is paid to livestock

marketing information where emphasis is given to some of the implication for prospective intervention to assist pastoralists to increase their returns from livestock.

### 1.2 Problem Statement.

Pastoralism is the key livestock production system in the ASALs. The ASALs constitute nearly three quarters of the land area of Kenya. Pastoralism is, therefore, of particular importance as source of income for the vast population in these areas. However, the development indicators have continued to remain low over the past decades and poverty levels are high. This has mainly been attributed to low returns from livestock, the main source of income.

Previous studies (Mbogoh *et al.,* 2005; Aklilu *et al.,* 2003; Aklilu *et al.,* 2002; Ndikumana *et al.,* 2000; Nyariki, 1990; Jarvis, 1974;) have reported that the most important factors that contribute to these low incomes are low prices of livestock and low commercial off-take. It is urged that, this is due to skewed nature of information symmetry which is in favour of traders. This has placed producers at a competitive disadvantage in the current market, because they cannot obtain higher share of consumer expenditure on their animals due to the lack of viable market information. For example, Aklilu *et al.,* (2003) reported that the producer's share of retail prices ranged from 47 percent to 52 percent depending on the terminal markets. This is in contrast to a country like Philippines where Hayami *et al.*, (1999) reported that 70 percent of the retail price goes to the farmers in the case of rice marketing. The situation in livestock marketing undermines the pastoralists' willingness to offer for sale more animals in the market.

Given the high dependency of pastoral communities on cash income generated from the sale of livestock and livestock products, institutional focus has been directed towards improving livestock market information, infrastructure, disease control and better animal husbandry practices. A review of available literature shows lack of studies directed towards evaluating the factors influencing the beef cattle marketing behavior in the pastoral areas of Kenya. The purpose of this study is to carry out an economic analysis of the impact of market information and its influence on beef cattle marketing behaviour among other factors and to identify the important attributes used in beef cattle valuation by producers and determine how this attributes influence price.

## 1.3 Objectives

The broad objective is to carry out an economic analysis of the impact of market information and its influence on beef cattle marketing behaviour among other factors and to identify the attributes used in beef cattle valuation by producers and determine how this attributes influence price.

The specific objectives:

1. Determine the extent to which relative market prices of beef cattle influence producer behavior.
2. Determine the impact of livestock price information on beef cattle commercial off-take rates.
3. Identify beef cattle attributes used by the producers in livestock valuation before sale and determine their effects on price differential (premiums).

## 1.4 Hypotheses

The following hypotheses were tested:

1. Beef cattle producers do not respond positively to price changes.
2. Livestock market information does not significantly influence the beef cattle commercial off-take rates.
3. There are no significant price differentials (premiums) in relation to the beef cattle attributes that determine the market price.

## 1.5 Justification

Eradication of extreme poverty and hunger is goal number one in MDGs with a target of halving the number of persons affected by poverty and hunger by 2015 (UNDP, 2003). This goal is more important especially in pastoral areas where poverty levels are extremely high (GoK, 2001). Such concerns make it imperative for researchers and policy makers to shift focus to identifying solutions to problems associated with pastoralist livelihoods. Livestock production has been singled out as an important activity and indeed a major one, if not the only source of livelihood for pastoral communities. Therefore, improving performance of the livestock industry will be a major means of enhancing pastoral incomes.

There have been substantial investments of aid by donors in livestock marketing in pastoral areas in Kenya for the last two decades. Most of these aid targets interventions focusing on addressing the issues of poverty alleviation. But recent studies and survey have continued to show that there is little evidence available that these interventions have benefited the poor livestock producers and that these areas have high poverty levels. This calls for further studies to bring new understanding on where we have gone wrong.

There has been tremendous improvement in information and communication technologies (ICT), and there are facts to support that if this potential is trapped it will achieve far reaching impacts in addressing the information asymmetry between producers in one hand and traders who are thought to be more advantaged.

The above goal can be achieved in these areas if focus is given to improving livestock markets, for example by enabling the market to attain marketing efficiency through improved livestock market information. This will benefit both consumers and producers. Therefore, an understanding of the impact of improved livestock market price information on off-take rates in the pastoralist areas justifies the thrust of this study.

The focus of this study will be on beef cattle prices because: (1) Previous studies in Kenya (Barrett *et al.*, 2001 and Ndikumana *et al.*, 2000) have revealed that cattle are more vulnerable to fluctuations in forage and water supplies and hence higher price fluctuation than any other livestock species traded in the pastoral areas of Eastern Africa region. (2) Beef cattle comprise the largest component of the livestock population in Kenya (17 per cent), (Mbogoh, *et al.*, 2005). (3) Kenya's economic survey 2003 (CBS, 2004) notes that the highest proportion of Kenya's households (35 percent) keep cattle. Therefore, the study of the impact of livestock market information on beef cattle marketing behavior is important from a planning perspective.

### 1.6 Organization of the Thesis.

The rest of the thesis is organized as follows: chapter 2 provides the review of existing literature on the subject; chapter 3 discusses the methodology and analytical techniques employed in the study; chapter 4 presents and discusses the results of the study: focusing on beef cattle supply response analysis, the beef cattle commercial off-take rate analysis and

beef cattle market price analysis; and finally chapter 5 gives a summary of the conclusions of the study in light of the study findings, the policy implications, and the recommendations adduced in the study.

# CHAPTER TWO
# *LITERATURE REVIEW*

## 2.1 An Overview on Marketing Information

Prior to the 1980's, the government was a major player in livestock marketing (Aklilu, *et al.*, 2003) through the participation of Livestock Marketing Division (LMD) of the Ministry of Livestock Development as the main purchaser of livestock from the ASAL areas for the Kenya Meat Commission (KMC). The LMD and KMC as government institutions provided a strategic drought management tool, as buyer of last resort, and a guaranteed market for surplus stock.

The LMD and KMC offered avenues to pastoralists to sell off their animals, especially during emergency situations. These avenues were removed after the adoption of the introduction of market liberalization policies which was part of what was referred to as the structural adjustment programs (SAPs). These SAPs forced the government to cut down funding to marketing related government parastatals and this negatively affected the performance of the KMC which was also experiencing market access problems due to sanitary and phyto-sanitary standards, eventually leading to its closure in 1988. Currently, the government has revived its operation amid sustainability challenges.

The livestock markets were left in a precarious state in which marketing decisions were left primarily in the domain of pastoralists (GoK, 1999). These decisions were made under an imperfect market situation. Pastoralists were ill-prepared to face these challenges and were easily outwitted by traders in prices negotiation. Pastoralists had to accept the prices offered for their animals, without knowing whether this was reasonable or not. These situations then led to declining producers' share of the beef cattle price in the terminal market; which has dropped to as low as 47 percent in some markets (Aklilu *et al.*, 2003).

This scenario has attracted government attention to come to the aid of these pastoralists and look for possibilities for intervention. The intervention needed to be done in a liberalized market environment. For example, Gatere and Dow (1980) consultancy report attributes the declining producer price to lack of viable market price information in the pastoral livestock

markets. The writers recommended the establishment of price information for the direct benefit of producers, buyers, and government policy makers and indirectly to benefit the consumer through the rationalization of the marketing system. In view of these findings, numerous efforts geared towards developing programs and projects charged with responsibility of collecting, analyzing, assembling and disseminating market information have emerged.

Initially, only a crop-based market information system (MIS) was available in Kenya. The crop based MIS started in 1978 with the support of a project sponsored by UNDP. The first attempt to establish an information system in the livestock sector was undertaken by the Ministry of Livestock Development (MOLD) between 1992 and 1994 in Kajiado and Narok Districts in the southern rangelands of Kenya with funding from Overseas Development Administration (ODA) (now the Department for International Development (DFID). The project gathered information on prices from livestock markets, abattoirs, and butcheries. The information was disseminated to all stakeholders in the industry by radio in conjunction with Voice of Kenya (VOK) (currently the Kenya Broadcasting Corporation) and also in the newspapers. When the project funding was terminated, the MIS became unsustainable (MOLD, 1991). The initiative was dogged by challenges, including lack of transport for monitors who at times had to travel more than 50 km to reach markets. From 1994 to 1996 the Netherlands Development Organization (SNV) ASAL project in Kajiado supported the MIS by providing stationery, transport expenses, and maintenance of the radios programme. Although data collection continued after 1996, reporting to Nairobi was discontinued because VoK stopped broadcasting the information due to the fact that VoK require market information from a least 10 stations. The situation remains unchanged (Agriconsortium, 2003).

The German bilateral agency, *Gesellschaft Für Technische Zusammernarbeit* (GTZ), undertook a similar program in the northern rangelands of Kenya. The collection, processing, and dissemination of livestock information in Marsabit district were executed through the Marsabit Development Project (MDP), which was operational between 1992 and 1999. A noted development in this program is the broadcasting of livestock market price information in local languages (Boran and Rendille) (Agriconsortium; 2003). The collection of data was also dogged with challenges. Market monitors collected information sporadically and this led to unreliability of the information (Barrett *et al.*, 2001). However, because of the importance

of the information, the Price Monitoring and Information Dissemination Services (PMIDS), a marketing group, was formed in pastoral areas of northern Kenya. Their objective was to enlighten potential investors on existing market opportunities in the district and also to avail market information to livestock producer and traders. However, its localized outlook limited the applicability of the market price information in other areas.

Another programme supported by the World Bank and managed by the Arid Lands Resource Management Project (ALRMP) planned the establishment of an MIS in which government officers were to gather information from markets and transmit it to ALRMP headquarters, Nairobi. The information was to be analyzed and broadcasted to the project area at a cost by Kenya Broadcasting Corporation in local languages. However, because of the budget constraints the project was shelved and ALRMP decided to strengthen the formation of user association. This was by empowering livestock associations to collect and disseminate livestock information. The Kenya Livestock Marketing Council (KLMC) was formed for this purpose (Agriconsortium, 2003).

Currently, a program of the NGO, Swiss Vétérinaires Sans Frontières (VSF) Suisse, is gathering data and reporting on livestock volumes and prices in northeastern Kenya and southern Somalia. The objective of this program is to gather information about the trading prices of different livestock species (cattle, sheep, goats and camels) at the producer, trader, and consumer levels. This information is then disseminated to the pastoralists and traders in order to empower them to make sound livestock marketing decisions based on prices in both the local and regional markets within the target area. The procedure involves collecting daily or weekly market information at the terminal, district and divisional markets depending on the market days assigned to each market, which vary in different locations. Market and slaughter prices are gathered at the following livestock markets: Njiru, Dagoretti, Mandera, Wajir, Garissa, Moyale, Modogashe, Garbatulla, Isiolo, Marsabit, Samburu and Laikipia. Information is then sent to VSF-Suisse after collection for recording and update. Mostly, transmission of information is done via telephone, fax, Internet, or spot delivery (mainly in Nairobi). Data is processed daily in the VSF-Suisse regional office in Nairobi and sent back to the different markets the same day by use of SMS cell phone messages and posted on billboards that are placed at the market centers. A summary report is also prepared at the end of each week and finally made available at the various markets.

Over the past five years, the Global Livestock Collaborative Research Support Projects (GL-CRSP) called LEWS (Livestock Early Warning System) has been developing a mechanism to provide spatial assessments of forage conditions across most of the Kenya rangelands (http://cnrit.tamu.edu/aflews). The LEWS provides a network of communication nodes across the region that indicates current forage conditions, conditions a year ago and forecasts expected forage conditions up to 90 days into the future with 10-day updates. Recently, surveys of pastoral communities have indicated that their decision to react to the LEWS reports would be greatly enhanced with more information on market prices of livestock at key markets (Kaitho *et al.*, 2004). To this end, the Global Livestock CRSP continues to fund Livestock Information Network and Knowledge Systems (LINKS) project, which stresses on the integration of information and communication technology (ICT) to provide drought and livestock market information in the region.

The LINKS project has just begun to collect and disseminate price and volume information for live animal traded in Kenya with focus on the major livestock markets in the country, including Nairobi, Garissa, Isiolo, Wajir, Marsabit and Moyale. The LINKS market information system can be accessed via www.lmiske.net (Kaitho *et al.*, 2004). The system has now been adopted for the development of a National Livestock Market Information System to cover as many markets as possible (Stuth *et al.*, 2006).

The information generated by the LINKS system will serve as the basis in the analysis of beef cattle attributes used in reporting of livestock market prices and in ascertaining the significance of price differentials for these beef cattle attributes. The system employs two procedures to come up with a report format to be used to collect and disseminate livestock market information. These procedures entail categorizing animal characteristics through sorting and/ or grading. Sorting and grading are often used indiscriminatively and applied to various selection procedures applied to various products. There is, however, some difference in the two terms; sorting tends to be used to describe the classification of animals based on objectively determined characteristics that are relatively easy to measure such as animal type, breed, class and weight. Grading on the other hand is more often associated with subjectively determined characteristics that are relatively difficult to measure such as animal body condition and frame characteristics. These two procedures have been employed by the LINKS system to come up with a well defined format for reporting livestock market prices. (See appendix 3 for details).

A primary concern for the information system and reporting has been the issue of accuracy, reliability and consistency; this of course will ensure demand for the service and its sustainability. However, despite the non-continuity of this important service, as evident in the previous programs, little, if not no work has been done to unearth the shortcomings of the various attempts at establishing a livestock market information system. Such work would have provided tangible solutions for further development of better market information system, especially in livestock marketing. It is, therefore, no wonder that recent studies have continued to point at the lack of viable livestock market information as the main reason for low marketing efficiency in pastoral areas (Barrett and Luseno , 2001). Yet some studies show that improved market information system can play a major role in promoting economic development and alleviating poverty in agricultural economies (Eggleston *et al.*, 2002; McCalla, 1997). Eggleston *et al.*, (2002) in particular point out that information can improve the bargaining position through enabling direct sales and through bypassing some unnecessary intermediaries. To harness this potential, there is need to develop consumer tailored MIS especially in developing countries to guide producers' marketing decision.

Bonnen and Harsh (1995) study on the establishing of a framework for an information system posits that for an information system to be reliable and accurate, three subsystems; (i.e. data collection, analysis and policy decision) must share the same base of concepts, measurable proxies from the real world to represent those concepts, and compatible measurement techniques and processing designs in the data used. Bonnen and Harsh (1995) note that all information systems must be closely adapted to specific context of the decisions they are intended to support. This is because information itself has become an important commodity. By examining the data generated by the price information providers, the present study brings to light the issues raised by analyzing the attributes such as animal class, sex, grade and breed used and relating them with what is being used presently by the livestock producers in the study areas.

Eggleston *et al.*, (2002) pointed out that information plays a role in providing coordination and efficiency. They argue that coordination involves bringing the consumers and producers together, thereby freeing the individual from self-reliance. Price is the vehicle that facilitates this coordination. Efficiency involves the reduction of transaction cost and market thinness. A thin market, according to Thompson and Sonka (1997) is defined as a market in which the

structure of the market inhibits or prevents prices across space, time, and form from attaining the relationships characteristic of a perfect market. The structural causes of thinness include erratic trade volumes, few sellers or buyers, barriers to entry, certain forms of government market intervention and scarcity of market information. The present study uses livestock market price to examine this role in the study areas.

## 2.2 Beef Cattle Producer Marketing Behavior

For many years studies of pastoral production system emphasized on increasing livestock off-take as a means of addressing the poverty in the rangelands (Agriconsortium, 2003). Their recommendations have not been effective. This has been attributed to the interventions conjectured by these earlier studies. In anthropology for example, earlier research results tended to report that pastoral production system is geared towards meeting basic food requirements such as meat and milk, and to a lesser extent towards selling to generate cash to buy grains (Blench, n.d). In agricultural economics, this assertion is reported to have changed overtime as needs of the pastoral communities have gone beyond basic necessities to comprise a whole array of other necessities of life. This situation has forced the pastoralists to change their objectives to embrace selling to meet needs beyond subsistence (Sieff, 1999). Anthropologist on the other hand tend to emphasis on what is termed has "leveling mechanism" which by definition, functioned to portrays an economic homogeneity of the pastoral community. For example polygamy was seen as having a leveling function as more wives means more children and consequently fragmentation of the producer's assets (Schroeder *et al.*, 2002). Therefore, there is need to understand the beef cattle producer marketing behavior as far as household size and dependency ratio on beef cattle commercial off-take rate at the household level is concern.

Sieff (1999) reports the effects of wealth on livestock dynamics among wealthier and poor households focusing on the Datoga pastoralists of Tanzania. Generally, the high commercial off-take rate of 19 per cent among the Datoga pastoralists is driven by subsistence needs and most income is used to buy veterinary products and grain. The study asserted that wealthier households have lower commercial off-take rates than the poorer households. The implication is that poorer pastoralists might eventually be forced to drop out of the pastoral system. However, Osterloh *et al.*, (2003) observed that the households with higher average livestock holdings (40TLUs) or (the wealthy households) are more active in the market than

the poorer households (average 10.8TLUs). The influence of wealth on beef cattle commercial off-take rate is still controversial; with some studies saying it is positive (Nyariki and Munei, 1993) and others say it is negative (Sieff, 1999). Those who ascribe to a positive response argue that it is due to increased motivation to sell beyond meeting the subsistence needs, while those disputing think it is due to subsistence stress (Sieff, 1999). If livestock producers are wealthy[2] and have more needs to meet above subsistence needs, they are likely to dispose animals as de-stocking mechanism to ease on workload, especially when the animals have reached saleable size and are males. On the other hand, the poor households will sell livestock only when they are pressed hard by their subsistence needs. While there are indications in the literature of the effects of wealth on livestock dynamics in pastoral areas, there seems to be some contradictory view. A systematic exploration of the influence of wealth difference in household commercial off-take is lacking. Thus, the inclusion of the wealth variable in the present study as a determinant of beef cattle commercial off-take rate was considered appropriate.

Nyariki (1990) discusses the factors that influence off-take rates of cattle ranching in Laikipia District. He notes that commercial off-take rate is determined by price, income, stocking rate, total rainfall and rainfall distribution. Raising the beef cattle prices is recommended as a factor to increase livestock off-take rates. Nyariki (1990) supports the contention that price alone is not the only factor that can increase off take rate. Nyariki (1990), however, did not incorporate the variables which the present study takes into consideration, such as the impact of livestock market information.

Osterloh *et al.,* (2003) examines pastoralist behavior in regard to the low response rate of marketed off-take of livestock even when faced with likely losses due to herd mortality. This aimed at understanding the constraints that need be addressed to foster more responsive pastoral livestock marketing systems. The factors identified include: lack of banking facilities, information, low and variable prices, high costs and risks of moving animals to the market, herd structures and restriction of cattle movement (Osterloh *et al.* 2003). In regard to banking facilities, the study noted that they offered an avenue to hold assets in a safer form away from raids, diseases and drought. It, however, found that they reduced marketable off-take rate because banks were seen to decrease pastoralist wealth, which had higher rate of

[2] Osterloh *et al.*, (2003) stated that it requires between 4 and 5 TLUs per capita to sustain herders, and thus it could be proper to state that the households with TLUs per capita below 4 can be considered poor

return (15 percent) than formal bank mediated savings (2 percent). Having money in the account, the study further noted, can also be a source of ready cash to smoothen income shocks without resorting to liquidating assets. Information is recognized as valuable in so far as people are willing and able to act upon it. Therefore, climate forecast information is of little significance to pastoralists since they move the herds from place to place scouting for water and pasture in places where such facilities can be found. These findings corroborates with Ndikumana *et al.* (2003) who found that rainfall does not influence off-take rates in pastoral production system. However, this is in contrast to Nyariki (1990) who reports that rainfall is a major factor that influenced off-take rate in a cattle ranch system. On price, Osterloh *et al.* (2003) notes that the pastoralists attach some importance to price information since they were found to be using at least two sources of information. Other researchers (McPeak, 2006; Barrett, 2001) also recommended on the need to improve livestock price information, to boost marketing efficiency.

The preceding accounts of the findings from previous studies lead to contradictory statements on the role of market information on pastoralists' behavior in cattle marketing. This study attempts to identify the key factors missing in other studies that influence beef cattle marketing behaviour in pastoral areas, giving special attention to the impact of marketing information.

### 2.3 Livestock Market Price Analysis

Providing timely, reliable and relevant livestock market information is an important pre-requisite that facilitates the price discovery process. Economic theory states price is determine by forces of supply and demand. These forces communicates, therefore, reflect a wealth of information and serves to inform otherwise uninformed market participant on the obligation in regard to demand and supply (Schroeder *et al.*, 2002). To properly understand this, an analysis of market price needs to be undertaken

In examining the impact of price with regard to cattle keepers' marketing behavior in Argentine cattle sector Jarvis (1974) asserted that if prices were increased and maintained at high levels, off-take rates would rise in the long run. This was under the assumption that production capacity had not been exhausted at the prevailing technologies and resources.

These assertion have been corroborated by Nyariki and Munei (1993), and Ouma *et al.*, (2003)

In another study on goat characteristics preferred by traders Orden *et al.*, (2005) found that meatiness, size, breed, sex and age were the dominant goat characteristics that traders preferred. This information, the study notes were important to goat raisers in responding to the needs of the local market. Richards *et al.* (1996) investigated the value of relevant production and semen traits for dairy bulls in Alberta and found that the most important characteristics selected by producers were milk volume, protein and fat content, general conformation, body capacity and the popularity of the bull.

Prices of livestock in the northern Kenya markets exhibit considerable variations across locations and seasons (Barrett *et al.*, 2003). Livestock pricing depends on the characteristics of the animal sold, age and sex, and whether it has been castrated or not. The main conclusion from these studies is that price depends on several characteristics which must be understood by all market participants.

William *et al.*, (2006) noted that economic and institutional barriers to livestock marketing are often underrated at considerable cost to the livestock sector. They pointed that this has impacted negatively on the welfare of the large population of smallholder producers and others who depend on the livestock sector for livelihoods. Among the barriers, William *et al.*, (2006) cites inadequate and uncoordinated livestock market information system and buyers' preferences.

Information plays a vital role in agricultural sector markets. For example, Wang *et al.*, (1999) pointed out that the use of information has enabled farmers in rural China to triple their agricultural production revenues. This benefit was achieved through internationalization of information in agricultural production decision through the use of Internet. This enabled farmers to get information on grain prices, supply and demand, on factors of production and other products from world market, thus enabling improved production decisions. These farmers have created social unions, called "information association of farmers" to enable them gain access to established sources of information.

The importance of establishing a livestock market information system (LMIS) has been continuously mentioned in several studies, consultancy reports and workshop discussion summary papers where livestock marketing was a subject of interest (Barrett and Luseno, 2001; Agriconsortium, 2003; Nyariki and Munei, 1993). The studies argue that the establishment of LMIS to address the information asymmetry would lead to better producer prices for the livestock producers and eventually to an increase in commercial off-take rate.

In information packaging, the main concern is to come up with methodologies which can be used to establish product attributes which best describe the product in relation to price. In determining an information package, a set of attributes of a product is used, such as a direct link between the consumers' desires, objective and subjective measures of quality. These attributes should have clear and consistent influence on price differentials. Inconsistencies would arise from the information package provided, if these attributes are not properly determined. This study undertakes to determine which attributes are significant in explaining livestock market price differentials in order to avoid such inconsistencies. Since grading is a new concept and a major aspect that is under development in LINKS and is also a key to the hypothesis of this research, the basis for the LINKS grading system is provided in Appendix 3.

Currently a framework to establish a reporting mechanism of livestock market prices is lacking (GoK, 2006). But given the heterogeneity of the cattle categories size, age such a framework is needed. Such framework could enable market monitor to collect representative price information from the markets through survey methods that are traditional used by the producers. Literature review shows that there is a wide gap in knowledge on the factors that influence livestock marketing behaviour and in particular the impact of that market information plays in livestock marketing efficiency and pastoral production system. With full knowledge about these factors and their impact, it would be possible to come up with measures to try and steer the livestock industry to fulfill its role in development, especially in the pastoral areas of Kenya. This study therefore seeks to reduce this literature gap in order to improve the wealth of pastoralists.

# CHAPTER THREE
# METHODOLOGY

## 3.1 Definition of Key Terms

In this study, some important key terms are used that need to be clarified in terms of their meaning and how they are operationalized in the study. These terms are:

### 3.1.1 Livestock market information

In literature review it was noted that price discovery is the process by which producers and traders use information to discern where they believe demand and supply intersect to arrive at an agreed price for a particular transaction. This information is what is referred to in the study as the livestock market information. It is visualized as a package of data, which is deemed to be useful in the process of decision making by market participants. This study will utilize data collected by the LINKS project. For a brief on LINKS reporting system see Appendix 3.

The livestock market information deemed to influence the livestock off-take was assessed on the basis of its accessibility and utilization. The herders were required to answer questions on whether they sought information on the prevailing market price before selling their livestock. They were to choose whether they sought the information always, sometimes or never. On utilization of the market price information, the respondents were required to answer whether they used the information always, sometimes or never.

### 3.1.2 Household commercial livestock off-take rate

Household commercial livestock off-take rate is used as a proxy for beef cattle marketing behavior, defined as the percent of animal units removed from the herd each year for sale in relation to the number of animals that were owned by the household at the beginning of the one year production period.

Nyariki and Munei, 1993 defined livestock off-take as the percentage of the current year's herds that is removed through sales, gifts, home- slaughters or theft. Livestock off-take is an important measure of herd dynamics as a means of estimating output from a pastoral

production system. Although non-commercial off-take form a significant part of the total livestock off-take in pastoral households, household commercial livestock off-take has taken an increasingly important dimension as pastoralism has slowly evolved from solely subsistence to commercial economy.

In computing Livestock off-take, the use of ratio is significantly emphasized in many studies (Mbogoh et al., 2005, Nyariki and Munei, 1993). This is so because it allows for comparison among households. The choice of the method of computation to be used depends largely on one's interests. Anthropologist have evaluated total off-take rates in terms of commercial sales and non-commercial transactions (e.g. transfers, exchange, gifts and slaughtered) Grandin and Bekure (1982). The agricultural economists have taken a commercial view as noted in study by Nyariki (1990). This study therefore takes this commercial view and consider livestock off-take rate as percentage of animal sold in relation to the initial animal herd.

#### 3.1.3 Beef cattle attributes

It has been noted in literature review that prices reflect the overall supply and demand situation of the market. The beef cattle attributes are, therefore, those animal characteristics that reflect the animal market price. In this study, the beef cattle attributes on focus are: (i) age, which was operationalized in terms of classes as: immature, young and mature; (ii) breed of the animal (zebu[3], boran, sahiwal, mixed crosses); (iii) animal body condition using the grade system designed by LINKS, in scales of 1 for very fat to 4 for emaciated animal;(iv) whether an animal is a castrate or non castrate; and (v) sex in terms of male and female. These attributes are evaluated from the perspective of the livestock producer for pastoral survey and traders from the livestock prices posted by LINKS. .

### 3.2 Supply Analysis Concept

Increasing agricultural productivity is a main concern in developing countries which depend largely on agriculture as the main mover of their economies (Goetz, 1992). The analysis of agricultural supply has long been a research agenda in these countries. In countries like Kenya, it has taken renewed urgency as policy makers battle to increase returns to producers

[3] Zebu here simply is the small East African zebu as opposed to boran who are a bit larger

and to bring intervening policies to boost production of commodities in which they have comparative advantage. Several methodologies have therefore been advanced by different authors on how well to analyze supply.

Goetz (1992) advanced the use of a selectivity model to analyze marketed surpluses in the context of polychotomous-choice situation[4]. The analysis separates the decision on "whether to buy and sell" from "how much to buy and sell". Osterloh *et al.*, (2003) employed the market participation approach using Heckman selection model. This model is used in studying market participation and market volume decision jointly- it is a dichotomous-choice situation. The Heckman's method involves a two stage estimator that controls statistically for those factors that affect households' discrete decision to either participate or not participate. It is used in estimating the relationship between net livestock sales volume and appropriate correlates of the continuous marketed off-take volume decision. The two approaches offered satisfactory results, but required repeat-visit survey data collected over a given time period. Because of the data requirements and considering the time period and resources, the two approaches could not be employed in the present study.

In this study the Nerlove Supply Response (NSR)[5] model is used. As suggested in micro-economic theory, the main determinant of the supply of a product is its own price. Nerlove developed his econometric model based on two important assumptions, which form the main component of the derived standard structural form of the model. The first assumption is the partial adjustment. This is based on the argument that producers are always trying to bring the actual level of output to some desired level. The economic unit to which this desired production refers may not always be able or willing to adjust to the transition instantaneously. For instance, if this desired level is beef cattle off-take rate, this optimal level may not be attained instantaneously because of the period the producer is required to breed stock to the desire level in terms of weight and age to be put in the market. This assumption may be represented as follows:

$$Y_t - Y_{t-1} = \beta (Y_t^* - Y_{t-1}) (0< \beta>1) \quad \text{.....eq (3.1)}$$

[4] Polychotomous- choice situation involves different states such as when household sell to (buy from) markets or both. It separates the decision of whether to buy and sell from that of how much to buy or sell. It therefore examines the rationed behaviour of households in the market. That is, do buyers and seller respond in the same way to exogenous factors (Goetz, 1992)

[5] The NSR model as it is referred to, was developed by Marc Leon Nerlove in 1956

This is to say, the change in output between the current and previous periods is only a proportion of the difference between the optimum level ($Y_t^*$) and the last year's output ($Y_{t-1}$)

β is the adjustment coefficient, which lies between zero and one. The restriction placed on the parameter ß in equation (1) is both intuitive, and theoretically sound. If ß = 1, it implies that producers are able to fully adjust to supply and demand shocks in one period and Yt* = Yt. If ß = 0, it implies that there is no adjustment and $Y_t = Y_{t-1}$. An estimate of ß close to one implies almost immediate adjustment, a low ß implies a very slow adjustment to changes in exogenous variables (Diebold and Lamb, 1996)

The NSR model, additionally to the adjustment component, includes also another assumption, the so called "price expectations component".

$P^*_t - P^*_{t-1} = ß\,(P_{t-1} - P^*_{t-1})$ ß. [0, 1] .....eq (3.2)

The price expectation component is based on the premise that producers' expectation is based on the idea that the current expectations are derived and modified by previous expectations in the light of current experience (Kmenta, 1971). The price expected in this year is denoted by $P^*_t$, the price expected last year by $P^*_{t-1}$, the actual price last year by $P_{t-1}$, and the proportion of the error, by which farmers revise their expectations, by a constant ß, which lies between zero and one (see equation 3.2). So the expected price $P^*_t$ is represented as a weighted moving average of past prices (equation 3.3)

$P^*_t = ß\,P_{t-1} + (1-ß)\,ß\,P_{t-2} + (1-β)βP_{t-3}$.....eq (3.3)

Nerlove (1956) argues, that although in theory all past prices must be included, the fact that the weights decline means that practically we can safely ignore prices in the very distant past. Thus, he achieves an equation of his second hypothesis (see equation 3.4), that farmers revise their expectations by a portion of the error they make in prediction. Thus he is able to obtain estimates both of the elasticity of output to expected price and of the coefficient of expectation. Nerlove restricts himself to the simple case, in which the output devoted to the product is a linear function of the expected relative price of that product alone:

$Y_t = \alpha_0 + \alpha_1 P^*_t + \varepsilon_t$, .....eq (3.4)

Where;

$Y_t$ – output,

$P^*_t$ – price of output y, expected this year,

$\varepsilon_t$, – random residual term.

We cannot observe $P^*_t$, declares Nerlove, and so we cannot estimate equation (3.4) as we would for any other simple equation. We must represent $P^*_t$ in terms of variables we can observe. Equation (3.4) means that we can write any expected price, $P^*_t$, as a linear function of output $Y_t$. In particular, last year's expected price, $P^*_{t-1}$, can be represented by last year's output, $Y_{t-1}$. But this means that expected price this year is a function of last year's actual price and last year's actual output. Because the expectation model, as expressed in equation (3.2), says that expected price this year is a function of actual price last year and expected price last year, we can replace last year's expected price in equation (3.2) by a linear function of last year's output. If we now substitute this new expression for expected price into the output response function, equation (3.2), we obtain a new relation between output this year and last year's actual price and last year's output:

$Yt = ß_0 + ß_1 P_{t-1} + \beta_2 Y_{t-1} + ß\varepsilon_t$.....eq (3.5)

(Adopted from Nerlove, 1956)

The standard structural model can be summarized as:

$Yt = ß_0 + ß P_{t-1} + P_{t-2} Y_{t-1} + ß\varepsilon_t$ .....eq (3.5)

$P^*t = ß P_{t-1} + (1 - ß) ß P_{t-2} +$ .....eq (3.3)

$Y_t = ß_0 + ß P_{t-1} + \beta (Y_t^* - Y_{t-1})$ $(0 < \beta > 1)$.....eq (3.6)

The reduced form equation relating to output and prices is solving equations 3.5, 3.3 above in terms of observable variables, yielding

$Y_t = ß_0 + ß P_{t-1} + ß Y_{t-1}$.....eq (3.7)

Adopting the approach taken by Askari and Cummings (1977) in estimating agricultural supply response and Low *et al.*, (1980) in analyzing cattle wealth and cash need in Swaziland, the study formulates the following model:

$Y_t = ß_0 + ß P_t + ß P_{t-1}$.....eq (3.8)

Equation 3.8 is then applied to the Kenyan beef cattle sector using time series data from 1972-2003. The interest is to examine the relationship between off-take rates in national beef cattle sector over the years. This is measured by degree of responsiveness of livestock producers to price changes in beef cattle sector. This can be investigated by estimating the partial regression coefficient of price variable in a multiple regression of off-take rate. The price elasticity of supply for a given commodity can be defined as the proportionate change in quantity supplied as a result of a one percent change in its price. According to economic theory, the price elasticity of supply for any commodity should be a positive number. This, however, need not be the case always, but it depends on type of commodity and stage of production of commodity in question (Kiiru, 1995).

The supply response model is also applied in examining the factors influencing off-take rate at the household level. In this case, the purpose is to examine how output is related to a number of important factors. The approach taken by Yotopoulos and Nugent (1976) is adopted. In the present study, the interest is to examine the factors influencing household beef cattle commercial off-take rates in selected pastoral market sheds. The household beef cattle commercial off-take rate is hypothesized as a function of beef cattle production dynamics and household characteristics. The estimation of the model is done using linear regression model that is consistent with general supply theory. This model can be illustrated as follows:

(1) $Y_i=\Sigma (X_i, Z_j)$ .....eq (3.9)

Where: $Y_i$ = the beef cattle commercial off-take rate of the $i^{th}$ household

$X_i$ = the $i^{th}$ household characteristics

$Z_j$ = the $j^{th}$ cattle production dynamics

The household characteristics that were postulated to influence commercial livestock off-take are household size, educational status, dependency ratio, non-pastoral income, wealth, the household knowledge and use of market information. The cattle production dynamics include cattle calving rate, mortality rate, home slaughters and purchase rate.

### 3.3 Price Analysis Concept.

In agriculture, pricing is particularly critical as a strategy for stimulating production. However this objective is only relevant where producers react rationally to price changes. It is, therefore, prudent for policy makers to have precise information on pricing that will assist in designing prospective interventions to address those inefficiencies attributed to pricing, in particular, on how to make price information more relevant to needs of the disadvantaged producers who derive their livelihoods from livestock.

Economic theory asserts that the price of a good is determined by demand and supply. The demand part as noted by previous studies has been determined by a combination of animal characteristics (Lenz *et al.*, 1994; Barrett *et al.*, 2003; Orden *et al.*, 2005). This is the view held by Lancaster (1971) when he formulated the Lancaster Consumer Goods Characteristics Model (CGCM)[6]. This study adopts his approach to bring an understanding of factors determining beef cattle price, which may be used in reporting livestock market information. To make it in conformity to the economic theory, volume and location of sale are incorporated in the model.

The model is based on the premise that "there is a distinct tendency for market prices of many commodities to vary with certain physical characteristics which the consumer identifies with quality and the relationship of these characteristics to prices may in many cases be fairly accurately determined by statistical analysis" (Ladd and Suvannunt, 1976).

The major contribution of this approach is the ability to distinguish between objective and subjective choice and demand theory. The idea behind this approach is that goods are consumed for the characteristics they posses and these characteristics are the objects of consumer preference or utility, with the number of characteristics being greater, equal or smaller than the number of goods available to the consumer. Model makes assertion that the consumer's real objective is to maximize the utility which the characteristics yield, not the amount of characteristics per se. To derive the model that presumes the ability to compare the utility of a linear combination of various characteristics, Lancaster makes the assumption of the utility independence of characteristics per consumption unit. This means that while total

[6] The Lancaster Consumer Goods Characteristics Model (CGCM) was first formulated by Kelvin Lancaster in 1971 as an extension of his earlier approach to the theory of consumer demand (Lancaster, 1966 as quoted by Hendler, 1975).

utility of each characteristic may depend on the total amount of the other characteristics, it is independent of the ratio of characteristics per unit of consumption.

The CGCM is useful for studying issues involving product heterogeneity, such as product differentiation, quality, grades and standards. The argument behind the model is that products are wanted because of the utilities they provide. The utilities provided depend upon the product characteristics. Hence, the total amount of utility that a consumer enjoys from his/her purchases of products depends upon the total amount of product characteristics purchased.

Hendler (1975) views this approach as a special case of consumer choice. This view is also shared by Ladd and Suvannunt (1976). They describe a good/product as collection of characteristics, which consumer pays for. A consumer interested in this collection of characteristics pays a price. The price of a product is, therefore, a linear summation of the implicit values of its characteristics (attributes). This consideration is consistent with the demand theory in relation to the consumer utility maximizing behaviour in which the consumer is posited as selecting the combination of product characteristics that maximize utility (Orden *et al.*, 2005).

Generally, the model could be expressed as follows:

(2) $P_b = \Sigma X_{bi} P_{bi}$ .....eq (3.10)

Where:

$P_b$ is the price of beef cattle,

$X_{bi}$ is the quantity of $i^{th}$ characteristic of beef cattle

$P_{bi}$ is the implicit price of $i^{th}$ characteristic of beef cattle

The $X_{bi}$ are treated as parameters to the consumer and variables to producers. The consumer can decide how much of the product $i^{th}$ to buy, but cannot decide the amount of each characteristic to be contained in or provided by one unit of product $i^{th}$.

One practical application of the model is in the use of implicit price to evaluate grading schemes for consumer products. It can also be used in product design, i.e. if the value of consumer's purchases of product characteristics is known a product can be designed to maximize profit by determining how much of each characteristic to put into the product.

The above model is commonly referred to as the hedonic price function. A hedonic price function relates the price of a product to the various attributes embodied in the commodity. The underlying hypothesis is that products have utility-bearing attributes and the values of those attributes contribute to the price of the product. In the marketplace, utility-maximizing buyers and sellers interact to establish the market value for a given attribute. The observed price of a good is therefore a composite of the implicit values of the product's attributes. Characteristics that are likely to influence the price of cattle include age, sex, color, breed, weight and body condition as well as quality attributes related to the intended use of the purchased animal (e.g. breeding, slaughter, fattening, traction and export). This approach has also been applied by William *et al.*, (2006) in examining livestock pricing in West Africa; Barrett *et al.*, (2003) in examining prices of livestock in northern Kenya rangelands, and Orden *et al.* (2005) and Lenz *et al.* (1994) to examine pricing in goats and milk respectively.

The economic rationale for the inclusion of any attribute should be its observably and relevance to the buyers. Information is a valuable commodity which can enhance the functioning of markets. But, what is information? This study conceptualized information as a package of data which is collected, analyzed, and disseminated to market participants for their marketing decision making. Since prices summarize all of the information that participants in the economy require in making effective decisions, the analysis of what constitutes price information is important. The study conceptualized information as the implicit values of animal attributes. The attributes posited are: sex; age (class, with immature, young and mature as proxies); animal body condition (estimated by grading system designed by LINKS in a scale of grade 1 to grade 4); and animal breed. The attributes were analyzed to determine their effect and significance on prices. The determination of this significance helped in explaining the level of preference for particular type of market price information, thus informing future reporting on those attributes that would be of importance to both the producer and traders.

### 3.4 Specification of Empirical Models.

#### 3.4.1 The model used in examining supply response in beef cattle sector

The econometric methodology employed in this paper is the structural time series approach as developed by Low *et al.*, (1980) and Askari and Cumming (1993), which builds on early work of Nerlove (1956). The essence of this approach is to set up a model, which estimates

the beef cattle supply response using a simple partial regression model which is developed using yearly time series data from 1972-2003. The variables used were the current prices and one year lagged prices. The empirical model was specified as follows:

(3) $LnQ = ß_0 + ß_1 \ln P_y + ß_2 \ln P_{y-1} + \mu$ .....eq(3.11)

Where:

Q= the beef cattle off-take rate in current year

$P_y$ = beef cattle prices per Kg of live weight in the current year

$P_{y-1}$ = one year lagged beef cattle prices per Kg of live weight

$\mu$= the error term

Ln - natural logarithms

In equation 3.3 above, it is hypothesized that the current off-take rate (Q) is a function of the current beef cattle price and one year lagged price. In this study, the hypothesis tested was that beef cattle producers respond positively to beef cattle price for both current and lagged price.

3.4.2 The model used in beef cattle commercial off-take rate analysis

The multivariate regression model was used to analyze the factors that influence the beef cattle commercial off-take rate amongst sampled pastoralist's households. This was done in order to quantify the significance of pastoral households' characteristics and beef cattle dynamics. This relationship is represented by the following equation:

$Yi = \Sigma X_i$ .....eq (3.12)

Where:

$Y_i$ = the $i^{th}$ household beef cattle commercial off-take rate

$X_i$ = $i^{th}$ household/ cattle dynamic variable to be estimated

The empirical model was specified as follows:

(4) $Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \varepsilon$- .....eq (3. 13)

Where:

Y = household beef -cattle commercial off-take rate

$\beta_0, \beta_1, \beta_2, \ldots, \beta_{11}$ = regression coefficients

$\varepsilon$ = the random term

$X_1$ = livestock market information used by the households; the dummy variable were specified as follows:

1 if the pastoralist always uses market information,

2 if s/he sometimes uses the information and

0 if s/he never uses the information for decision making.

$X_2$= dependency ratio of the household (household size divided by the number of household members between the age of 18 years and 65years).

$X_3$ = wealth variable (using the total livestock units (TLU)[7] possessed by the $i^{th}$ household)

$X_4$ = education level of the household head or the decision maker in five level categorical variables:

0. Never been to school
1. Adult education/religious education (also referred to as "Madrasa")
2. Primary level
3. Secondary level
4. above secondary

$X_5$ = household size (numerical). (Number of household members)

$X_6$ = non-pastoral annual income in Kenya Shilling (Kshs.)

$X_7$ = age of household head in years.

$X_8$ = price of the beef cattle (Kshs.)

$X_9$ =beef cattle calving rate

$X_{10}$ = beef cattle slaughter rate

$X_{11}$ = beef cattle purchase rate

These variables are described in details below:

[7] TLU is a convenient way to sum livestock quantities across species. One TLU is equivalent to one head of cattle, 10 goats, 11 sheep or 0.7 camels (Osterloh et al., 2003) to get the per capita TLU we divide the TLU by the household size (Sieff, 1999).

The dependent variable

The dependent variable is pastoral household beef cattle commercial off-take rate, which is calculated as a percent of the animal units put on the market and sold in relation to the number of units that were available at the beginning of the production year. It is actually the measure of output from the household.

The independent variables

Household beef cattle commercial off-take rates, as the case with most agricultural activities, are usually influenced by many factors. These factors range from controllable to uncontrollable ones. However, in this analysis, the determinants of the household beef cattle commercial off-take rate specified in the regression model included:

(a) Livestock market information.

Pastoralists need market price information in making decision on whether to sell or not sell, at what price to sell and how many animals to sell. The market price information is expected to act as an incentive that motivates the herders to participate in the market. It is therefore expected that, with availability of market price information, herders will respond by quoting the current or higher market price. Eventually, this would result in an increase in beef cattle commercial off-take rate and higher income for pastoral households. This would transpire because the herder is expected to be rational and choose where and when to trade to maximize income. This positive relationship between beef cattle commercial off-take rate and information use was tested at two levels; first, on whether the herders were enthusiastic in knowing previous market price information, and second, whether they considered this information in making marketing decisions. These two variables were characterized categorically into three levels:

0. Never sought/used livestock market information before making selling decisions.
1. Sometimes sought/used livestock market information before making selling decisions.
2. Always sought/used livestock market information before making selling decisions.

(b) Wealth

Wealth is measured in TLU, which is a better indicator of household's livestock holdings. This measure allows for comparison across different households. The wealth variable is expected to be positively related to commercial off-take rate.

(c) Household size

The household size is expected to have a positive relationship with beef cattle commercial off-take rate, since the higher the numbers, the more the households need cash to support them (in terms of upkeep).

(d) Dependency ratio

The dependency ratio is calculated as the ratio of household size divided by the total number of actively working adults between the ages of 18 years and below the age of 65 years. This is expected to have a positive relationship with beef cattle commercial off-take rate.

(e) Non-pastoral income

Non-pastoral incomes include income derived from either casual and regular employment or business. The diversification of income sources or engagement in temporary paid labor is an indirect means of restocking. Money gained in other sectors can be channeled into pastoralism, particularly after a drought when the animal numbers are low and prices high. There is, however a twin argument as to what this response will be. On one hand pastoralists who have cash may be willing to sell off the animals when affected by adverse conditions, with the understanding that they will restock when conditions improve than those pastoralist without other sources of income. On the other hand pastoralists with extra income can draw upon their money in times of stress, to smooth over income shocks without resorting to liquidating their assets (Osterloh *et al.*, (2003).This variable was therefore incorporated in the model.

(f) Beef cattle Price

This will be the average market price at the market where the farmer trades his animals. On a priori basis, this is expected to have a positive relationship with beef cattle commercial off-take rate. This can be attributed by the demand theory which states that when price increase quantity demanded increases and vice versa.

(g) Variables related to Beef cattle dynamics:

Beef- cattle dynamics are affected by calving, mortality, purchasing and slaughtering. These were computed from beef cattle household herd structure and incorporated into the model. The cattle dynamic variables used in the model were:

(i) Cattle calving rate

Cattle calving rate was calculated as number of births realized in the production year as a percentage of the initial cattle herd in the beginning of that production year. The cattle calving rate was expected to be positively related to beef cattle commercial off-take rate.

(ii) Mortality rate

Mortality rate is calculated as the percentage of deaths and losses that occurred during production year in relation to the initial household beef cattle herd. The mortality rate was expected to be negatively related to beef cattle commercial off-take rate.

(iii) Purchase rate

Purchase rate was calculated as the percentage of beef cattle purchased by household during the production year in relation to the initial household herd size. The purchase rate was expected to be positively related to commercial off-take rate. This so because it is commonly assumed that households with higher purchasing power are likely to engage in commercial activities to increases their disposal income, that is buying livestock during adverse condition at lower prices and dispose off these animal when prices are higher.

(iv) Slaughter rate

Slaughter rate was calculated as the percentage of the number of beef cattle slaughtered by the household during the one year period in relation to the initial herd size. Slaughter rate was to have a negative response in relation to beef cattle commercial off-take rate.

### 3.4.3 The model used in beef cattle price information analysis

The study uses the Lancaster consumer goods characteristics model to provide insights into the understanding of how livestock market information influences prices in pastoral areas. The effect of animal attributes in terms of grade, class, sex and breed as independent

variables on price was determined using multiple regression models. The general model is represented by the following functional equation:

(5) Price = f (sex, grade, class, breed, market, volume) ..... eq (3.14)

The variables in this analysis are: (1) Price (Kenya Shilling per head); 2) grade in a scale of 1 for very good quality beef cattle to 4 for emaciated poor quality beef cattle; 3) class in terms of whether beef cattle are immature, young or mature; 4) breed, that is whether beef cattle are boran, sahiwal, zebu or mixed cross; 5) sex in terms of male or female; 6) market for Nairobi, Isiolo and Garissa; 7) volume traded in the market.

The purpose of this model was to test for the significance of animal attributes specified in a standard reporting format designed by LINKS. The model was estimated using ordinary least squares regression analysis. Data for Isiolo, Garissa and Nairobi markets were downloaded from the LINKS database site http://links.tamu.edu/ for the period from September 2004 to September 2005.

The specific empirical model is estimated using the following equation:

(6) $\ln P = \alpha + \beta_i B_i + \delta_i G_i + \phi_i C_i + \gamma_i S_i + \lambda_i M_i + \varepsilon$ .....eq(3.15)

Where:

ln P = natural log of price of the beef cattle

B = dummy variable for animal breed

B= 1 if animal is Boran and 0 otherwise.

B= 2 if animal was Sahiwal and 0 otherwise.

B=3 if animal was mixed and 0 otherwise.

(Zebu was the base i.e. zebu = 0)

G = dummy variable for the animal grade

G= 1 if animal was grade 1 and 0 otherwise

G=2 if animal was grade 3 and 0 otherwise

G= 3 if animal was grade 4 and 0 otherwise.

(Grade 2 being the base)

C = dummy variable for the class of animal

C= 1 if animal is mature and 0 otherwise.

C= 2 if animal is young and 0 otherwise.

(Immature class being the base)

S = dummy variable for sex of the animal.

S= 1 if animal is female and 0 otherwise.

M = dummy variable for market

M = 1 if market was Garissa and 0 otherwise

M = 2 if market was Isiolo and 0 otherwise

(Nairobi market was the base)

$\varepsilon$ = Error term

$\alpha$ ,$\beta$,$\delta$,$\phi$, $\gamma$ and $\lambda$ are parameters of the equation.

Apart from volume, which was incorporated as a continuous variable, all the other variables were incorporated as shift factors using dummies and categorical variables.

3.4.4 The Analysis of Variance

Because of the complexity of testing for independence of samples, the analysis of variance, commonly referred to as ANOVA, is used. At its lowest level ANOVA is essentially an extension of the logic of t-test to those situations where one wishes to compare the means of different samples concurrently. As its name suggests, the analysis focuses on variability. It involves the calculation of several measures of variability, all of which come down to the measures of sums of squared deviates.

The purpose of ANOVA is to figure out a way of measuring the mean differences of a set of data with more than two sample groups. And because of more samples there is need to have an aggregate degree to which the group means differ. This is measured by the "the sum of squared deviates". The basic concept is that whenever you have three or more numerical values, the measure of their variability is equivalent to the measure of their aggregate difference. The sum of the resulting values of measure of aggregate difference gives *the sum of squared deviates between groups (SS)* that is the aggregate measure of the degree to which the sample means differs from one another (Dobson,1986).

The relationship between two values of the estimates, i.e. difference among the means of several independent samples and variance estimate reflecting random variability that is present in the situation, is described by a ratio known as F-ratio

The null hypothesis is true if F-ratio is equal to or less than 1.0 within the limits of the random variability.

The null hypothesis is false, if the F-ratio is significantly greater than 1.0

In assessing the relative effects of the different attributes used in valuation of beef cattle, ANOVA is used, with the aim of determining whether each of the attributes has significant effect on the price of beef cattle. If the different types of attributes have different effects on price, it is expected that this fact is reflected in significant differences among the means of the attributes in the three markets. If an observed result is found to be significant at 0.05 level, what this means is that there is only a 5 % chance of it having occurred through mere chance.

The model is used to test the null hypothesis

$H_0: \mu_1 = \mu_2$.....eq (3.16)

Where $\mu_1$ represents the mean of the $i^{th}$ beef cattle attribute

$\mu_2$ represents the mean of the $j^{th}$ beef cattle attribute

Basically, rejection of the null hypothesis indicates that variation in the price is due to variation between attributes and not due to random error. If the null hypothesis is rejected, there are price differentials in the different attributes at the significance level of 0.05 (Dobson, 1986).

Once the differences have been determined among the means, post hoc range test and pairwise comparison are used to determine how and which means differ. The range tests identify homogenous subsets of means that are not different from each other; pairwise multiple comparisons test the difference each pair of means and yield a matrix where asterisks indicate significantly different for group means at alpha level of 0.05.

### 3.5 Description of the Study Area.

This survey study was carried out in Garissa and Isiolo districts of northern and northeastern pastoral areas of Kenya. These pastoral areas were selected because of their predominance in pastoral activity in Kenya. The study also sourced data from Nairobi an important terminal market in Kenya. These areas are described in details below.

Garissa district is one of the districts of North-Eastern province, occupying an area of 33,620 $Km^2$, with a population of 392,510 people according to 1999 population census. The district borders Isiolo district to the northwest, Wajir to the north, Republic of Somalia to the east, Tana River district to the west and Ijara to the south. It lies on the equator between the latitudes of $1^0$ N and $1.2^0$ S and longitudes of 38.60 E and $41^0$ E. Garissa is low lying with an altitude range of between 80 to 100 meters above sea level. The climate is arid and rainfall is bimodal with mean annual rainfall of 434.8 mm. Livestock production, mainly pastoralism, is the main source of livelihood and supports over 90 % of the population. The sale of livestock constitutes the basis for the commercial sector. The district has a beef cattle population of about 700,000, with sales of approximately 70,000 heads of cattle per year. However, over 75 per cent of the population is recipients of food aid (GoK, 2001; GoK, 1997a). It is widely recognized that food aid can distort market (McPeak and Barret, 2001). This, therefore, calls for an approach that will address the poverty without compromising the role of market in the area.

Isiolo district, Eastern province, has an area of 25,605 $Km^2$ with a population of 100,861 people according to 1999 population census. It borders Marsabit to the north, Garissa and Wajir districts to the southeast and east respectively. It also borders Tana River , Nyambene and Meru District to the south, Laikipia and Samburu districts to the west. It is located between longitudes $36^0\,60'$ and $38^0\,50'$ east and latitude $0^0\,5'$ and $2^0$ north. It lies in an altitude of 200 meters above sea level at Lorian swamp to 1104 meters above sea level in the southern plains. Isiolo has 3 agro ecologically zones, namely: semi arid, arid and very Arid, which is suitable for pastoral livestock production system (GoK, 1997b). The district average cattle population is estimated at 175,000 animals, with an annual sales average of 15,440 herds of cattle. It also estimated that 83.5 % of households own livestock. The district is a transitional market for cattle from neighboring districts and countries of Ethiopia and Sudan

(Aklilu et al., 2003). However, the district recorded an absolute poverty level of 82.18 percent (GoK, 2001) which places among districts with the highest poverty levels in Kenya.

The city of Nairobi is the principal terminal market for beef cattle in Kenya. The City had a population of 2,143,254 people in 1999, occupying an area of 696 squares kilometers, with an annual growth rate of 7 percent. Nairobi is said to be one of the fastest growing cities of Africa (APHRC, 2002). The average recorded annual beef cattle slaughtered in Nairobi stand at 33,000[8] heads (Aklilu 2002). The City has 11 slaughterhouses.

### 3.6 Sources of Data

Data were collected from both primary and secondary sources. The primary sources were pastoralist household surveys. The secondary sources were: LINKS website, Kenya Central Bureau of Statistical; Statistical Abstracts and FAO data bank for year 1972 – 2003. The sources are further explained below.

#### 3.6.1 Primary data source.

The pastoralist household survey was designed and implemented to generate primary data. Enumerators using structured questionnaires gathered primary data from 160 pastoral households. A household is defined as an independent decision making unit with regard to the management of livestock and humans (Dahl and Hjort, 1976, as quoted by Sieff, 1999).

The types of data collected included pastoralist household socioeconomic characteristics such as age, wealth, dependency ratios and household structure and herd's dynamics, such as herd structure, livestock off-take structure. Data on the sources and utilization of livestock market price information in the pastoral areas were also collected. The basis of animal evaluation before sale was explored. The reasons are given for the preferred method and basis.

#### 3.6.2 Secondary sources

Data on pastoral markets of Garissa and Isiolo and Nairobi terminal market were obtained from the LINKS website www.lmiske.net . These data are daily and weekly and were

[8] The figure is only for beef slaughters inspected by Nairobi meat inspector (usually slaughters can be done outside the city slaughter houses so the actual beef consumed is high).

collected, semi-processed and posted to the website by the LINKS monitors from the selected markets. A total of 1233 market transactions data for the months of September 2004 to September 2005 were obtained from the website. This was the period for which consistent data could be obtained. The data indicated weekly volumes and prices per class, breed, sex and grade. These data were based on interviews with traders during the peak market days for the selected markets.

## 3.7 Survey and Sampling Procedures

### 3.7.1 Sampling Population.

The sample population consisted of pastoralists' household heads participating in market sheds[9] of both Isiolo and Garissa. The study population was limited to one central division in each of the two districts. Although it was anticipated that a randomly selected sample of 80 pastoral households per district would be ideal for interviews, this proved optimistic as some of the respondents were hostile or refused to participate in the survey, while some could not complete the questionnaires. In the final analysis, 135 households were interviewed between November 2005 and January 2006.

### 3.7.2 Sampling Procedure

A reconnaissance survey of the livestock markets in Isiolo and Garissa was made before data collection commenced. The main objectives were to identify and select one main market in each of the areas and to get an appraisal on how to develop and administer the survey instrument. The survey instrument was pre-tested at the Garissa market in order to ascertain its consistency and validity. The selection of the markets was done purposively, based on how rooted the markets were in livestock marketing activities and also based on the LINKS operational areas. The selection method also allowed for regional representation with Isiolo for eastern rangelands and Garissa for northeastern rangelands.

### 3.7.3 Data collection

The data was obtained through a cross-sectional survey of the sampled pastoralist's households in the two market sheds of Isiolo and Garissa. This was done within a period of two months using trained enumerators drawn from the community. A multi-stage sampling

[9] A market shed is defined as an area from which a market receives its livestock for sale

method was used. First, one division was selected purposively. The aim was to capture the one which had an active market within it. In the second stage, 80 respondents were selected randomly from all the locations in the selected division. For example, in a case where there were four locations, all were selected and enumerators sent to administer the questionnaires to randomly selected respondents based on sub-locations. If an enumerator went to a location with 4 sub-locations and s/he had 20 questionnaires, s/he administered 5 questionnaires to each sub-location. The first respondent was selected randomly starting from the sub-location centre along a transect walk drawn using compass bearings to take care of each direction. Generally 80 pastoralists' households were expected to be interviewed in each of the market sheds.

## 3.8 Methods of Data Analysis

### 3.8.1 Descriptive Statistics

The data was first entered in to the computer using the Microsoft Excel program® and cleaned up for the computation of the variables used in the regression analysis, such as the dependency ratio, cattle birth rate, cattle purchase rate, commercial livestock off-take rates, cattle mortality rate, and cattle slaughter rate among others. The main analysis was done using the SPSS® version 10 software package.

Descriptive analysis was undertaken to elicit interrelationships among the variables. For example, in the second objective, an analysis of pastoral beef cattle dynamics in pastoral market sheds was undertaken to generate the characteristics of pastoral cattle system, while a descriptive analysis of the various issues concerning present livestock market information system in the pastoral area was undertaken to evaluate the influence of market information in cattle marketing. This served as foundational knowledge in describing the impact of livestock market information among the explanatory variables in the model.

In the evaluation of the beef cattle attributes used by the pastoral communities when assessing their animals before sale, the attributes were assessed by ascertaining the level of the producers' agreement with the attributes identified and presented to them. The pastoralists were asked to rate the attributes in a scale of 1-5 (1 – most considered to 5 for never considered attribute).

### 3.8.2 Supply Response

Determination of supply elasticity in the cattle beef sector was undertaken using a single equation regression model and following the method advanced by Low, *et al.* (1980). Using the data on beef cattle population, slaughters and prices from 1972 to 2003, the hypothesis is tested based on β- coefficients and their magnitude.

Economic theory states that the price elasticity of supply for agricultural commodities is positive. This is because; it is generally assumed that with increase in price producers would react by increase their produce to the market. However, this need not be the case, and the β coefficient could be positive or negative at the 10% level of significance. It will be positive, if producers increase the supply in reaction to increased price. Negative, if producers react to increase price by withholding their produce from the market. The magnitude can be less or greater than one. The coefficient is less than one if fewer cattle are sold with a positive change in price, and greater than one if sales increase substantially with change in price. In this case, a value less than 1 is said to be low and value more than 1 is said to be high.

### 3.8.3 Factors Influencing Commercial Beef Cattle Off-take rate at the Household level

Analysis of factors influencing beef cattle commercial off-take rate at the household level was done using a multivariate regression model and following the Nerlove Supply Response model (NSR) as applied by Low, *et al.*, (1980).

A model incorporating off-pastoral income, household size, wealth, awareness of price information, utilization of market information, calving rate, mortality rate, price of beef cattle, education level of household head, purchase rate and household slaughter rate was estimated on the assumption that the factors included influenced commercial off-take rate collectively.

### 3.8.4 Analysis of Prices Differential for the Different Beef Cattle Attributes

Price formation is analyzed at three levels. First, comparisons of prices in different markets as well as differences in animal classes, sexes, breeds and grades are done. Price differentials were examined by analysis of variance (ANOVA). This was validated through post hoc range and pair wise range test at .05 levels. This test determines which means differ and it therefore allows one to judge whether the inclusion of these attributes is of importance in beef cattle

marketing, either at the terminal or peripheral markets. Finally, the extent of the effect of this prices differential is examined through the CGCM regression model. The purpose is to provide more insight on which of the attributes carries more weight in determining the beef cattle price.

### 3.9 Multicollinearity and Heteroscedasticity in the Regression Model

Regression analysis, as it were, is bound to have limitations. It is, therefore, important to outline how these problems were dealt with in this study. The limitations envisaged in the study are multicollinearity and heteroscedasticity. They are briefly discussed below:

#### 3.9.1 Multicollinearity

Multicollinearity is a term used to denote the presence of linear relationship among explanatory variables (Koutsoyiannis, 1977). This phenomenon is caused by the inclusion of related variables in the regression model.

There are a number of diagnostic tests, which may show the existence of multicollinearity. These are:

1. Large variance; hence t-ratios are small. $R^2$ are also high.
2. F-ratios are high, indicating that all explanatory variables taken together affect dependent variables.
3. The coefficients of the explanatory variables become sensitive to inclusion or exclusion of certain variables as well as addition of data.

Hence, the separate effects of each of the individual variables cannot be distinguished. Similarly the estimates are imprecise and unstable.

Presence of multicollinearity was tested by determining the degree of inter-correlation of explanatory variables ($r^2$) as well as by the overall correlation coefficients between the dependent variable and independent variables ($R^2$).

In the study, scanning for multicollinearity involved inspection of spearman rank correlation coefficients among independent variables using Kennedy (1985) criteria, which state that a

value of 0.8 or higher in absolute terms for any of the correlation coefficients indicates a high degree of correlation between the two variables.

### 3.9.2 Heteroscedasticity

This is a problem that arises when the assumptions for any of the properties of homoscedasticity is violated. The assumption of homoscedasticity states that the probability of distribution of the error (disturbance) term is the same in all observations of the independent variables, implying that the error term has constant variance in all observations. Practically, this assumption is usually violated, but it is acceptable on empirical grounds to certain limits. If a serious violation occurs, the variances of the coefficients are never minimum or efficient and t and F ratios will no longer be valid. Therefore, the judgment on the level of significance becomes unreliable. In such cases, it is recommended that the model be transformed in order to minimize the heteroscedasticity.

In this study the test of the severity of heteroscedasticity was done using the Pearson product moment correlation. According to Graham and Darroch, (2001), a variable is not severely heteroscedastic if its correlation with any other explanatory variable does not exceed 0.35.

# CHAPTER FOUR
## *RESULTS AND DISCUSSIONS*

### 4.1 Results of Descriptive Analysis

#### 4.1.1 Introduction

This section summarizes the findings of the pastoralist survey covering socio-economic characteristics of the pastoralists, beef cattle dynamics, current status of market information, and beef cattle attributes affecting the selling behaviour of pastoralist households. In the study, a total of 135 household questionnaires were processed and analyzed. These included 78 and 57 household questionnaires for Garissa and Isiolo respectively.

#### 4.1.2 The socio-economic characteristics of pastoralist households.

The pastoralist household's characteristics were assessed using means and percentages of the relevant variables that were likely to affect beef cattle marketing in pastoral areas of Garissa and Isiolo. This is consistent with the objective of identifying and determining the factors that influence household commercial off-take rate at the household level. The results are presented in Table 4.1 below.

The mean household size in the two pastoral districts was about 10 persons. Isiolo had 10.5 slightly bigger household sizes than Garissa at 10.4. However, the difference in household sizes in the two market sheds was minimal.

The results show that mean dependency ratios were 1: 3.4 and 1:3.9 for Garissa and Isiolo respectively. The ratio reflects the household obligations in term of cash needs for basic needs and especially consumption purpose. There seems to be a direct relationship between wealth and dependency ratio.

Education reflects the household's technical and managerial competence in decision making. The literacy level in pastoral areas is very low as reflected by the fact that 52 and 39 percent of the household heads in Isiolo and Garissa respectively are illiterate. Most educated pastoralists were found in Isiolo where 10 percent completed secondary education. Education seemed not to play a key role in determining the level of off-pastoral income, a well held

assertion. For example respondents from Isiolo with high level of illiteracy had higher level of off-pastoral income than those from Garissa.

Age reflects the level of accumulated experience in beef cattle keeping. The mean age of the household head was 44 years. Pastoralist household heads were slightly older in Garissa than in Isiolo. The wealth variable shows that the average TLU holding is 45, but there was a big variation between pastoralists in the two districts. Garissa pastoralists were twice as wealthier as those in Isiolo.

**Table 4.1: Socio-Economic Characteristics of Pastoralist Households in Isiolo and Garissa District in 2004 and 2005.**

| | Percentage per district | |
|---|---|---|
| | Isiolo (N=57) | Garissa (N= 78) |
| **Household size** | | |
| 5 and Below | 14 % | 8 % |
| 6- 10 | 44 % | 44 % |
| 11-15 | 28 % | 41 % |
| 16 and above | 14 % | 7 % |
| Mean household size | 10.5 persons | 10.4 persons |
| **Dependency ratio** | | |
| Below 3 | 74 % | 51 % |
| 3.1- 6 | 24 % | 38 % |
| Above 6.1 | 2 % | 10 % |
| Mean dependency ratio | 3.4 ratio | 3.9 ratio |
| **Education Level** | | |
| 0= illiterate | 52 % | 39% |
| 1=adult/religious ("madras") | 16 % | 10 % |
| 2=primary level | 27 % | 41 % |
| 3=secondary level | 5 % | 10 % |
| 4=above secondary level | 0 | 0 |
| Mean education level | 0.08 | 1.3 |
| **Age** | | |
| Below 18 | 1 % | 0 % |
| 18- 35 | 13 % | 35 % |
| 36- 49 | 46 % | 38 % |
| 50- 60 | 28 % | 18 % |
| 61 and above | 12 % | 9 % |
| Mean age in years | 48 | 39 |
| **Wealth in TLUs** | | |
| 0-35 | 69 % | 60 % |
| 36-45 | 13 % | 21% |
| 46-60 | 10 % | 3 % |
| 61 and above | 8 % | 15 % |
| Mean wealth in TLUs | 31 | 89 |
| **Off –pastoral Income (Kshs.)** | | |
| 0- 10,000 | 32 % | 78 % |
| 10,000 – 50,000 | 14 % | 10 % |
| 50,000- 100,000 | 29 % | 6 % |
| 100,000- 200,000 | 15 % | 2 % |
| 200,000- 500,000 | 4 % | 0 % |
| Above 500,000 | 6 % | 4 % |
| Mean off-pastoral income(Kshs.) | Kshs. 261,000 | Kshs.160,000 |

**Source: Author's survey, 2005**

The results show that the mean household off-pastoral income was Kshs.. 218,763 per year. It should be noted, however, that less than 10 percent of the pastoralists actually received this

level of income. About 78 percent and 32 percent of the households from Garissa and Isiolo respectively earned less Kshs.10, 000 per annum. Respondents with higher off-pastoral tend to have less wealth in term of TLUs.

### 4.1.3 Beef-cattle herd dynamics

According to Ndikumana *et al.,* (2000), beef cattle herd dynamics is defines as a reflection of all events that affect the herd numbers (births, purchases, slaughters and mortality) over time. In this study, the cattle herd dynamics is observed for the period December 2004 to November 2005. This period was selected to assure one year's production period while it was recent enough to allow for easy recall of the events under consideration by the pastoralist respondents.

Table 4.2 gives a summary of this study's findings on herd dynamics in the sample districts.

**Table 4. 2: Mean beef cattle dynamics in the market sheds of Garissa and Isiolo in December 2004- November 2005.**

| Variable | Garissa | Isiolo | Overall mean |
|---|---|---|---|
| **Herd size** | | | |
| Total number of cattle | 58 | 28 | 41.09 |
| Male cattle | 10 | 7 | 8.88 |
| Female cattle | 48 | 20 | 31.86 |
| **Purchases** | | | |
| Total Number of cattle purchased | 1.7 | 2.1 | 1.8963 |
| Males | 1.1 | 0.57 | .9179 |
| Female | 0.56 | 1.7 | 1.0746 |
| Cattle purchase rate | 0.048 | 0.1665 | .0982 |
| **Mortality** | | | |
| Number of cattle mortalities | 13 | 12.4 | 12.6148 |
| Male cattle | 4 | 3.9 | 4.1579 |
| Female cattle | 8 | 8 | 8.5489 |
| Mortality rate of cattle | 0.329 | 0.318 | .3247 |
| **Reproduction** | | | |
| Number of cattle calves | 10.5 | 17.8 | 13.6370 |
| Male cattle calves | 3.37 | 7.9 | 5.2481 |
| Female cattle calves | 5.5 | 9.8 | 7.3233 |
| Calving rate | 0.52 | 0.3833 | .4624 |
| **Home Slaughters** | | | |
| Home slaughters | .023 | .8 | .4741 |
| Male cattle | .15 | .65 | .3609 |
| Female cattle | .07 | .18 | .1203 |
| Household home slaughter rate | 0.0118 | 0.0131 | .0124 |
| **Transfers** | | | |
| Number of cattle given out | .5 | .8 | .6296 |
| Male cattle given out | .14 | .18 | .1579 |
| Female cattle given out | .35 | .72 | .5113 |
| Number of cattle received | .35 | .26 | .3185 |
| Male cattle received | .15 | .125 | .1418 |
| Female cattle received | .20 | .14 | .1791 |
| **Sales** | | | |
| Total sales | 4 | 6 | 4.9926 |
| Male | 2 | 4 | 3.3233 |
| Female | 1.4 | 1.7 | 1.5682 |
| Commercial beef cattle off take rate | 0.132 | 0.105 | .1209 |

**Source: Author's Survey, 2005**

Overall, the pastoralist households owned an average of 41 head of cattle. The mean beef cattle number was 58 and 28 in Garissa and Isiolo respectively. In general, the herd had a ratio of 1:4 for males: females. The ratio was slightly higher in Garissa than in Isiolo. This finding corroborates those of the other studies in pastoral areas (Ndikumana *et al.*, 2000).

Table 4.2 shows that the overall cattle purchase rate is 9.8%, with female animals forming a higher proportion of the purchases. On average the households purchased 1.1 female cattle

compared to 0.9 male cattle. About 61 percent of the beef cattle purchased were mature; young cattle accounted for 33 percent while the remaining 5 percent were immature animals. Compared to sales, it can be seen that more young cattle were purchased than those sold. The purposes of purchasing beef cattle were cited as restocking, resale, ceremonial and festivities. These purposes in terms of percentages were 61%, 23%, 11%, and 5% respectively. It is worth noting that 70% of the respondents stated that they did not purchase any cattle.

Mortality is defined as death or loss of livestock due to factors other than slaughtering. Table 4.2 shows that the households lost an average of 12 animals in a year. Most of the losses are mainly female. It was also observed that 77% of these mortalities are mature class, while 16% are young animals and 7% are immature. The main cause of cattle mortality was drought, accounting for 76 per cent. Others are attributed to cattle disease (10%), wildlife (3.2%), floods (6.5%), and theft (3.2 %). The overall mortality rate observed in the study area, as indicated in Table 4.2 is 32.5 %. There was a slight variation in mortality rates in the two districts of Garissa and Isiolo.

Table 4.2 shows that the mean beef cattle calving rate observed in the surveyed area was 14 calves. On average, the households recorded 5 male and 7 female calves born during the year. In the pastoral areas, uncontrolled breeding was practiced. Gestation period for indigenous cattle is estimated in the range of 285.5 to 297.7 days. Most of the calves were born during the long rainy season. Calving in pastoral areas is mainly determined by body condition of the female animals, which largely depends on pasture and water availability. The study observed an average calving rate of 46%. Survey data on calving pattern with Garissa having 52 percent whereas Isiolo had 38 percent. This difference can be explained in that Garissa had a high female numbers than Isiolo, that is, 48 and 20 respectively.

Home slaughters refer to those cattle that were slaughtered by the household during the year. Table 4.2 indicates that, on average the households slaughtered one beef cattle in 2 years. The households reported slaughtering twice as many male animals as female animals. The study also observed that the pastoralists slaughter more mature than young cattle. The overall average slaughter rate observed in the study was 1.2 %. This corroborates with findings by Ndikumana *et al.*, (2000).

The transferring animals by pastoral communities are risk mitigating mechanisms used against drought and other disasters (McPeak and Barrett, 2001). Although the numbers involved are small, it however plays an important part in the maintenance of the herd structures in the pastoral areas. Table 4.2 indicates that, on average, the households gave out 0.6 cattle and received 0.3 cattle. More female cattle were transferred than males.

With regard to cattle sales, Table 4.2 indicates that more males were sold than females. On average the pastoralist households sold 5 animals per year. These sales were 90% for the beef cattle of mature class, followed by 8% for young class and 2% for immature class. The sales were done for purposes of meeting household food needs, educational needs, medical attention, and the buying of other livestock on the basis of 47%, 46%, 5% and 2% respectively.

In this study an overall commercial off-take rate of 12% was observed for the entire sample of households in Isiolo and Garissa. Garissa had slightly higher rate of 13.2 compared with 10.5 % for Isiolo, and the results are consistent with the commercial off-take rate observed in other studies (Ndikumana *et al.*, 2000). However, a few studies have observed higher rates (e.g.19% in the case of Datoga pastoralists of Tanzania (Sieff, 1999).

4.1.4 Current status of market information in the study area

This section uses the cross-section survey data from pastoral market sheds of Isiolo and Garissa to illustrate the degree of accessibility and utilization of livestock market information in study area. The results revealed that 51 % of the livestock producers had access to radio, while 28%, 11% and 10% had access to cello-phone, newsprint and television respectively. However, 75% of the respondents relied on their neighbors and their own personal visit to the market to obtain information on prices of livestock. The findings corroborate with those of Osterloh *et al.,* (2003) who reported that people relied on information networks to generate and distribute information. As regards the need for price information on other markets outside their areas, 77.8% of the respondents expressed a need. Of these pastoralists, 32%, 54%, and 9% desired to have the information on daily, weekly, monthly and quarterly basis respectively, while 5% were indifferent about the frequency.

This study finds that a total of 96% of the respondents preferred to sell their animals in markets within the region, citing (in order of consideration) length of trip, security, volume of sales and unfamiliarity with distant markets as the major factors influencing the decision. The study also found that over 75% of the pastoral households used visual assessment to peg prices to their animals before sale. This finding corroborates with Kaitho *et al.,* (2004) on the use of visual assessment.

4.1.5 Beef cattle attributes

In this section, the attributes used by producers to value their beef cattle before sale in the pastoral markets is discussed.

**Table 4: 3: Ranking of beef cattle attributes that influence cattle prices according to pastoralists' consideration in pastoral areas of Isiolo and Garissa, December 2005**

| ATTRIBUTE | Description of attributes | Rank | Mean score in the scale of 1-5* | No. of respondents (N=135) | % of respondents |
|---|---|---|---|---|---|
| Sex | Animal is male or female | 1 | 1.1 | 131 | 97 |
| Age | immature(<1year)young(1-2years), mature above 2years | 2 | 1.4 | 109 | 80.7 |
| Body condition | muscle and fat distribution | 3 | 1.5 | 100 | 74.1 |
| Castration status | Male castrated or not | 4 | 2.3 | 58 | 43.0 |
| Breed | Boran, Zebu, Sahiwal or Mixed | 5 | 2.4 | 48 | 35.6 |
| Breeding ability | Reproductive ability-short calving interval and twinning | 6 | 2.9 | 32 | 23.7 |
| Character | Aggressive to people and other animals or docile | 7 | 3.4 | 21 | 15.6 |
| Lactation | Level of milk production and milk length | 8 | 3.8 | 18 | 13.3 |
| Pregnancy status | female animal whether they are pregnant or not | 9 | 3.9 | 16 | 11.9 |

*Scale: 1 mostly considered; 5 never considered. The rank is based on mean score of consideration.

**Source: Author's survey, 2005**

Table 4:3 summaries result of the ranking done by respondent pastoralists' households on response on the beef cattle physical attributes they considered most important when selecting their animals for sale.

These attributes preference and ranking are behavioral aspects that influence producers in selecting which beef cattle to put in the market. The respondents ranked the attributes in a

scale of 1 for most considered to 5 not considered. The results per attributes are discussed in details below.

Sex

A total of 131 respondents considered sex of the animal as the most important attribute they would first consider when selecting which animal to sell, accounting for 97% of all the respondents in the sample. On a scale of 1 to 5, it had an average of 1.1. This means that on average almost all the respondents scored this attribute as most considered. According to the respondents, male beef cattle were heavier and meatier in appearance and were hence preferred by traders. The traders also preferred the males and were willing to offer better prices for them than for females.

In contrast, female beef cattle were preferred for breeding purposes. Producers therefore were willing to postpone putting them in the market, preferring to keep them for production purposes. Females were mostly sold as culls or as last resort when males have been exhausted.

Age

Age was ranked second. It had an average scale of 1.4 and about 80 percent, that is 109 respondents, considered it most important attribute. Mature cattle were considered for sale because they were preferred by traders due to their readiness for slaughter and they therefore offered better price for them. Moreover, a continual withholding of the mature cattle was deemed uneconomical in comparison to selling young or immature ones. Young beef cattle were preferred by buyers who were willing to rear them in better pastures to take advantage of better prices offered for mature animals. Producers could only sell their young stock if the mature stock had been exhausted.

Body condition

The body condition was ranked third. 74 percent of respondent on average gave a rank of 1 that is, they mostly considered body condition of the animal before selling them. Body condition is usually considered as a proxy for meat quality and quantity. An animal with good body condition fetch better prices. During severe droughts, pastoralists prefer withholding their animals with the anticipation that pasture and water availability will improve later for the animals to gain good body condition.

Castration

The fourth ranked attribute was castration. Castration was rarely practiced in pastoral areas owing to the risk of losing the males, for breeding purposes, especially in the event of drought or disease outbreak. Others, however, noted that castration made animals docile and easily manageable. Meat of castrates tends to be tender than that from non-castrates.

Breed

Breed attribute was ranked fifth among the attributes considered by the pastoralists in assessing their livestock for sale. 48 respondents rank breed as mostly considered attribute. This attribute was not ranked highly considered by other respondents they mostly kept or had only one type of breed. Therefore, the issue of consideration did not arise in most of the cases.

Breeding ability

The breeding ability here refers to the prolific abilities such as short calving interval and twinning. Thirty two (32) respondents ranked this attribute as most considered. Some respondents observed that when one is pressed hard (by need of money), one could approach a neighbor who understands this ability for an exchange or sale to him at a premium. The practice of selling to someone who is known is used as a "bank reserve" for easy availability of good breeding ability within the reach of the previous owner. When the previous owner needs those breeding abilities, he or she can still "redeem" them. In some instances some of these animals with very good breeding abilities are not sold in spite of an approaching drought.

Animal character

For animal character, the factors considered were the aggressiveness to people and other animals in the herd. Only 21 of the respondents ranked this attribute as most considered. It was revealed that pastoralists would easily sell animals which were considered hostile as opposed to docile animals.

Lactation

Lactation was ranked eighth among the attributes considered by pastoralists when assessing their animals for sale. About 13 percent of the respondents ranked this attribute among the most considered attribute before sale. Those who did not consider it important noted they were more interested on the meat production and less inclined to milk production. It was further reveal animals with good milk production delayed in being sold because of the need

for milk by the pastoralist family. These milk yielders were kept near the homestead when others are driven far in search of pastures.

Pregnancy status

On this attribute, only 16 percent of the respondent considered it most important. It was revealed that in some instances old animals are sold when they are in-calf to boost the body condition. In-calf animals score well in body condition than dry animals. Some pastoralist also bought in-calf for breeding purposes.

## 4.2 Empirical Results of Econometric Analysis

### 4.2.1 Some Econometric Tests Undertaken On the Data

Before the econometric analysis was undertaken the data was examined for two important econometric assumptions in order to render them useful in regression analysis. These two are severity of heteroscedasticity and multicollinearity of variables of study.

**Table 4. 4: Pearson Correlation Matrix for Livestock Price Model For testing of heteroscedasticity**

| | Market | volume | breed | class | sex | castration | Grade | price |
|---|---|---|---|---|---|---|---|---|
| Market | 1 | | | | | | | |
| | | | | | | | | |
| | 1213 | | | | | | | |
| Volume | .218(**) | 1 | | | | | | |
| | .000 | | | | | | | |
| | 1213 | 1233 | | | | | | |
| Breed | -.012 | .002 | 1 | | | | | |
| | .679 | .945 | | | | | | |
| | 1213 | 1233 | 1233 | | | | | |
| Class | .257(**) | .331(**) | -.030 | 1 | | | | |
| | .000 | .000 | .301 | | | | | |
| | 1211 | 1231 | 1231 | 1231 | | | | |
| Sex | -.031 | .020 | .014 | .337(**) | 1 | | | |
| | .274 | .485 | .624 | .000 | | | | |
| | 1213 | 1233 | 1233 | 1231 | 1233 | | | |
| Castration | -.229(**) | -.360(**) | -.018 | -.228(**) | .069(*) | 1 | | |
| | .000 | .000 | .597 | .000 | .036 | | | |
| | 895 | 909 | 909 | 908 | 909 | 909 | | |
| Grade | -.237(**) | -.062(*) | -.036 | -.064(*) | -.140(**) | .095(**) | 1 | |
| | .000 | .029 | .210 | .024 | .000 | .004 | | |
| | 1213 | 1233 | 1233 | 1231 | 1233 | 909 | 1233 | |
| price | -.296(**) | -.335(**) | .036 | -.416(**) | .113(**) | .164(**) | -.172(**) | 1 |
| | .000 | .000 | .203 | .000 | .000 | .000 | .000 | |
| | 1213 | 1233 | 1233 | 1231 | 1233 | 909 | 1233 | 1233 |

* significant at 5 %, **significant at 1%

**Source: Author's analysis 2005.**

Table 4.4 presents the results of Pearson product moment correlation matrix for the livestock price formation model. An examination of the result, and applying Graham *et al.*, (2001), which states that a variable is not severally heteroscedasticity if its coefficient with other explanatory variable does not exceed 0.35, shows that the heteroscedasticity is not severe

and can be tolerated in the regression analysis. The results derived by the livestock price formation model can offer plausible result for economic interpretation

**TABLE 4. 5: Partial correlation Matrix for Livestock Off-Take rate Analysis Testing for multicollinearity**

| | Dependency ratio | Household size | Wealth | Calving rate | Mortality rate | Off pastoral income | Slaughter rate | Purchase rate | Education | Age | Market information used | Herders knowledge of market prices | Livestock off take rate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dependency ratio | 1 | | | | | | | | | | | | |
| Household size | .270(**) | 1 | | | | | | | | | | | |
| Wealth in TLU | .177(*) | .342(**) | 1 | | | | | | | | | | |
| Calving rate of cattle | 0.136 | .170(*) | 0.158 | 1 | | | | | | | | | |
| Mortality rate | 0.046 | 0.009 | -.339(**) | 0.166 | 1 | | | | | | | | |
| Off pastoral income | .260(**) | -0.084 | -0.059 | -0.11 | .207(*) | 1 | | | | | | | |
| Slaughter rate | 0.036 | .317(**) | .373(**) | .246(**) | -0.093 | -0.144 | 1 | | | | | | |
| Purchase rate | 0.022 | .234(**) | .219(*) | 0.113 | 0.053 | 0.143 | .173(*) | 1 | | | | | |
| education | 0.048 | -.234(**) | 0.028 | -0.016 | 0.051 | 0.149 | 0.001 | 0.12 | 1 | | | | |
| Age | 0.091 | .282(**) | 0.059 | 0.038 | 0.019 | -0.096 | 0.112 | -0.07 | -.476(**) | 1 | | | |
| Market information used | 0.062 | .213(*) | 0.037 | 0.112 | -0.063 | 0.035 | 0.025 | 0.001 | -0.016 | -0.023 | 1 | | |
| Herders knowledge of market prices | -0.098 | 0.039 | 0.101 | 0.134 | 0.021 | -0.077 | -0.01 | 0.065 | .247(**) | -.237(**) | .251(**) | 1 | |
| Commercial livestock off take rate | .595(**) | .267(**) | .275(**) | .211(*) | -0.014 | 0.159 | 0.056 | 0.098 | -0.06 | 0.046 | 0.019 | -0.094 | 1 |

* significant at 5 %, ** significant at 1 %

**Source: Author's Analysis 2005**

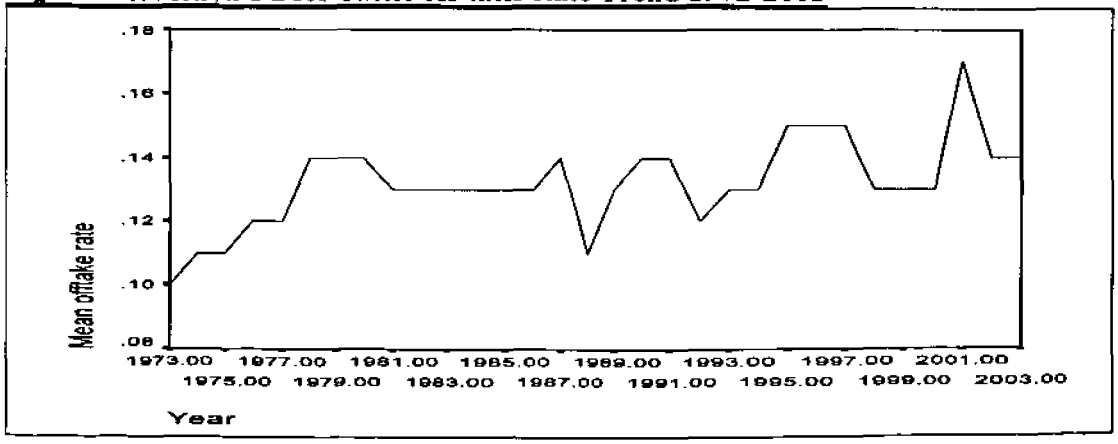
Table 4.5 presents the results of Spearman rank correlation matrix derived from the analysis of variables used in commercial beef off-take rate analysis model. The variables were examined for multicollinearity using Kennedy (1985) criteria, which states that a value of 0.8 or higher in absolute terms for any of the correlation coefficients indicates a high degree of multicollinearity between the two explanatory variables. The results of this examination show that there is no severe multicollinearity among the explanatory variables. The results of the model can offer plausible results for economic inferences.

4.2.2 Beef cattle supply response analysis

In examining the data used in the beef cattle supply response analysis, a few intuitive findings can be deduced (Appendix 6). The data used covered the 1972- 2003 period during which the government actively participated in the marketing of livestock and after the liberalization policies of the 1980s, a period during which the private sector started to participate in marketing with minimal government interventions.

As Figure 4.1 finds, in 30 years of marketing history of the Kenya beef cattle sector, livestock off-take rate has steadily increased over the years. Though it is more pronounced in some years than others, the general pattern is an increasing rate, with highest livestock off-take rates experienced in 2001 year. Figure 4.1 is a representation of the beef cattle behavior in ASALs. It is, however, worth noting that the figure is based on the data drawn from off-take rates for both the pastoral and ranching systems of production; the later usually has higher off-take rate than the pastoral system (Nyariki, 1990). Ackello (2006) estimated the pastoral system off-take rate of 10%.

**Figure 4:1: Kenya's Beef Cattle off-take Rate Trend 1972-2003**




**Source: Author's, work 2005**

From Figure 4.1 above, it is clear that the liberalization reforms of the1980s have not affected substantially the cattle off-take rates in the Kenya beef cattle sector. Contrary to held assertion that liberalization of livestock marketing can be used as a mechanism of generating price signals that could stimulate increased production, read marketable off-take rate. The same data was also subjected to analysis using regression model specified in equation 3.11. The results are given in Table 4.6.

**Table 4.6: Regression Results of Beef Cattle Supply Response Model for the period 1972-2003**

| Variable | Ln (price per Kilogram live weight ) | |
|---|---|---|
| | Beta coefficient | t-value |
| (Constant) | | .000 |
| Current Beef cattle price | -.521 | .370 |
| One year lag beef cattle price | .873 | .126 |

Dependent Variable: Quantity of beef cattle sold

Source: Author's work, 2005

Table 4.6 shows the results of the regression model examining the supply response of Kenya's beef cattle sector. The results of this model did not show any significance which could allow for economic interpretation. However an examination of beta coefficient offers some intuitive insights for economic interpretation. Beef cattle supply elasticity in Kenya was found to be inelastic at (-0.5) for current price and at (+ 0.873) for one year lagged prices ($p< 0.3$). The low response to price changes in the beef cattle sector results from the nature of production. Beef cattle producers rely mostly on the traditional methods of raising the animals.

A plausible explanation could be that female animals take long to mature for production and the calving interval in some case may go beyond 2 years. Further it could be associated with cultural tendencies of producers because they tend to sell livestock only for specific needs.

The negative response for the current price means that when prices are increased producers withhold the animals from the market. A positive response for the one year lagged price mean that producers will increase their animals to the market in the long run. This phenomenon is what Jarvis (1974) associated with the explanation that producers in the beef cattle sector considered the cattle as capital goods. Therefore, with an increase in price, producers withhold the cattle for production in order to take advantage of these better prices in future (Jarvis 1974).

4.2.3 Factors influencing household beef cattle commercial off-take rate

They survey data was used to analyzed the factors that influence household beef cattle off-take rate using empirical model specified in equation 3.13. Table 4.7 presents the result of the regression model. The model had R-square value of 0.702, meaning that 70 percent of the factors that influence the household beef cattle off-take rates are explained by variables in the model. The resulting coefficients had the expected signs and F-ratio statistic was highly significant for the model. The combinations of these factors suggest goodness of fit for the model.

The empirical results in Table 4.7 revealed that livestock marketing information coefficient in the two levels examined was not statistically significant at p> 0.05. This suggests that market information does not necessarily influence producers to increase the sales of beef cattle.

**Table 4.7: Regression results for commercial beef cattle off-take rate in market sheds of Garissa and Isiolo in 2005**

| | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|
| X | Variable | Beta | T value | |
| | (Constant) | | .737 | .463 |
| 1 | Dependency ratio* | .218 | 3.961 | .000 |
| 2 | Off-pastoral income. | .119 | 2.235 | .027 |
| 3 | Herders knowledge of market prices | .039 | .694 | .489 |
| 4 | Household size | .069 | 1.295 | .198 |
| 5 | Mortality rate of cattle | -.060 | -1.034 | .303 |
| 6 | Calving rate of cattle* | .751 | 8.474 | .000 |
| 7 | Beef cattle price | -.049 | -.831 | .408 |
| 8 | Wealth | .027 | .513 | .609 |
| 9 | Cattle purchase rate* | .247 | 3.782 | .000 |
| 10 | Cattle slaughter rate | -.098 | -1.017 | .311 |
| 11 | Use of Market information in price determination | .014 | .264 | .792 |

Dependent Variable: Commercial beef cattle off take rate.

Independent variables: X

R Square .702, F- ratio. 26.372, * p>0.05.

Source: Author's Work, 2005

The results showed that cattle calving rate was a significant factor influencing the commercial livestock off-take rate. Cattle production can be increased by increasing the size of the breeding herd. Therefore, pastoralists hold onto animals especially females for

future beef production. The above results show that calving rate contribute up to 0.751 in commercial beef cattle off-take rate. This implies that with the assurance of an increase of cattle numbers, the pastoralists are willing to sell off some of their livestock. These findings corroborate the findings of Osterloh *et al.*, (2003) and Ndikumana *et al.*, (2000) where it was reported that biology remains the dominant regulator of pastoralist herd size even in the most market oriented sites in northern Kenya.

Purchase rate was also an important factor in influencing the level of beef cattle off-take rate. The results show that cattle off-take rate was increased by 0.247 with an increase of 1 % of purchase rate. This implies that the pastoralists who purchase more in the market tend to have higher off-take rate than those who purchase few.

The results of the survey indicate that beef cattle commercial off-take rates among Isiolo and Garissa pastoralists are also affected positively (0.218) by the dependency ratio. The economic postulation is that household off-take rate decisions are influenced by the number of dependants in the household. This is plausible given that with increased number of members to feed coupled with other individual needs, households must sell more of its animals. This is further support by descriptive results which shows household with high dependency ratios had low off-pastoral income, meaning livestock selling was mostly the source of livelihood.

The survey results also reveal that off-pastoral income has a significant positive response on commercial beef cattle off-take rates. This can be explained in that with more off-pastoral income, households may have more money at their disposal to buy drugs and have assurance of survivability of their cattle. This will enhance planned sale of cattle. Such households will also dispose off their cattle in case of an approaching disaster. Moreover, they can restock their herd when conditions are favorable. This is possible given the fact that those pastoralists with more off-pastoral income are able to purchase cattle either for resale or for restocking.

From the above findings, it is evident that incentives to increase off-take rate should take care of these significant factors, which focus on; increasing calving rate, off-pastoral income, purchase rate and, and dependency ratio.

4.2.4 Beef cattle pricing in pastoral areas of Kenya.

This section utilizes data obtained from the LINKS website from the markets of Nairobi, Isiolo and Garissa. A total of 1233 transactional data were used in the analysis. They include 415 transactional data from Garissa market, 244 transactional data from Isiolo market and 574 transactional data from Nairobi market.

This section examines the factors influencing beef cattle market price. The presentation begins by examining the mean average price differences between different cattle attributes and between different markets, followed by a discussion of results obtained from the ANOVA and post-hoc range tests and pairwise multiple comparisons. Finally, the determinants of beef cattle price are discussed. These results together assist to clarify the importance of including different attributes in the beef cattle information format.

Attributes affecting Beef cattle market price

The results of the analysis of the various attributes deemed to determine price, as reported in LINKS market price information, could be viewed as the traders' valuation of beef cattle. The 1233 market information data were analyzed using Ms Excel® in order to obtain the mean prices and standard deviation in each of beef cattle attributes describing them. The results are presented in Table 4.8.

Column 1 shows the different type of attributes and parameters used by LINKS in reporting prices in beef cattle markets in Kenya. The attributes and parameter are grade, sex, breeds, class, castration and markets. Using column 1 for grade as an example, the results show that the attributes column "grade" has three levels of categorization, that is 'Grade two", "Grade three" and "Grade four". The second column has the mean price under each category. In the last row, the attribute is "market" categorized into Garissa, Isiolo and Nairobi. The price variations noted in different categories suggest that there are reasonable price differential between attributes as presented in the reporting format.

**Table 4.8: Mean price per head (Kshs..) of beef cattle on the basis of given attributes in markets of Nairobi, Garissa and Isiolo: September 2004- September 2005**

| Attribute | Mean average price | Minimum price | Maximum price | Standard deviation | No. of transactions(N) | % of total Transaction(N) |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Grade** | | | | | | |
| Grade two | 15,498 | 1,480 | 38,800 | 7,510 | 585 | 47.4 |
| Grade three | 12,053 | 2,180 | 25,400 | 5,085 | 646 | 52.4 |
| Grade four | 5,890 | 5,,340 | 6,440 | 777 | 2 | 0.2 |
| **Sex** | | | | | | |
| Female | 11,844 | 1,480 | 34,500 | 3,413 | 339 | 27.5 |
| Male | 14,387 | 2,060 | 38,800 | 7,277 | 894 | 72.5 |
| **Breeds** | | | | | | |
| Boran | 18,829 | 2,180 | 36,000 | 6,794 | 263 | 21.3 |
| Mixed | 19,779 | 6,800 | 38,800 | 6,178 | 142 | 11.5 |
| Sahiwal | 9,450 | 7,900 | 11,000 | 2,192 | 2 | 0.2 |
| Zebu | 11,013 | 1,480 | 29,800 | 4,831 | 826 | 67.0 |
| **Class** | | | | | | |
| 1 mature | 15,965 | 1,480 | 38,800 | 10,481 | 914 | 74.2 |
| 2 young | 7,134 | 4,860 | 14,200 | 1,695 | 166 | 13.4 |
| 3 immature | 5,497 | 2,360 | 10,040 | 1,267 | 153 | 12.3 |
| **Castration** | | | | | | |
| Non-castrates | 12,985 | 2,060 | 38,800 | 7,394 | 637 | 70.1 |
| Castrates | 16,591 | 2,180 | 37,800 | 6,208 | 272 | 29.9 |
| **Market** | | | | | | |
| Garissa | 8,564 | 2,360 | 23,500 | 3,720 | 415 | 34.2 |
| Isiolo | 12,367 | 4,640 | 19,600 | 4,160 | 244 | 20.1 |
| Nairobi | 17,699 | 1,480 | 38,800 | 6,290 | 574 | 45.7 |

**Source: Author's work, 2005.**

Table 4.8 also shows the percentage number of transactions (column 5). Under "grade" attribute, "grade three" has the highest percentage of transactions; 52.4 %, with "grade two" accounting for 47.4% transactions and "grade four" with only 0.2% transactions.

Assuming that the prices in Garissa and Isiolo are the producer prices and Nairobi is the consumer market, the producer's share[10] range between 45 % and 65 % depending on the producers market. It is noteworthy that sometimes the brokers assume ownership of the beef animal during negotiation. Therefore, the percent may be shared further between livestock producers and brokers who take between 2.5 % and 5 %[11] of the producer price; in such a case the produce share could go as low as 40 %.

[10] Producer's share is calculated as follows (Nairobi mean average price - Isiolo or Garissa mean Average price) as percentage of Nairobi mean average

[11] Brokerage commission was obtained during tangential interviews with pastoralists in the markets of Isiolo and Garissa.

Table 4.8 in summary illustrates how prices differ in different grades, sex, breeds, class and among males who are castrated and those not. The results show that these characteristics matter to traders who paid a premium for mixed breed, mature castrated males with high body condition scoring grade in the terminal market of Nairobi. This confirms the earlier inference drawn from producers ranking of these attributes (Table 4.3). Table 4.8 also shows that producers are not taking full advantage of this knowledge as no animals were traded in excellent condition (grade 1) and a large proportion (about 52.4 %) of the animals traded in all the three markets were only grade 3.

Analysis of Variance Results

Analysis of variance was applied to test the differences in prices between: grades, breeds, classes, castration condition, and markets, and within the different categories. This is also done to test the hypothesis that there are no price differentials in relation to the beef cattle attributes that determine the market price. Results are presented in Table 4.9.

**Table 4.9 One-way ANOVA results of beef cattle attributes**

| Cattle attributes | Source of variation | Sum of Squares | Degree of freedom | Mean Square | F ratio | Sig. |
|---|---|---|---|---|---|---|
| class | Between Groups | 527.833 | 480 | 1.100 | 12.405 | .000 |
| | Within Groups | 66.482 | 750 | .089 | | |
| | Total | 594.315 | 1230 | | | |
| breed | Between Groups | 337.369 | 480 | .703 | 1.067 | .213 |
| | Within Groups | 495.202 | 752 | .659 | | |
| | Total | 832.571 | 1232 | | | |
| sex | Between Groups | 147.870 | 480 | .308 | 2.366 | .000 |
| | Within Groups | 97.925 | 752 | .130 | | |
| | Total | 245.796 | 1232 | | | |
| castration | Between Groups | 171.863 | 403 | .426 | 1.624 | .000 |
| | Within Groups | 132.652 | 505 | .263 | | |
| | Total | 304.515 | 908 | | | |
| Grade | Between Groups | 662.245 | 480 | 1.380 | 1.810 | .000 |
| | Within Groups | 573.329 | 752 | .762 | | |
| | Total | 1235.573 | 1232 | | | |

Significance 0.05

**Source: Author's Work, 2005**

Table 4.9 summaries the one-way ANOVA result of beef cattle attributes traded in the 3 markets of Nairobi, Isiolo and Garissa. The model had also highly significant F-ratio in all the variables. This means that there were significant price differential in animal

classes, sex, castration condition and grade. Based on these results the hypotheses on class, sex, castration condition, and grade attributes are rejected. Implying that each level of attribute attracted a different price, and hence the importance of value attached to different levels of attribute by traders. This suggests that differences exist among the attributes means. Hence, the need to disseminate this information to producers for them to meet the demand of the market is important. The study, however, failed to reject the hypothesis on the attribute of breed.

One-Way ANOVA Post Hoc Tests

Once the existence of mean differences was determined, post hoc range tests and pairwise multiple comparisons were applied to the data to determine which attributes means were different in the three markets of Nairobi, Garissa and Isiolo. The purpose of running these tests is to identify homogeneous subsets of means that are not different from each other in the three markets. Table 4.10 presents the results of post hoc range and pairwise multiple comparison.

The results in Table 4.10 showed that prices were significantly different in the three markets. Nairobi had the highest prices, these being Kshs. 9593 and Kshs. 5790 higher than Garissa and Isiolo prices respectively. Garissa had the lowest price (Kshs. 3802 lower than price in Isiolo). These price variations in the 3 markets are substantial and are way above the marketing cost, transportation cost and other related charges and levies.

Nairobi also had better grades than the other two markets (exceeding Garissa by 0.32 and Isiolo by 0.61) (in the scale of 1 for fat to 4 for emaciated). This difference can be explained in that the traders select the best animals for the terminal market. The inferior grades are either slaughtered in peripheral markets or taken to fattening farms in Laikipia (notably Lewa downs and Kisima farms and also ADC farms between Garissa and Nairobi).

On volumes, Garissa sold the largest number of animals (by 2273 in Nairobi and by 2276 animals in Isiolo (Table 4.10)). Nairobi and Isiolo had more or less the same number of animals. It is worthwhile to note that LINKS covers only a few markets in Nairobi (currently there are 11 markets in Nairobi, but previous studies have estimated an average of 400 animals slaughtered on a daily basis (Agriconsortium; 2003).

**Table 4.10: Mean difference in attributes between markets of Nairobi, Garissa and Isiolo between 2004 -2005**

| Dependent Variable | (I) MARKET | (J) MARKET | Mean Difference (I-J) | Std. Error |
|---|---|---|---|---|
| PRICE | Nairobi | Garissa | 9,593.5(*) | 594.44 |
| | | Isiolo | 5,790.6(*) | 703.52 |
| | Garissa | Nairobi | -9,593.5(*) | 594.44 |
| | | Isiolo | -3,802.8(*) | 738.67 |
| | Isiolo | Nairobi | -5,790.6(*) | 703.52 |
| | | Garissa | 3,802.8(*) | 738.67 |
| GRADEDMY | Nairobi | Garissa | .32(*) | 6.32E-02 |
| | | Isiolo | .61(*) | 7.48E-02 |
| | Garissa | Nairobi | -.32(*) | 6.32E-02 |
| | | Isiolo | .30(*) | 7.86E-02 |
| | Isiolo | Nairobi | -.61(*) | 7.48E-02 |
| | | Garissa | -.30(*) | 7.86E-02 |
| SEX | Nairobi | Garissa | -1.11E-02 | 2.90E-02 |
| | | Isiolo | 4.66E-02 | 3.43E-02 |
| | Garissa | Nairobi | 1.11E-02 | 2.90E-02 |
| | | Isiolo | 5.77E-02 | 3.60E-02 |
| | Isiolo | Nairobi | -4.66E-02 | 3.43E-02 |
| | | Garissa | -5.77E-02 | 3.60E-02 |
| CLASS | Nairobi | Garissa | -.6300(*) | 4.14E-02 |
| | | Isiolo | -.3268(*) | 4.89E-02 |
| | Garissa | Nairobi | .6300(*) | 4.14E-02 |
| | | Isiolo | .3032(*) | 5.13E-02 |
| | Isiolo | Nairobi | .3268(*) | 4.89E-02 |
| | | Garissa | -.3032(*) | 5.13E-02 |
| BREED | Nairobi | Garissa | 7.80E-03 | 5.35E-02 |
| | | Isiolo | 2.71E-02 | 6.33E-02 |
| | Garissa | Nairobi | -7.80E-03 | 5.35E-02 |
| | | Isiolo | 1.93E-02 | 6.64E-02 |
| | Isiolo | Nairobi | -2.71E-02 | 6.33E-02 |
| | | Garissa | -1.93E-02 | 6.64E-02 |
| VOLUME | Nairobi | Garissa | -2273.54(*) | 31.39 |
| | | Isiolo | 2.89 | 37.15 |
| | Garissa | Nairobi | 2273.54(*) | 31.39 |
| | | Isiolo | 2276.43(*) | 39.01 |
| | Isiolo | Nairobi | -2.89 | 37.15 |
| | | Garissa | -2276.43(*) | 39.01 |

* significantly different group means at $\alpha$=0.05

**Source: Author's work, 2005.**

The survey results indicated that the difference in numbers on the basis of breeds and sexes in the three markets was not statistically significant at 5% level. This finding suggests that the three markets sold the same proportion of breeds and sexes of animals.

The regression analysis of beef cattle Price formation

To determine the relative importance of various attributes affecting price variability, a regression model was used. The choice of the model was made intuitively based on the value of R-squared, the significance of individual regression coefficients and the ability to provide results that were both statistically and economically meaningful. Semi-log model appeared to be most appropriate, based on the above criteria. The linear model appeared to be less satisfactory. The results of semi-log regression model are given in the Table 4.11.

**Table 4.11: The results of the beef cattle price analysis of the markets of Nairobi, Isiolo and Garissa for September 2004- September 2005.**

| X | | Standardized Coefficients | | Sig. |
|---|---|---|---|---|
| | variable | Beta | T value | |
| | (Constant) | | 151.036 | .000 |
| 1 | Castration condition | -.026 | -1.691 | .091 |
| 2 | Grade | -.249 | -16.861 | .000 |
| 3 | Sex | .087 | 6.018 | .000 |
| 4 | Class | -.686 | -42.229 | .000 |
| 5 | Breed | .037 | 2.592 | .010 |
| 6 | volume | -.235 | -14.388 | .000 |
| 7 | Market | -.192 | -12.114 | .000 |

Dependent Variable: Natural log of price. X: independent variables
*Significant at 5% level $R^2 = 0.821$
F-statistic = 578.9

**Source: Author's work, 2005**

It is clear from the results that animal attributes matter in beef cattle pricing. Apart from castration, all the other attributes significantly ($p<0.001$) influence the price of the beef cattle. The castration was, however, significant only at ($p<0.1$).

The analyses for the individual attributes indicate the relationships as given and discussed below.

Class:

The results from price formation model showed that the buyers paid a premium for mature cattle compared to the young and immature animals. The class of beef animal is used as a proxy for age. The coefficient for the dummy variable for class suggests that

class had the largest influence on beef cattle price as indicated by the highest negative coefficient. Beef cattle prices decreased by 53 % for 1% change in every class, that is traders paid premium of over half for mature than young and similar premium for young animal than immature. This implies that producers could reap twice as higher price if they waited for young to mature. Table 4.9 gives the price premium of Kshs. 5234 on average from one class to the next.

Sex:

The expectation that males earn a premium over females is clearly shown by the results. Males fetched higher prices than females (on average by a premium of Kshs.2, 543 (See Table 4.8)). This result corroborates findings of the study by Sieff (1999) that showed that males generally fetched higher prices than females. The positive effect observed for sex indicates that males are preferred over females. This can be explained by the fact that males are bought for both breeding and slaughter purposes. The demand for males, therefore, exceeds that of female cattle which are mainly required for breeding purposes.

Market:

The market variable has a negative coefficient (-0.149). The negative coefficient indicates that prices in Nairobi are higher than prices in other markets of Isiolo and Garissa (coding was; Nairobi = 0, Garissa = 1 and Isiolo = 2). The reverse holds true. This is reasonable, given that Nairobi is the terminal market. The price differential is clearly seen in the post hoc range and pairwise comparison test (See Table 8).

Grade:

The dummy variable for grade (grade 1, 2, 3, 4; the higher the grade, the poorer the body condition) is used to reflect the influence of the cattle body condition scoring (a rough proxy for meat quality and weight) as developed by LINKS. This emerged as a significant explanatory variable. It has a negative coefficient of -0.147 (Coding; grade 2 = 0 and grade 3 = 2, grade 4 = 3)[12]. Animals available for sale on the market were grade 2, 3 and 4. Grade 2 fetches higher prices than grade 3. For instance, the post hoc range and pairwise comparison test (See Table 8) indicate that grade 2 had a premium of Kshs..3,445 over grade 3, grade 3 had premium of Kshs. 6,163 over grade 4.

[12] This grade system was advanced by the LINKS project. More details see appendix 3 on LINKS reporting format.

Volume:

Volume was the other factor affecting beef cattle prices. The volume had a standardized coefficient of -0.235. This corroborates well with the standard supply theory which states that the lower the supply (volume) the higher the price and vice versa. In this case, it indicates that a 1% increase in volume could decrease the average price of beef cattle by approximately 23.5%. This is equivalent to Kshs. 3,026 drop in price.

Breed:

The breed variable was coded as follows; Boran=0, zebu = 1, Sahiwal = 2 and mixed =3. Breed had positive coefficient of 0.037 (The breed variable commanded, on average a premium of Kshs. 476.). Table 4.8 gives the average premiums per breed. Generally, mixed breed (crosses between the other exotic breeds) commanded higher price than such local breeds as Boran and Zebus.

Castration:

The castration variable (coded: castrates = 1, non-castrates = 0) showed a negative coefficient of – 0.026. This implies that castrates commanded a premium Kshs. 3,606.51 (28%) over the non-castrates (See Table 4.8) However, the non-castrates in some cases fetched higher prices, because they were demanded both for breeding purpose as well as for slaughtering purpose (See Table 4.8). In most of the cases, non-castrate males for breeding purpose had high premiums.

In sum, the results presented in Tables 4.3, 4.6, 4.7, and 4.8 give sound evidence that producers and buyer share the same parameters in valuation of beef cattle in the Garissa and Isiolo. Although there is clear price differential in animal attributes, the information that arrives at the isolated village arrives too late and is somehow not considered accurate and reliable[13]. This has also been confirmed by the results presented on the current status of livestock market information. Eggleston *et al.*, (2002) have pointed to the frustration one faces in disentangling the impact of information, noting that it requires good data which is scarce.

[13] One local household head expressed the rationale as follows:
"The market price information I have received from my neighbor is his. I will get my price in the market." (Personal interview with Hirsi Farah, September 2005) This was in response to the perception of market price information received by pastoralist household heads through a neighbor. This implies that though the information given through a neighbor may be true, the belief is that the market is the only place where one can get accurate and reliable information, commonly known as "first hand information".

# CHAPTER FIVE

# CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

## 5.1 Conclusions

a) The beef cattle sector supply response estimated equation provides evidence that beef cattle sector in Kenya have responded in an economic manner to changes of beef prices. Beef cattle supply elasticity in Kenya was found to be inelastic at (-0.5) for current price and at (+ 0.873) for one year lagged prices ($p< 0.3$) (see Table 4.4). Plausible explanation of the low response is that beef cattle sector results from the nature of production, which cannot instantaneously respond by increasing the supply as production of a saleable beef animal takes time. This is based on the fact that beef cattle occupy the ASAL areas where most of the producers rely on the traditional methods of raising animals. This low response is also associated with cultural tendencies of producers because they tend to sell livestock only for specific needs. The negative response is associated with argument that pastoralists treat beef cattle as capital goods. Faced with increase in beef cattle prices producers react by withholding their cattle for two reasons; one, for fattening for better future prices (this applies mostly to male animal), and two, for breeding purposes. Lastly the positive sign in the one lagged price indicates that in long run producers will react rationally by increase in the output (cattle) to the market.

b) The study found that livestock market information does not significantly influence commercial beef cattle off-take rates in household level both in two levels tested; awareness of market prices and utilization of the price information. The livestock off take decisions was established to be influenced by; beef cattle calving rate, off-pastoral income, household dependency ratio and household purchase rate. A plausible explanation of this conclusion is that household beef cattle off-take decision were done mainly on household food needs and education which was found to constitute about 91 % of the reasons why household sell their animals (for the descriptive statistics). Another explanation could be that the information received arrived into the isolated villages too late when it was no longer relevant or accurate. There was a strong indication of a weak flow of information in the study area during they survey period (Kaitho et al., 2004).

c) The Beef cattle producers in Garissa and Isiolo used attributes of sex, age, body condition, breed, breeding ability, character, lactation and pregnancy status in the valuation of beef cattle before sale. The attributes of grade, sex class, breed and variables such as volume of traded cattle and market locations were statistically significant in determining price. The ANOVA and Post-hoc range test results confirmed the presence of significant differential between each of the parameters. The study also found out that the producer share of the terminal price ranges from 45% and 65% depending on the producer market. This suggests that there was a well differentiated pricing system based on beef cattle attributes such as animal class, grade, sex and that these attributes, which is not fully exploited by the beef cattle producer in Garissa and Isiolo.

In summary, this study extends analysis of the factors influencing beef cattle marketing behaviour to variables hitherto unexplored in the literature. It used market transactional data to provide a body of empirical verifiable research results regarding attributes that are important in beef cattle market information packaging. These findings provide important insights into the ability of market information to accomplish its intended goal of enhancing efficiency of livestock price discovery.

### 5.2 Implication

The finding of low elasticities and the perverse behaviour of the beef cattle producers in pastoral production system offers policy makers guidance to tread on when formulating policy that is aimed at increasing off-take rate. Programme designers should take cognizance of scenario when designing programmes for interventions, where off-take rate is one of objectively verifiable indicators, since the outcomes of this programme need to be evaluated after sometime, probably 3 years. This will have allowed the producer to fully respond to the intervention.

Since livestock market information was found to have not influenced beef cattle off-take rate, interventions directed towards achieving high off-take rate should focus on increasing calving rate, off-pastoral income, purchase rate and household dependency ratio rather than investing on provision of price information. This, however, does not mean that provision of market information is not important rather it may not be useful only in increasing beef cattle off-take.

Since there appears to be a well differentiated pricing system based on beef cattle attributes, this implies that the livestock market information provided by the service provider (LINKS) are relevant. Producers can increase the producer's share of beef cattle terminal market price if they are provided with this information in more reliable and accurate manner.

### 5.3 Recommendation

The role of market information needs to be further explored. In order to clearly disentangle the contribution of market information to the welfare of the pastoral communities, the study recommends that more research be done on the composition of marketing costs, and the proportion of the costs that is associated with lack of livestock market information.

There is need to direct efforts to addressing the problems inherent in the quality of market information disseminated. Currently, there is no sound policy which has been put in place to regulate the quality of market information received by producers in the agriculture sector (GoK, 2006). It is, therefore, prudent for policy makers to design a policy that will engender this important aspect in the agricultural sector which supports a sizeable part of Kenya's population. Kenya can borrow a leaf from the USA where an act of parliament was enacted to make it mandatory for traders to report their prices (Geoffrey, 2005). Such policy will increase the usefulness of market information; through setting up of standardized reporting format for the market information system, not only for livestock and livestock products but also for the other agricultural products; harmonization of livestock market price reporting data formats to reflect understandable data standards. This will be of great convenience to producers, traders and other intermediaries so that they have a code which more or less precisely describes the characteristics of the product. This way, transactions will be consummated both easily and at less cost.

To address the problems of low beef cattle off-take rate at the household level the study recommend an increased diversification of sources of income for the pastoral communities, improving beef cattle breeds, and improving pastures.

To increased calving rate, the study recommend that pastoralists adopt and keep beef cattle breeds with high calving rates. To sustain such superior breeds in pastoral areas, strategies must be put in place to support this intervention. Practical strategies include provision of increased veterinary services, including compulsory vaccination of livestock and reviving of cattle dips for disease control, which have been lacking or are rare and poorly distributed in pastoral areas. Provisions of extension services geared towards improved pasture through promotion of sound range management practices in pastoral areas would also support this cause. The use of LEWS weather reports by pastoralists should also be encouraged; this should be coupled with the promotion of emergency sales of livestock in good time to avert losses occasioned by drought. The revival of Kenya Meat Commission (KMC) as a major market and the proper management of the Agricultural Development Corporation (ADC) to serve as an emergency outlet with livestock feedlot facilities towards playing a leading role in this aspect.

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Appendix 1: Livestock Producers' Questionnaire

EMPIRICAL ANALYSIS OF BEEF CATTLE MARKETING BEHAVIOUR IN PASTORAL AREAS OF KENYA, WITH SPECIAL REFERENCE TO THE ROLE OF LIVESTOCK MARKET INFORMATION

Department of agricultural economics
University of Nairobi

**District** _____
**Division** _____
**Location** _____
**Enumerator**_____
**Questionnaire Serial Number [ ]**

SERIAL NUMBER ___ DATE (DD/MM/YY)/___/____/ 2006

Enumerator Name _____

Date of interview (DD/MM/YY) _____/_____/2006

Questionnaire no._____

District_____

Division _____

Location _____

GPS Location _____

1. Family name _____

2. Respondent's name _____

3. Respondent's position in the household
1 = husband 5 = daughter
2 = wife 6 = house help/farm laborer
3 = co-wife 7 = hired manager
4 = son 8 = other (specify) _____

5. Household structure

| Sex | Infants Below 3years | Children 3-18 years | Adults 18-55 years | Elderly Above 55 years |
|---|---|---|---|---|
| Males | | | | |
| Females | | | | |

5. How far is the household from (in kilometers);

| Distance of household from | In kilometers |
|---|---|
| A road open to vehicles all year | |
| A road passable only during the dry season | |
| The closest market or trading centre | |

6. What is the education level of the household head? (Tick where appropriate)
0. Never been in a class
1. Adult education/religious education
2. Primary level (...)
3. Secondary level (...)
4. above secondary (...)

7. What is his/her age? (In years) _____

8. What other occupation is done by the household head apart from livestock keeping?
1. Civil servant
2. Teacher
3. Businessman or businesswomen.
4. Not applicable
5. Others specify_____

9. Estimate the annual income accruing from this occupation in KSHS..._____

10. Livestock off take structure during the last one year and purpose/reason/cause (P.R.C)

| Animal Kind | births | | Sold | | Loss | | Consumed | | Give out | | Received | | Bought | | present herd | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | F | M | F | M | F | M | F | M | F | M | F | M | F | M | F |
| Sheep no. | | | | | | | | | | | | | | | | |
| Class | | | | | | | | | | | | | | | | |
| P.R.C | | | | | | | | | | | | | | | | |
| Goats no. | | | | | | | | | | | | | | | | |
| Class | | | | | | | | | | | | | | | | |
| P.R.C. | | | | | | | | | | | | | | | | |
| Cattle no. | | | | | | | | | | | | | | | | |
| Class | | | | | | | | | | | | | | | | |
| P.R.C. | | | | | | | | | | | | | | | | |
| Cameino. | | | | | | | | | | | | | | | | |
| Class | | | | | | | | | | | | | | | | |
| P.R.C. | | | | | | | | | | | | | | | | |

**Purpose for sale.**
1. School fees
2. Consumption
3. Medical expenditure.
4. Ceremonial /festivals
5. Not applicable
6. Theft

**Cause of loss.**
1. Diseases
2. Drought
3. Wildlife
4. Floods
5. Not applicable

**Reason of giving/ receiving.**
1 Gifts to friend/relative
2. Loans
3. Communal work
4. Ceremonial festivals
5. Not applicable

**Reason for buying**
1.restocking
2.Ceremonial
3.resale
4. Festivals
5. Not applicable

**Reason for consumption**
1. Normal
2. Religious festivals
3. Cultural festivals
4. Not applicable
5. Others specify_____

**Animal class**
1. Mature
2. Young
3. Immature
4. Castrates
5. Not applicable

11. Before any of the sales did you find out about the market situation; that is, price and the number of livestock in the markets?

0 never sought information
1 sometimes
2 always

12. What was your mostly used source/media of the information? Rate in the scale of 1- for mostly used to 5- for the not used media.

| Media | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Local authority | | | | | |
| Farmers association | | | | | |
| Market participant | | | | | |
| Links | | | | | |

13. Have you heard of the LINKS market information system?

1. yes
2. no

14. If no, can you use the market information if it is available to decide asking price for your animals to be sold?

1. no
2. I don't know
3. yes

15. How would you like the market information represented? Most preferred 1 to least preferred media

| media | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Bulletin | | | | |
| Radio | | | | |
| Cello phone server | | | | |

16. Do you have access to the following means of accessing information?

1. Radio 1. Yes 2. No
2. Cello phone 1. Yes 2. No
3. Newspaper 1. Yes 2. No
4. Television 1. Yes 2. No
5. others specify_____

17. What is your desired frequency of availability of this information?

1. Daily
2. Weekly
3. Monthly
4. Quarterly

18. Would you like to have livestock market prices from other markets such as Nairobi, Mombasa Etc?

1. yes
2. no

19. How did you acquire market information on prevailing price? (Rate from the most used 1 to less used 5)

| channel | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Neighbor | | | | | |
| Radio/satellite | | | | | |
| Cello phone | | | | | |
| Billboards | | | | | |
| Personal visit to the market | | | | | |

20. Was the information used in determining the selling price?

0. Never used the information
1. Sometimes
2. Always

21. Where was most of the selling activity undertaken?

1 In the village or grazing field or outside the formal markets
2 At village or local periodic market.
3 At the major regional market.
4 At the major market further down the marketing chain.
5 Name of the market _____

22. Please give reason for using the chosen market outlet. Rate reasons on order of the most important to the less important reason

| Reason | 1 | 2 | 3 |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Length of trip | | | |
| Unfamiliarity with market and intermediaries | | | |
| Volume of sales | | | |
| Security | | | |

23. What were the criteria used in determining the value (price) of the animal?

| Criteria | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Live weight | | | | | |
| Visual assessment | | | | | |
| Estimation of carcass weight on live animal | | | | | |

24. What beef cattle attributes do you consider when determining the value of the animal? Rank consideration in scale of 1 for mostly considered to 5 for least considered

| Attribute | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Age | | | | | |
| Breed | | | | | |
| In calf | | | | | |
| Body condition | | | | | |
| Castration condition | | | | | |
| Lactating | | | | | |
| Character/Behavior | | | | | |
| Breeding ability | | | | | |
| Sex | | | | | |

*Thanks for your cooperation*

## Appendix 2: Post Hoc Tests

| Dependent Variable | | (I) MARKET | (J) MARKET | Mean Difference (I-J) | Std. Error | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| PRICE | Tukey HSD | Nairobi | Garissa | 9,593.5107(*) | 594.44 | KS200.3192 | KS10986.7023 |
| | | | Isiolo | 5,790.6966(*) | 703.52 | KS141.8528 | KS7439.5405 |
| | | Garissa | Nairobi | -9,593.5107(*) | 594.44 | KS-10986.7023 | KS-8200.3192 |
| | | | Isiolo | -3,802.8141(*) | 738.67 | KS-5534.0315 | KS-2071.5966 |
| | | Isiolo | Nairobi | -5,790.6966(*) | 703.52 | KS-7439.5405 | KS-4141.8528 |
| | | | Garissa | 3,802.8141(*) | 738.67 | KS2071.5966 | KS5534.0315 |
| GRADEDMY | Tukey HSD | Nairobi | Garissa | .32(*) | 6.32E-02 | 0.17 | 0.46 |
| | | | Isiolo | .61(*) | 7.48E-02 | 0.44 | 0.79 |
| | | Garissa | Nairobi | -.32(*) | 6.32E-02 | -0.46 | -0.17 |
| | | | Isiolo | .30(*) | 7.86E-02 | 0.11 | 0.48 |
| | | Isiolo | Nairobi | -.61(*) | 7.48E-02 | -0.79 | -0.44 |
| | | | Garissa | -.30(*) | 7.86E-02 | -0.48 | -0.11 |
| SEX | Tukey HSD | Nairobi | Garissa | -1.11E-02 | 2.90E-02 | -7.90E-02 | 5.68E-02 |
| | | | Isiolo | 4.66E-02 | 3.43E-02 | -3.38E-02 | 0.127 |
| | | Garissa | Nairobi | 1.11E-02 | 2.90E-02 | -5.68E-02 | 7.90E-02 |
| | | | Isiolo | 5.77E-02 | 3.60E-02 | -2.66E-02 | 0.1421 |
| | | Isiolo | Nairobi | -4.66E-02 | 3.43E-02 | -0.127 | 3.38E-02 |
| | | | Garissa | -5.77E-02 | 3.60E-02 | -0.1421 | 2.66E-02 |
| CLASS | Tukey HSD | Nairobi | Garissa | -.6300(*) | 4.14E-02 | -0.7269 | -0.5331 |
| | | | Isiolo | -.3268(*) | 4.89E-02 | -0.4414 | -0.2122 |
| | | Garissa | Nairobi | .6300(*) | 4.14E-02 | 0.5331 | 0.7269 |
| | | | Isiolo | .3032(*) | 5.13E-02 | 0.1829 | 0.4236 |
| | | Isiolo | Nairobi | .3268(*) | 4.89E-02 | 0.2122 | 0.4414 |
| | | | Garissa | -.3032(*) | 5.13E-02 | -0.4236 | -0.1829 |
| BREED | Tukey HSD | Nairobi | Garissa | 7.80E-03 | 5.35E-02 | -0.12 | 0.13 |
| | | | Isiolo | 2.71E-02 | 6.33E-02 | -0.12 | 0.18 |
| | | Garissa | Nairobi | -7.80E-03 | 5.35E-02 | -0.13 | 0.12 |
| | | | Isiolo | 1.93E-02 | 6.64E-02 | -0.14 | 0.17 |
| | | Isiolo | Nairobi | -2.71E-02 | 6.33E-02 | -0.18 | 0.12 |
| | | | Garissa | -1.93E-02 | 6.64E-02 | -0.17 | 0.14 |
| VOLUME | Tukey HSD | Nairobi | Garissa | -2273.54(*) | 31.39 | -2347.1 | -2199.97 |
| | | | Isiolo | 2.89 | 37.15 | -84.18 | 89.96 |
| | | Garissa | Nairobi | 2273.54(*) | 31.39 | 2199.97 | 2347.1 |
| | | | Isiolo | 2276.43(*) | 39.01 | 2185.01 | 2367.84 |
| | | Isiolo | Nairobi | -2.89 | 37.15 | -89.96 | 84.18 |
| | | | Garissa | -2276.43(*) | 39.01 | -2367.84 | -2185.01 |

## Appendix 3: Links Reporting Format

### Grading system

The LINKS grading system uses visual assessment as this is a common practice observed in eastern Africa region (Kaitho *et al.*, 2004). This is in contrast with weighing as normally done in developed countries. The LINKS grading system consists of a combination of body condition (fatness) of a given breed and class of an animal. This LINKS grading system is a compressed version of body scoring system developed by Nicholson and Butterworth (1986) for zebu cattle. This grading allows for the practical separation of livestock into heterogeneity within breeds and classes to reflect expected differences in prices. The LINKS system is based on a scale of 1 to 4 depending on visual assessment of body condition of the animals.

**Table 1**: Animal Grades and Related Body Condition Scores

| Grade | Condition | Body Condition score | Description |
|---|---|---|---|
| 1 | Fat | >7 | This grade ranges from animals that are smooth and well covered, but fat deposits are not marked where dorsal spines can be felt with firm pressure and transverse processes cannot be seen or felt to animals with heavy deposits of fat clearly visible on tail-head, brisket with dorsal spines, ribs, hooks and pins fully covered and cannot be felt even with firm pressure. |
| 2 | Moderate | 5-7 | This grades ranges from animals with ribs usually visible, little fat cover, dorsal spines barely visible to animals with smooth and well covered; dorsal spines cannot be seen, but are easily felt. |
| 3 | Thin | 3-4.9 | These grades ranges from animals with individual dorsal spines pointed to the touch; hips, pins, tail-head and ribs are prominent to animals with transverse processes visible, usually individually. Ribs, hips and pins clearly visible. Muscle mass between hooks and pins slightly concave. |
| 4 | Emaciated | <3 | Marked emaciation with Transverse processes projecting prominently and where neural spines appear sharply. |

Adapted and modified from Nicholson and Butterworth (1986)

### Type of market Data collected

Livestock prices and volumes are collected through interviews with traders during peak market day for selected markets. Average prices by animal kind, breed, class and grade are recorded on a weekly or daily along with the total volumes of livestock by animal Kind coming to the market. The information is recorded in the following formats.

**Livestock market information collection format**

| *Country* | | *Market name* | *Market GPS* | *Monitors name* | *Date* |
|---|---|---|---|---|---|
| | | | | | |
| | | | | *Price range* | |
| *Kind* | *Class* | *Breed* | *Grade* | *Lowest* | *Highest* |
| *Cattle* | *Mature male* (>=4 years) | | *1-4* | | |
| *Cattle* | *Young male* (>2<4 years) | | 1-4 | | |
| *Cattle* | *Immature male (<2 years)* | | 1-4 | | |
| *Cattle* | *Mature female (>=4 years)* | | 1-4 | | |
| *Cattle* | *Young female (>2<4 years)* | | 1-4 | | |
| *Cattle* | *Immature female (<2 years)* | | 1-4 | | |

| *Volume by animal kind* | |
|---|---|
| ***Type/kind*** | ***Number of animals*** |
| ***Cattle*** | |
| ***Goats*** | |
| ***Sheep*** | |
| ***Camels*** | |

The LINKS project was initiated with the prime objective to increase the household income of the pastoral communities in Eastern African by improving livestock marketing efficiency, strengthening institutional market policy and increasing commercial livestock off-take rates during the emergence of drought, through implementation of an integrated livestock marketing system (Stuth *et al.*, 2003). The project is in ending stages of development with development focusing on information using market monitors; usually they are staff of the Ministry of Livestock and Fisheries Development. The LINKS project connects the pastoralists to the market by providing information on cell phones about market prices.

**Source: Links Operational Manual**

## Appendix 4: Summary for Beef Cattle Off take rate Model

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| 1 | .838(a) | .702 | .676 | .06855 | 1.912 |

a. Predictors: (Constant), market information used in price determination, cattle slaughter rate, per capita TLU, off-pastoral income in KSHS..., dependency ratio, mortality rate of cattle, household size, herders knowledge of market prices, average price of cattle during the year in different markets, cattle purchase rate, and birth rate of cattle
b. Dependent Variable: commercial beef cattle off take rate

**ANOVA (b)**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 1.363 | 11 | .124 | 26.372 | .000(a) |
| | Residual | .578 | 123 | .005 | | |
| | Total | 1.941 | 134 | | | |

a. Predictors: (Constant), market information used in price determination, cattle slaughter rate, per capita TLU, off-pastoral income in KSHS..., dependency ratio, mortality rate of cattle, household size, herders knowledge of market prices, average price of cattle during the year in different markets, cattle purchase rate, birth rate of cattle
b. Dependent Variable: commercial beef cattle off take rate

**Coefficients (a)**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | .032 | .044 | | .737 | .463 |
| | dependency ratio | .015 | .004 | .218 | 3.961 | .000 |
| | Off-pastoral income in KSHS... | 1.62E-008 | .000 | .119 | 2.235 | .027 |
| | herders knowledge of market prices | .007 | .010 | .039 | .694 | .489 |
| | household size | .002 | .002 | .069 | 1.295 | .198 |
| | mortality rate of cattle | -.024 | .023 | -.060 | -1.034 | .303 |
| | birth rate of cattle | .073 | .009 | .751 | 8.474 | .000 |
| | average price of cattle during the year in different markets | -3.17E-006 | .000 | -.049 | -.831 | .408 |
| | Per capita TLU | .001 | .001 | .027 | .513 | .609 |
| | cattle purchase rate | .077 | .020 | .247 | 3.782 | .000 |
| | cattle slaughter rate | -.267 | .262 | -.098 | -1.017 | .311 |
| | market information used in price determination | .004 | .016 | .014 | .264 | .792 |

**Source: Author's Analysis 2005**

## Appendix 5: Summary for Beef Cattle Price Analysis Model

**Variables Entered**

| Model | Variables Entered | Method |
|---|---|---|
| 1 | Market , breed , sex , volume, grade , castration , class (a) | Enter |

a. All requested variables entered.
b. Dependent Variable: Natural log of price

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .906(a) | .821 | .819 | .25143 |

a. Predictors: (Constant), Market, breed, sex, volume, grade, castration, class

**ANOVA (b)**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 256.218 | 7 | 36.603 | 578.994 | .000(a) |
| | Residual | 56.011 | 886 | .063 | | |
| | Total | 312.228 | 893 | | | |

a. Predictors: (Constant), Market, breed, sex, volume, grade, castration, class
b. Dependent Variable: Natural log of price

**Coefficients (a)**

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | 10.170 | .067 | | 151.036 | .000 |
| Castration | -.027 | .016 | -.026 | -1.691 | .091 |
| Grade | -.147 | .009 | -.249 | -16.861 | .000 |
| Sex | .399 | .066 | .087 | 6.018 | .000 |
| Class | -.531 | .013 | -.686 | -42.229 | .000 |
| Breed | .025 | .010 | .037 | 2.592 | .010 |
| volume | .000 | .000 | -.235 | -14.388 | .000 |
| Market | -.149 | .012 | -.192 | -12.114 | .000 |

Dependent Variable: Natural log of price

**Source: Author's Analysis 2005**

## Appendix 6: Data Used in the Supply Response Regression Analysis

| Year | Cattle population | National number of slaughters | Price per KG of live weight in KSHS... |
|---|---|---|---|
| 1973 | 7370 | 759 | 3.91 |
| 1974 | 7400 | 780 | 4.50 |
| 1975 | 7600 | 830 | 5.10 |
| 1976 | 7500 | 920 | 5.53 |
| 1977 | 7350 | 880 | 6.13 |
| 1978 | 10200 | 1433 | 7.11 |
| 1979 | 10600 | 1480 | 7.26 |
| 1980 | 11000 | 1540 | 8.32 |
| 1981 | 9800 | 1274 | 9.84 |
| 1982 | 11000 | 1430 | 12.75 |
| 1983 | 12500 | 1640 | 12.03 |
| 1984 | 13082 | 1650 | 12.18 |
| 1985 | 12000 | 1560 | 17.16 |
| 1986 | 9000 | 1170 | 19.37 |
| 1987 | 9500 | 1300 | 16.87 |
| 1988 | 13050 | 1372 | 18.50 |
| 1989 | 13457 | 1789 | 19.34 |
| 1990 | 13792 | 1878 | 23.92 |
| 1991 | 13075 | 1770 | 24.97 |
| 1992 | 13000 | 1600 | 27.00 |
| 1993 | 13000 | 1750 | 27.10 |
| 1994 | 13000 | 1750 | 30.00 |
| 1995 | 12779 | 1895 | 33.00 |
| 1996 | 12820 | 1930 | 34.00 |
| 1997 | 13235 | 1940 | 35.80 |
| 1998 | 13492 | 1733 | 38.24 |
| 1999 | 13690 | 1802 | 47.99 |
| 2000 | 13931 | 1874 | 81.54 |
| 2001 | 13500 | 2252 | 93.75 |
| 2002 | 13500 | 1854 | 121.65 |
| 2003 | 13500 | 1850 | 118.65 |

**Sources: FAO Production Yearbook, various years and Central Bureau of Statistics – Statistical Abstracts, various years.**