ECONOMIC ANALYSIS OF INDIGENOUS SMALL RUMINANT BREEDS IN THE PASTORAL SYSTEM: A CASE OF SHEEP AND GOATS IN MARSABIT DISTRICT, KENYA

Omondi Immaculate Akinyi

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DECLARATION AND APPROVAL

DECLARATION

This thesis is my original work and has not, wholly or in part, been presented for an award of any degree in any institution or University.

Sign………………………………….

Omondi Immaculate A.

Date……………………………

RECOMMENDATION

This thesis has been approved for final submission with our approval as University supervisors.

Signed…………………………

Prof. Gideon A. Obare

Date…………………………..

Signed…………………………

Dr. Isabelle Baltenweck

Date……………………………

Sign……………………………

Dr. Adam Drucker

Date……………………………

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ABSTRACT

Small ruminants provide very important genetic resources that can be exploited for continued improvements of the livelihoods of poor livestock keepers in the pastoral production system, particularly in the developing country situation, Kenya being one of them. Though important, the motivation of livestock keepers to hold and maintain particular AnGr in conditions of decreasing animal genetic resource base is imperfectly understood. Consequently, in an endeavour to improve the livelihoods of resource-poor small ruminant livestock keepers, it is important to understand the underlying drive that motivates livestock keepers to keep and maintain particular AnGR. This can be achieved if producer responses in production that lead to either loss or conservation of these resources are sufficiently known. This study contributes to the existing knowledge gap by analysing the status of small ruminant breeds in the pastoral production system in Marsabit district of Kenya. Primary data, collected from livestock keepers using structured questionnaires, revealed that small ruminants contribute enormously towards livestock keepers' livelihoods, especially the poor, and subsequently, to conservation of the resource. The results obtained from multinomial logit models derived from stated choice data collected from 314 respondents in the semi-arid Marsabit district of Kenya reveal that disease resistance is the most highly valued trait whose resultant augmentation results into a welfare improvement of up to KShs.3082 and 1480 in goats and sheep, respectively. In goats, drought tolerance and milk traits were found to be implicitly valued for up to KShs.2695 and 1163 respectively, while in sheep, drought tolerance and fat deposition traits were found to be implicitly valued at KShs.973 and 748 respectively. The study further revealed that improvement in milk trait in does, body size and disease resistance traits in bucks, and drought tolerance trait in both does and bucks will collectively improve the producers' welfare hence should be given priority. However, improvement in the reproduction and production ("overall body condition/ meatiness" trait) potential of goats will be worthwhile only if issues concerning access to pasture and water resources are addressed prior and simultaneously. The results further point out that for livestock stakeholders to effectively improve the livelihoods of poor livestock-keepers, development strategies for improving the management and/ or utilisation of small ruminant genetic resources in terms of drought tolerance in sheep, should not only be tailor made to target regions that are frequently devastated by drought but should also precede other strategies or efforts that would first lead to the improvement of producers' economic status.

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LIST OF ACRONYMS, SYMBOLS AND ABBREVIATIONS

AFF	Asset Function Framework
AnGR	Animal Genetic Resources
ASALs	Arid and Semi-Arid Lands
CBM	Community Based Management
CBO	Community Based Organisations
CBS	Central Bureau of Statistics
CE	Choice Experiments
Coeff	Coefficient
df	Degrees of freedom
FAnGR	Farm Animal Genetic Resources
FAO	Food and Agricultural Organisation of the United Nations
FHI	Food for the Hungry International
GIS	Geographical Information System
GDP	Gross Domestic Product
IIA	Independence of Irrelevant Attributes
IK	Indigenous Knowledge
ILRI	International Livestock Research Institute
ML	Maximum Likelihood
MNL	Multinomial Logit
NGO	Non-Governmental Organisation
RPL	Random Parameter Logit
SSA	Sub-Saharan Africa
STATA	Statistical Analysis software
SRGR	Small Ruminant Genetic Resource
TLU	Tropical Livestock Unit
WTA	Willingness to Accept
WTP	Willingness to Pay
WTO	World Trade Organisation
WWL-DAD	World Watch List for Domestic Animal Diversity

CHAPTER ONE

GENERAL INTRODUCTION

1.1. Background of the Study

Indigenous sheep and goat breeds constitute 95 percent of the small ruminant population of Africa; they are owned by the majority of smallholder rural farmers for whom this resource is critical for nutrition and income (Rege, 1994). Small ruminants are widespread in the tropics and are important to the subsistence, economic and social livelihoods of a large human population in these areas especially women, children and the aged, who are often the most vulnerable members of the society in terms of under nutrition and poverty (Lebbie and Ramsay, 1999).

Small ruminants also play a complementary role to other livestock in the utilisation of available feed resources and provide one of the practical means of using vast areas of natural grassland in regions where crop production is impractical (Baker and Rege, 1994). Thus in face of the declining crop yields due to movement of cropping onto marginal soil types and diminishing fallow periods, improvement in the production of sheep and goats (management, nutrition and health care and/or by genetic improvement) is likely to improve the welfare of smallholders (Peacock, 1987). According to Orden et al. (2005), among livestock, small ruminants, particularly goats, possess inherent characteristics (refer to section 4.1.) that could provide a comparative advantage in production compared with large ruminants, poultry and swine.

In Kenya, small ruminants are predominantly kept under pastoral production systems in Arid and Semi-Arid areas (Kinyamario and Ekeya, 2001). Arid and Semi-Arid Lands (ASALs) cover 80 per cent of the total land surface and provide subsistence economy to 25 per cent of the population who are mainly pastoralists and agropastoralists (GOK, 2002). These areas have experienced high levels of poverty over the years with the prevalence of overall poverty being high in these areas. For instance, the government's report on the geographic dimensions of well - being in Kenya in 2005, revealed that 64 percent and 58 percent of the population in North Eastern and Eastern Provinces respectively, were living below the poverty line (Daily Nation, 02/11/2005).

The livestock sector in Kenya, accounts for about 10 percent of the GDP and over 30 percent of farm gate value of agricultural commodities; employs over 50 percent of agricultural labour force; and provides substantial raw material for local dairy, meat, hides and skins processing industries (GOK, 1997). The livestock population in Kenya was estimated at 14.6 million cattle, 8.2 million sheep, 10.6 million meat goats, 33.3 million poultry, 0.87 million camels and 0.35 million pigs in 2002 (GOK, 2002). At the national level, the sheep and goat industry contributes about 30 percent of the total red meat consumed in the country (GOK, 2003).

One of the country's greatest assets is its livestock diversity (Carles et al., 1986). Diversity within a livestock species is reflected in the range of types and breeds that exist and in the intra-breed and intra-type variations (NRC, 1993). The indigenous small ruminant genetic resources (SRGRs) are a source of livelihood to the poor livestock-keepers; however, their genetic diversity is being eroded rapidly due to lack of adequate knowledge on incentives that support their sustainable utilisation (Delgado et al, 1999). The gradual and continuous erosion of animal genetic resources (AnGR) is recognised as a major threat to agro-biodiversity, agricultural sustainability and the livelihoods of many farmers (Drucker et al, 2001). The range of genetic diversity in livestock species must be preserved and maintained as foundation stocks for future improvements and adjustments to changing production conditions (NRC, 1993).

1.2. Statement of the Problem

Given the production systems and the rationality of the producers, producers' responses that would be reflected in productivity, loss and/or conservation trends and patterns of indigenous traits are not sufficiently known. This information is very crucial as basis for priority setting and policy formulation. If this remains unknown, it would render decision-making, in terms of identifying incentive structures and policies that need to be put in place to improve the livelihoods of poor livestock keepers, for instance, incentive structures that may need to be put in place to conserve threatened or endangered breeds that play an important role in the sustainability of farming systems. In addition, lack of information on the values of indigenous traits would contribute to the undervaluation of these values and as a result, the erosion of biodiversity. This would consequently place important indigenous breeds at risk of extinction, which is detrimental to agro-biodiversity, agricultural productivity, sustainability and the livelihoods of many livestock keepers. This study aimed at filling this knowledge gap by analysing the status of small ruminant breeds in the pastoral production system as a source of AnGR and stock of the same to improve livelihoods and hence mitigate erosion.

1.3. Objectives

The overall objective was to analyze the status of small ruminant breeds in the pastoral production system focusing on indigenous AnGR. The specific objectives were:

(i). To identify producers' preferences and determine factors that influence the choice of indigenous small ruminant breed categories as defined by the small ruminant producers

(ii). To identify benefits and/ or reasons for keeping priority breed category(s) and alternative breed categories through assessment of levels and determinants of production and marketed surplus, and the value of non-marketed benefits

(iii). To assess and compare contributions to livelihoods of small ruminants in terms of household income, nutrition, investment and other social functions, of priority breed categories and alternative categories

(iv). To establish the relationship between household vulnerability and livestock asset holding; and management

1.4. Research Questions

To achieve the above objectives, the following research questions were posed to guide the study:

(i). Do some small ruminant producers prefer or choose a particular indigenous breed category over other(s) and what influences the choice?

(ii). Are the production and marketed surpluses of priority breed category(s) and alternative category(s) determined by household characteristics, farm characteristics and other external factors such as distance to the nearest livestock market and perceived market price?

(iii). What values, if any, are attached to specific non-marketed traits of small ruminant priority breed category(s) and alternative categories by producers?

(iv). Are the contribution of priority breed category(s) and alternative categories to livelihoods in terms of household income, nutrition, investment and other social functions significantly different?

(v). Is there a relationship between household vulnerability and livestock asset holding and if so, is this relationship significant?

1.5. Justification

Rural poor livestock-keepers depend on livestock as a component of their livelihoods yet livestock diversity is shrinking rapidly. Indigenous SRGRs are a source of livelihood to the poor livestock-keepers. To understand the productivity; the process of loss and/ or conservation of genetic resources; and be able to sustainably utilize these resources, it is imperative to understand what motivates households to keep specific animal breeds and maintain certain breed ecotypes at the expense of others even at the cost of acceleration of diversity erosion. Genetic diversity is significant in maintaining the ability to develop more efficient production systems and flexibility in meeting consumer and producer demands both in present and/ or in future. Narrow genetic bases are susceptible to environmental, socio-economic and disease challenges and threats. This study is part of a wider study aimed at improving the livelihoods of poor livestock-keepers through Community-Based Management of indigenous Farm AnGRs. The study will provide a basis in terms of knowledge of genetic resource conservation within the context of farm circumstance (as the custodian of these resources) and enable policy makers formulate strategies that would contribute to wide genetic diversity while at the same time ensuring that the livelihood functions of the said resources are improved. Consequently, the result of the study will provide inputs into an analysis of the present policy environment in order to identify policies threatening the improved use of indigenous breeds/ strains, as well as possible policy options to address current constraints/ threats.

1.6. Scope and Limitations of the Study

This study focused only on indigenous sheep and goats (small ruminants) and not all livestock species. The uniqueness of the setting of the study delimited the study in terms of generalisation. The setting of the study in pastoralist/ extensive farming system to a small extent limited the generalisation of the results to other farming systems, for instance, intensive farming system. The agro-ecological condition of the area, its market access and other level of infrastructures, and ethnical characteristics also differs from some other parts of the country making generalization of the results to the country as a whole limited to some extent. The orientation of the study towards the particular livestock keepers' perspective of the breeds and more so the focus on breed categories also limits generalization to the perspectives of the communities under study hence further studies, especially molecular and phenotypic chararacterisation) need to be carried out to complement this findings . Utilising cross-sectional data from household survey, the study can only measure diversity both within and between breeds but not genetic resources erosion which might require some time series data.

1.7. Operationalization of Terms

AnGR – is an acronym that stands for Animal Genetic Resources and include all animal species, breeds and strains (and their wild relatives) that are of economic, scientific and cultural value to humankind in terms of food and agricultural production for the present and/ or in the future (FAO, 2000 in Rege and Gibson, 2003).

A breed - is either a homogenous, sub-specific group of domestic livestock with definable and identifiable external characteristics that enable it to be separated by visual appraisal from other similarly defined groups within the same species, or a homogenous group for which geographical separation from phenotypically similar groups has led to general acceptance of its separate identity (WWL-DAD by FAO, 2000 in Rege, 2001). In the context of conservation of domestic animal diversity, the term "breed " is used to include local populations, the members of which are distinguished from other such groups in local, national or regional usage (Barker, 2001).

Breed categories - this is a phrase used in this study to refer to strains within a particular breed that show peculiar characteristics in their performance or appearance as described by the livestock keepers. In this study, the producers define their animals in terms of the mix of traits, performance and adaptive, the resultant animals from the producer description will be referred to as breed categories. This is because this study is based on the small ruminants producers' perspective of their animals

Indigenous breeds of livestock - are uniquely adapted to the conditions where they developed. They thrive in conditions where modern "high-performance" breeds quickly succumb to drought, hunger and disease. They are vital for the livelihoods of millions of farmers and livestock keepers throughout the developing world. They are also an undervalued resource for the outside world, since they represent a wide range of genetic diversity on which animal breeders can draw. (Sansthan and Köhler-Rollefson, 2005).

Priority breed category (also referred to as dominant category) - In this study, priority breed category will be used to refer to those particular indigenous breed categories of sheep and goats that are kept in larger numbers by the livestock keepers in the area of study.

Alternative breed categories - For the purpose of this study, the term alternative breed categories will be used to refer to all other indigenous sheep and goat categories that are kept by farmers in the area of study and are not classified as a priority breed category(s)

Livelihood and Vulnerability - A livelihood comprises of the capabilities, assets (including both material and social resources) and activities required for to earn a living. Vulnerability is the extent to which different groups are exposed to particular trends, shocks and seasonality; and the sensitivity of their livelihoods to these factors (this relates directly to resilience) (Chambers and Conway, 1992).

Rural poor – these are rural inhabitants who live on less than $1 income per day.

1.8. Outline of Chapters

Subsequent to chapter one that presents the general introduction, chapter two, presents literature review of the various aspects of small ruminants relevant to this study. In this chapter, various findings and ideas presented in different studies on the small ruminants' contribution to livelihoods, the aspects of genetic resources, livestock asset functions and the methodological aspects of valuing the genetic resources embedded in livestock in form of non-market traits are highlighted. Chapter three details of the methodologies used in answering the study's research questions. Chapter four presents the first section of results by detailing some elements of small ruminant production in terms of the breed categories of small ruminants kept and their levels. The chapter mainly aims at highlighting on breed category preferences and the determinants of these preferences. It also aims at identifying the level and the determinants of production and marketed surplus of small ruminant breed categories among pastoral households. While chapter five details the various small ruminant contributions to livelihoods, chapter six presents the producer preferences and valuation of small ruminant non-market traits. Unlike chapter four and five where the animals are classified in terms of breed categories (based on sexes and mixes of particular traits), chapter six has the animals under reference, classified in terms of sexes (either female or male) only and referred to as 'animal classes'. Finally chapter seven integrates all the previous results and other relevant information into general considerations for indigenous small ruminant breeds in the pastoral production system.

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CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1. Literature Review

This section presents a review of literary work on areas and topical issues that are relevant to this study. Various issues surrounding Animal genetic recourses (AnGR) and subsequently small ruminant genetic resources (SRGRs) are discussed to bring out a picture of their importance and contributions to livelihoods. The section also discussed several studies that reveal some important traits in livestock for producers along with the methods that can be used to value the traits. Theoretical and conceptual frameworks are presented in sections 2.2 and 2.3 respectively.

2.1.1. Small Ruminants and their Contribution to Livelihoods

Small ruminants, found all over the world, are particularly concentrated in dry areas such as the sub tropics and seasonally dry tropical regions and make a significant contribution to the farm economy in mixed farming systems. In rural areas, which are too dry for cropping, where steppes and ranges are found, they are the main source of income for the population (Rodriquez, 1997). This gives small ruminants increased significance as living capital, in addition to being multi-purpose animals (Thomson, 1997).

Panin (1996), in a case study aimed at assessing the profitability and economic viability of small ruminant production in Botswana, showed that average income returns of households owning small ruminants was approximately US $ 4.19 per animal with 34 percent return on capital investment in the enterprise and 15 percent contribution to the household income. The author argued that smallholder farmers need to exploit the potential benefits of small ruminant production to increase their household income by allocating more resources to its improvement. However certain issues such as the contribution of the small ruminant production to household nutrition, the role these small ruminants can play in poverty reduction and genetic diversity evaluation are also relevant and need to be considered in an economic assessment of small ruminants.

Small ruminant production objectives are varied; for instance, in The Gambia, Bennison et al. (1997) showed that the ranking of small ruminants, which are mainly kept as investment and/or for ceremonial purposes, varied significantly, for instance, milking goats did appear to be important in certain villages. It follows therefore that policy makers, researchers and farmers should be made aware of the economic viability of small ruminant production in the tropics (Bennison et al., ibid). There is need to also quantify the values attached to the non-marketed traits of small ruminants as these have a bearing on producer objectives of keeping these animals.

In Kenya the sheep population is dominated by native breed types such as Red Maasai, Black-headed Persian and various types of East African fat tailed sheep. Among goats, the Small East African is most dominant (Mburu, 1986). The indigenous Red Maasai and Somali sheep, Small East African Goat (SEAG) and Galla goats are mainly found in pastoral systems which are predominant in the medium to low potential areas with livestock forming a pivotal part of the socio-cultural life of the rural people (Kosgey, 2004). Kosgey (ibid) found that livestock was ranked higher than other sources of income in both smallholder and pastoral/ extensive farming systems in Kenya. The study elicited rankings in both smallholder and pastoral farming systems, of livestock species like sheep, goats, cattle and others[1]. Though the study uncovered the purposes of keeping small ruminants and the economic value of traits in meat sheep, the results of the study would be inadequate in providing empirical information required to understand the producer motives in maintaining particular levels of small ruminant indigenous genetic resources since the contribution of different breeds to livelihoods and also the values attached to the non-marketed traits of these breeds by the community were not highlighted.

2.1.2. Animal Genetic Resources

An estimated eighty two percent of the total contribution of AnGR to global food and agricultural production comes from only 14 species. Among these genetic resources, small ruminants are an important component of the subsistence, economic and social livelihoods of the human population (Kiwuwa, 1992). Thirty two percent of livestock breeds are at risk of becoming extinct and the rate of extinction continues to accelerate (FAO, 2000). Since the turn of the last century, some 16 percent of uniquely adopted breeds are believed to have become extinct (Hall and Ruane, 1993). According to Simianer, (2005), it is estimated that 1–2 percent of the described farm animal breeds go extinct per year. This is equivalent to the vanishing of one or two breeds per week.

[1] such as pigs, donkeys, rabbits, bees, fish, and types of poultry

Genetic erosion can happen at trait (phenotypic and genotypic) level, breed level and species level. Some interdependence exists in that erosion of the trait leads to breed extinction and then vanishing of species. As such, the gradual process of genetic erosion starts from loosing traits (or the diversity within the breed) resulting to species level extinction being highly unlikely (Rege and Gibson, 2003). Erosion of genetic diversity in farm animals is mainly a process that happens within species, none of the approximately 30 mammalian and avian farm animal species is endangered as such (Simianer, 2005). In other words, genetic erosion, loss of heterogeneity in breeds and/or traits, results into homogeneity in breeds and/or traits.

In a study of the contribution of animal genetic resources to economic development, Rege and Gibson (2003) point out that livestock genetic resource underlie the productivity of local agricultural systems and also provide a resource of genetic variation that can be exploited to provide continued improvements in adaptation and productivity. Thus genetic erosion within livestock species, including their wild ancestors, is of particular concern because of its implications for the sustainability of location specific agricultural practices and the consequent impact on food supply and security. Once lost, the current enormous genetic diversity of AnGR will be all but impossible to recreate.

Several factors threaten AnGR. These include: genetic dilution or eradication through the use of exotic germplasm; changes in production systems leading to change in breed use or crossbreeding; and changes in producer preference - usually in response to changes in socio-economic factors, droughts, famine, disease epidemics, civil strife/ war and other catastrophes and/ or political instability (Rege and Gibson, 2003). Tisdell (2003) argues that emerging markets and economic development also favour a shift from multi-purpose local to specialized global breeds. With improved access to global markets, production systems in developing countries tend to become standardised and uniform allowing the production with global breeds, while local production for local markets is more diverse both with respect to production systems and breeds used.

According to Simianer (2005), since economic performance is of increasing importance and, as a consequence of World Trade Organisation (WTO) regulations, global trade of animal products is steadily increasing, local and well adapted breeds are continuously replaced by global, more productive breeds. This development is accompanied by the use of standardised animal husbandry systems, for instance feeding, air-conditioning and hygienic regimes mostly in developed countries, to compensate for the higher and more specific environmental requirements of the high performance breeds. Although the use of locally adapted breeds might be more rewarding and sustainable in a macro-economic sense, these decisions are often made on a microeconomic scale with a short to medium term perspective (Simianer, 2005).

Farm animal breeds are adapted to specific challenges which encompass specific environmental conditions, disease challenges or market needs; some breeds are more adapted to specific heterogeneous environmental profiles than others and therefore are, locally or globally, more successful than others (Simianer, 2005). In addition, Wollny (2003) argues that introducing animals with increased productivity through import or crossbreeding with exotic breeds requires that the necessary production factors, access to market for animal products and adequate animal husbandry knowledge are provided simultaneously. If that is not the case, the risk of failure is immense with the consequence that the original breeds are replaced through imported breeds which are not sustainably viable in the respective production environment. Hence, diversity is a factor of economic stability in extensive livestock production systems, while introduction of exotic breeds or strains potentially distorts the balance of these production schemes, and ultimately threatens the existence of the local breeds in the system.

From an ecological perspective, species richness in an ecosystem is seen as a barrier against ecological invasion of alien species (Kennedy et al., 2002). In extensive livestock production systems simultaneous use of diverse species (like chicken, sheep, goat and cattle) and eventually different breeds or crosses within species guarantees the most efficient usage of the available resources (e.g. Ayalew et al., 2003). Though production efficiency in pastoralist species is closely tied to the use of diverse genetic types, greater genetic uniformity has evolved in intensively raised species (Notter, 1999).

Genetic diversity can be seen as an insurance against future changes (Lebbie and Ramsay, 1999) required to meet current production needs in various environments; to allow sustained genetic improvement; and facilitate rapid adaptation to changing breeding objectives (Notter, 1999). The objective (‘priority in maintaining breeds) might be defined as to maintain sufficient genetic diversity to be able to adapt to the challenges that lie ahead in as far as livestock is concerned. Those challenges might be a change of market requirements (for instance, other composition of the fatty acids in animal products); a change of production conditions (for instance, as a consequence of global warming); resistance or immunity against new diseases (comparable to the relatively recent advent of Bovine Spongiform Encephalopathy (BSE) or new variants of avian influenza) (Simianer, 2005).

The Convention on Biological Diversity (CBD, 1992) has put the need to conserve farm animal genetic diversity on the agenda. Conservation of AnGR is justified due to its contribution to human livelihoods rather than in the interest of the biological resources (Rege and Gibson, 2003). The objective of livestock conservation is a composite of maintaining between and within breed diversity and single breeds of recognised value (Simianer, 2005). Conservation is not only about endangered breeds, but also about those that are not being utilized effectively (Barker, 2001). In order to make SRGR conservation attractive and sustainable, the strategy must be associated with some economic benefits. This could be achieved by commercialising SRGR by adding value to them, particularly the indigenous breeds. There is also a need to promote conservation awareness and build capacity among the stakeholders through research, extension and training. Policy changes and political as well as financial commitment are needed at both national and regional levels to implement these actions (Lebbie and Ramsay, 1999). The success of any conservation or improvement programme depends upon the actions of livestock keepers who own, utilize and adopt breeds and adapt them to their needs (Mwacharo and Drucker, 2005).

Work on AnGR as a component of the overall global genetic diversity is recent and the players have, to date, remained animal geneticists/ breeders. This has led to important social and economic dimensions of AnGR conservation and utilisation being inadequately addressed. The process, from characterisation (including identification and quantification of values of breeds and traits/functions) through prioritisation of breeds, to allocation of conservation resources and determination of cost-effective conservation strategies, require an interdisciplinary approach in which economists and social scientists have a key role to play (Rege and Gibson, 2003).

2.1.3. Small Ruminant Genetic Resources (SRGR)

In Sub-Saharan Africa (SSA), which is endowed with a considerable and diverse Small Ruminant Genetic Resources (SRGRs) maintained under equally diverse and complex production systems, SRGR play an important role in the welfare of the people, especially the resource poor (Lebbie and Ramsay, 1999) and consist of about 61 sheep and 42 goat genotypes

(Lebbie et al.,1996). SRGRs account for sixty two percent of the total domesticated ruminant livestock in SSA, with goats and sheep accounting for thirty four percent and twenty eight percent, respectively. About ninety percent of the SRGR are indigenous, predominantly associated with traditional farming practices and are widely distributed across the major agro-ecological zones and geographical regions; sixty four percent of the goats and fifty seven percent of the sheep are found in the drier and fragile arid and semi-arid zones (Lebbie and Ramsay, ibid). While Goats tend to be more numerous than sheep in all zones, except in the cool highlands where the reverse is true, East and West Africa together account for the largest number of SRGR in SSA with the East dominating in sheep and the West in goats (Lebbie and Ramsay, ibid).

Worth noting is the fact that except for the exotic and synthetic or composites, the real genetic distinctiveness of most of these major small ruminant genotypes and their varieties or strains, particularly the indigenous ones, is not known. As could be noted, the indigenous SRGR are usually named after specific ethnic groups (e.g. the Red Maasai sheep) or geographical locations (e.g. the West African Dwarf). Similarly, the classification of these major types is largely based on morphological or physical characteristics. Generally, there has been limited systematic and comprehensive characterization of the indigenous SRGR (Lebbie and Ramsay, 1999).

Crossbreeding, effects of drought, famine and prolonged civil wars and developments in biotechnology (the possibilities of identifying and manipulating genes) are, among others, factors that have led to the erosion of indigenous SRGRs (Rege, 1994). Biotechnology-derived (transgenic) animals are generally known for improved animal health, increased productivity and product quality, and also mitigation of some environmental impacts of food animal production (Kochhar et al., 2005). However, the widespread use of homogeneous transgenic varieties will unavoidably lead to "genetic erosion," as the local varieties used by thousands of farmers in the developing world are replaced by the new varieties (Robinson, l996). The rate of erosion of indigenous AnGRs therefore threatens prospects of providing the livelihood of present and future human generations (Rege, ibid).

2.1.4. Livestock Asset Function

An insufficient asset entitlement is the main determinant of poverty (de Janvry and Sadoulet, 1995; 2000). For rural households, who typically pursue multiple sources of income, assets that determine the choice of income earning strategies and the levels of income achieved are quite diverse. In agriculture, they include land, irrigation, productive capital, and livestock for direct production and organisational capital for the reduction of transactions costs in accessing markets (de Janvry and Sadoulet, 1995).

Livestock of different species fulfill multiple functions in the household economy and poor families often keep a diversity of species for this reason (Anderson, 2003). Therefore, livelihoods can be enhanced through their sustainable use while pursuing conservation objectives (Mwacharo and Drucker, 2005). Drucker and Anderson (2005) postulate that the purposes of raising livestock go beyond their output functions and include other significant socio-economic and socio-cultural roles. Anderson (2003), using the sustainable livelihoods approach, evaluated the importance of AnGR to the poor. He argues that the importance of local AnGR is not only in their ability to fulfil livelihood functions (socio-cultural and non-income), but also in their contribution in terms of adaptive traits, non-income and productive traits to crossbred animals since crossbreds ('local' with 'exotic') may express a combination of important (adaptive and productive) traits. Facilitating increases in the productivity and production of such livestock is one of the major means of improving the livelihoods of poor livestock keepers, reducing poverty, and attaining sustainable agriculture and universal food security (Mwacharo and Drucker, 2005).

According to Anderson (2003), use of asset function approach to analyse household data where families keep different breeds to fulfil the same livelihood function allows ranking of the breeds by their contribution to the reduction of vulnerability. Dorward et al. (2001), while using Asset Function Framework in investigating the roles of livestock in the livelihoods of poor families in four villages in the Yucatan, south eastern Mexico, found that the value of asset portfolio and the range of assets held is an increasing function of well being status. It is also worth noting that different management systems, breeding practices and functions of small ruminants have evolved in response to factors such as farmers' needs, and economic and technology levels (Njoro, 2003).

2.1.5. Important Traits in Livestock

According to Kosgey, (2004), in selecting the most desirable breed or breed combination and selecting within a breed, one needs to start with defining the breeding objective, which includes all relevant characteristics of an animal (e. g., production, reproduction, fitness and health characteristics) and assigns a value to each trait. The economic importance of each trait depends largely on the production circumstances.

In developing countries, some of the important nonincome and sociocultural functions of cattle in developing countries are embedded in traits that are not traded in the market, therefore lacking price or market values (Ouma et al., 2007). In a study aimed at measuring heterogeneous preferences for cattle traits among cattle-keeping households in East Africa, Ouma et al. (ibid)'s mixed logit model revealed significant preference heterogeneity among cattle owners, based on the environment and production system. Good traction potential, fertility, and trypanotolerance were found to be the most preferred traits in the model of bull preferences. The most valued traits in the cow preference models were trypanotolerance and reproductive performance.

Mwacharo and Drucker (2005), in their study of the production objectives and management strategies of livestock keepers in south-east Kenya, found that five adaptive traits (disease resistance, drought tolerance, feed requirement, heat tolerance and water requirement) were ranked as most important by pastoralists in the case of Masai Zebu breed. Six productive traits (growth rate, milk yield, fertility, ease of sale, meat quality and body condition) were ranked high in the case of Sahiwal breed. The most important traits considered by livestock keepers when selecting or purchasing an animal were: animal health/ body condition, growth rate, traction ability, milk production, age and adaptation (disease resistance and drought tolerance). However, both the overall ranking and relative strength of the preferences for these traits differed significantly by animal class and production system. The reasons for keeping cattle and the breed/ trait preferences identified reflect the multiple objectives of the livestock keepers in south-east Kenya (Mwacharo and Drucker, ibid). The study shows that livestock keepers have varied rankings of the importance of the different traits depending on their purposes and objectives of raising the respective breeds.

In Canada however, Sy et al. (1997) found that for bulls, calving ease was the most important followed by weaning weight, milking ability of the bulls' offspring, feed efficiency, carcass yield and lastly, fertility of bulls. For steers, temperament was the most preferred trait followed by slaughter weight, weaning weight, feed efficiency, muscling and lastly, carcass yield. Segmenting the beef producers based on their purposes and objectives of raising the stocks, the results in Sy et al. (ibid) indicate that though calving ease for bulls' off-springs and weaning weight for steers were the highly preferred traits across the industry segments, the cow-calf operators preferred calving ease and the breeders preferred weaning weight more than any other producer group. In the West African context, Tano et al. (2003) found that the most important bull traits in order of preference were as follows: fitness to traction, disease resistance, fertility, temperament, feeding ease, size and weight gain. In the same way, the most important traits of cows were found to be: reproductive performance, disease resistance, feeding ease, weight gain, temperament, milk yield and size.

For small ruminants, Orden et al. (2005) used hedonic pricing technique in the Philippines to quantify traders' preferences for goat characteristics (traits) and their results indicate five dominant characteristics, namely (in descending order), meatiness, size, breed, sex and age. Meatiness is defined by well-muscled forequarters, rib and hind areas, and a wide back, particularly in the loin. They argue, in the study, that although buyers have previously indicated their preference for some quality attributes in goats, these are not well documented; moreover, there has been no precise estimate to quantify the value of these attributes. The results of their study show that measured physical attributes of goats can explain the price of goats. Among the goat's characteristics, size and meatiness exerted the highest influence on the price as traders were willing to pay higher prices for these traits (Orden et al. (ibid).

But Sy et al. (1997) argue that although market prices of animals may be linked to those traits in animals that are of interest to buyers, there is no definite account of the value of each trait embodied in the animals i.e. market prices do not specifically provide information (signals) on the marginal value of specific characteristics that are important to producers in different segments of the market system. Rather, price is a composite for the bundle of genetic characteristics that define the overall quality of beef animals. In addition, market prices may be highly distorted due to the presence of intermediaries. Consequently, price data is likely to be incomplete and can suffer from substantial measurement errors (Ouma et al., 2004). In order to better link economic decision criteria to improvement of genetic characteristics in beef cattle, it is useful to have a measure of the marginal contribution of the specific characteristics to quality (total economic value of the animal) (Sy et al., ibid).

However, apart from this study by Orden et al. (2005), other available literature on preferences of livestock traits, for instance Sy et al. (1997); Tano et al. (2003); Ouma et al. (2007) and Ruto et al. (2008) focus on cattle, leaving a wide information gap in the case of small ruminants. A study exploring the preferences and values of small ruminant traits would therefore go a long way in providing the much needed information for the livestock subsector.

2.1.6. Methods of Valuing Non-market Traits

According to Scarpa et al. (2003a) since many of the benefits derived from the existence of well-adapted indigenous AnGR are not transacted in any market, non-market valuation tools are required to identify the magnitude of these benefits. While welfare effects due to changes in prices for market goods (benefits) have been defined in terms of the area under appropriate Hicks-compensated demand curve, welfare effects due to changes in quantities of non-market benefits have been defined in terms of the area under the marginal WTP curve for the good or service (Freeman, 2003). Marginal WTP curves exist for public and non-market goods but cannot be estimated from direct observations of transactions in these goods (Freeman, 2003). There are basically two approaches to obtaining demand and value information for changes in the quantities of non-market goods: revealed preference (RP) and stated preference (SP) methods. RP methods involve the estimation of value from observations of behaviour in the markets for related good while SP methods derive values from responses to hypothetical questions (Freeman, 2003).

Drucker et al. (2001) suggest a range of valuation methodologies that can be used to measure the value of AnGR. These include contingent valuation, an application of SP methodology, and Hedonic pricing (also known as hedonic price analysis) an application of RP methodology. While hedonic pricing identifies trait value and requires data on characteristics of animals and market prices, contingent valuation requires data on society preferences in terms of willingness to pay (WTP) or willingness to accept compensation (WTA). Contingent Valuation, which gives the most complete estimation of the AnGR's total economic value (TEV) (Cicia et al., 2003), is inadequate in valuing single attributes of a multi-attribute good such as the genetic attributes embedded in the phenotype of an animal of a given breed (Scarpa et al., 2003a). Choice Experiments (CE) (Louviere et al., 2000), another application of the SP technique, allows a systematic investigation of the single attributes of a bundled good and passed the external test of 'criterion validity' as it produces estimates of marginal values similar to those obtained by the theoretically more valid method of hedonic regression on observed transaction prices (Scarpa et al., 2003a). The CE methodology is expounded later in this section.

Data availability and/ or the potential for acquiring relevant data will clearly be an important determinant of the decision of which technique to use in valuing non-market traits for a particular application, given the problems of missing markets and market imperfections commonly encountered in developing country situations (Drucker et al., 2001). For instance, (Tano et al., 2003) indicate that using hedonic price analysis to estimate cattle owner's preferences in rural Africa can be very difficult in that most cattle transactions do not take place in formal markets where transactions are transparent and easily recorded. Rather, transactions usually take the form of private agreements between buyers and sellers using cash, barter or exchange; many cattle are never traded or sold, but stay within the farm household or are passed on to other households through traditional practices such as dowry payments; breeding cattle and young animals are thinly traded in African markets; and unfamiliar breeds are not traded. In the presence of many different market failures (such as intermediaries, asymmetric information or unpredictable market behaviour after catastrophes such as droughts), the collection of price data is likely to be incomplete and can suffer from substantial measurement errors (Tano et al., ibid). In addition, market prices may be highly distorted (often underestimated) due to the presence of these market failures.

Conjoint analysis and hedonic price analysis are alternative empirical applications to the Lancaster consumer theory. Conjoint analysis is best utilized as an alternative to hedonic estimation when market transactions data are poor. Because preferences are measured directly, the results are less likely to be adversely affected by traits that are not priced or transactions that do not occur through organised markets (or occur for non-consumptive purposes). Conjoint analysis is useful for quantifying preferences in less developed countries for livestock and for the wide variety of other multiple-attribute goods. (Tano et al., 2003). However, according to DeSarbo and Green (1984) choice predictions constructed from the results of ranking or rating conjoint may not be accurate; (classic) conjoint studies are subject to incompleteness with respect to profiles, because the profile is never equal to the product, incompleteness with respect to model specification, because most often only main effects and some two-way interaction effects are estimated, and incompleteness with respect to situation, because conjoint analysis assumes equal effects for marketing control variables across suppliers. Nevertheless, the aggregate market predictions from conjoint analysis can be quite good (DeSarbo and Green, ibid).

Efforts to improve the classical conjoint analysis include the incorporation of discrete choice experiments (CE) in the classical conjoint analysis procedure. Based on attributes and levels, a set of (often hypothetical) products (called profiles) are constructed. The traditional way to measure the preferences of respondents for these profiles is to let them rank the total set of profiles or to let them rate each of them, for instance on a 0-100 scale. However, ranking and rating of products is not how respondents normally act in the real marketplace. In the conjoint choice approach (also referred to as CE) respondents do not have to give a score to all profiles, including the non-preferred ones, but they have to choose their most preferred product from a small set of profiles (called a choice set), or alternatively pick one by one from the most to the least preferred one (called choice ranking (CR)). In this case, the total set of profiles designed by the analyst is divided into several smaller choice sets containing different profiles from which respondents have to choose one profile. Since this way of selecting a preferred product is much closer to the way people select products in the real marketplace hence conjoint CE have become very popular (Haaijer, 1999). Moreover, choice modelling results can be used to estimate implicit prices for the different traits (Ouma et al., 2007).

Carroll and Green (1995) point out some of the advantages of experimental choice analysis as compared to conventional conjoint analysis. They mention that there are no differences in response scales between individuals, choice tasks are more realistic than ranking or rating tasks, respondents can evaluate a larger number of profiles, choice probabilities can be directly estimated, and ad hoc and potentially incorrect assumptions to design choice simulators are avoided. Several other authors point out similar (as well as some additional) advantages of the choice approach relative to the conventional approach (e.g., Louviere, 1988; Elrod et al., 1992; DeSarbo et al., 1995; Cohen, 1997; Vriens et al., 1998). On the negative side, choice data provide minimal information since nothing is known on the non-chosen alternatives. When differences in response scales are of interest, rating data give more information. As a result of this limited information in choice data, no individual estimates can be obtained using a standard choice approach (Haaijer, 1999). However, in his conclusion, Madansky (1980) point out that conjoint analysts could adopt the random utility model approach (of conjoint CEs) to explain gross trends or predilections in decisions instead of each person's specific decision in each choice presented.

The actual coding of levels in the conjoint (choice) designs can be done in several ways. For numerical attributes (e.g., price) actual values can be used in the design which leads to so-called linear attributes. However, most of the time some dummy specifications is used. This can be regular dummies (e.g., "1" if a level is present and "0" if it is not present) or so-called effects-type coding. In the situation of three levels of an alternative, with effects-type coding, the first level is, for instance, coded as $[1\ 0]$, the second as $[0\ 1]$ and the third as $[-1\ -1]$. For attributes with two levels, the codes are +1 and -1 respectively. This way of coding has an advantage that all effects are stated in deviation from some average, and interaction terms, if present in the design, are uncorrelated with the main variables. When all attributes are coded this way and each level appears with equal frequency in the design, the sum of the part-worths across attributes is equal to zero (Haaijer, 1999).

A specific characteristic of conjoint CEs is that one needs two designs in principle, instead of one design in the classic conjoint approach, to set up the experiment, although combined designs are possible (Louviere and Timmermans, 1990). One design is needed to construct the profiles, like in the classic conjoint approach, but an additional design (e.g., a "blocking" design) is needed to put these profiles in various choice sets (Haaijer, 1999). Huber and Zwerina (1996) describe four properties that characterize efficient choice designs, namely: level balance, orthogonality, minimal overlap and utility balance. A level balanced design means that each level of an attribute appears with equal frequency. However, level balance and orthogonality are often conflicting. Choice sets should have minimal overlap since alternatives that have the same level of an attribute provide no information on the preference for that attribute. Hence, the probability that an attribute level repeats itself in each choice set should be as low as possible. Level balance, orthogonality, and minimal overlap are used to construct optimal utility-neutral designs. The efficiency of such design can be improved by balancing the utilities of the alternatives in each choice set. This is important since choice sets that generate extreme probabilities are less effective at constraining the parameters of the choice model than are moderate ones. Oliphant et al., (1992) reported that choice based conjoint can predict choices in holdout sets as well as, or even better than, individual level rating based conjoint.

In conjoint CE, the design of product profiles on the basis of product attributes specified at certain levels requires respondents to repeatedly choose (in a conjoint CE) or rank (in a CR) one alternative from different sets of profiles offered to them. An advantage of the choice approach in conjoint analysis with respect to the "classic" approach is that in choice sets the option not to choose can be introduced, which makes the task even more realistic to respondents. The 0/1 choice data arising from such conjoint CEs have been typically analyzed with the Multinomial Logit (MNL) model using maximum likelihood (ML) or weighted regression techniques (Haaijer, 1999).

The models used for the purpose, conjoint CE models, fall within the class of random utility choice models, in which each alternative is selected with a certain probability. The MNL model, mostly used to analyze conjoint choice data, has a major advantage of its simple form for the choice probabilities. One problem arising with the standard MNL model is because it is derived from random utility maximization, based on the assumption that the error terms are independent across alternatives, choice sets, and subjects (Louviere and Woodworth, 1983). This leads to the IIA property, where little is known about its validity in conjoint CEs (Carroll and Green, 1995). IIA occurs in cases where the utility of a certain alternative could be influenced by the presence or absence of other alternatives in the choice set (e.g., Louviere and Woodworth, 1983). However, the IIA property may not be a realistic assumption hence statistical tests can be performed to test whether IIA holds in a particular application (e.g., Louviere and Woodworth, ibid). In order to test for IIA, fractional factorial design can be constructed such that also (2-way) interaction effects, which accounts for the situation that the (partial) utility of an attribute depends on the level of another attribute, can be estimated in the model (e.g., Louviere and Woodworth, ibid), whose resultant non-significance indicates that IIA holds (see, e.g., Louviere and Woodworth 1983; McFadden 1986). When all (2-way) interactions are insignificant, the IIA property holds and hence the MNL model produces unbiased estimates (Haaijer, 1999). However, when the IIA property does not hold, other models which avoid IIA, should be used instead of the standard MNL model, however, at the cost of computational complexity (Haaijer, 1999).

Some of the large number of alternative choice models proposed in the literature has turned out to be tools that have aided the research community in its search for truly improved specifications (Hensher et al., 2005). One such choice model is the Random Parameter Logit

(RPL, also referred to as mixed logit, mixed multinomial logit or hybrid logit) models which are a generalization of standard logit that do not exhibit the restrictive "IIA" property and explicitly account for correlations in unobserved utility over repeated choices by each individual, (Revelt, and Train, 1998). RPL models are also instrumental in determining whether there exists heterogeneity around the mean population parameter through the estimation of a standard deviation parameter associated with each random parameter estimate. One of the appeals of the RPL model is its ability to determine the possible sources of any heterogeneity that may exist. This is established through the interaction of each random parameter with other attributes or variables that one suspect may be possible sources of preference heterogeneity (Hensher et al., 2005). Multinomial Probit (MNP) models also alleviates IIA in the conjoint choice context, and not only offers the major advantage of allowing correlations among the random utilities of alternatives within choice sets, but in addition, among the repeated choices that consumers make from the multiple choice sets (Haaijer, 1999).

A number of studies have been conducted using the conjoint analysis methodology for instance, Sy et al. (1997) and Tano et al. (2003). These two studies used an ordered probit model whereas others such as Scarpa et al. (2003a and b) used a discrete choice estimator -MNL model using Maximum Likelihood (ML) technique. Others still, for instance Zander, (2006) applied the RPL model in valuing the traits of Borana cattle in East Africa while Ouma et al. (2007) measured the heterogeneous preferences for cattle traits among cattle-keeping households in East Africa using both RPL and latent class models. None of this studies focused on small ruminants.

2.2. Theoretical Framework

The theoretical backgrounds underpinning the valuation of non-market traits, breed choice and household economic status are discussed in the following sections.

2.2.1. Valuation of Non-market Traits/ Attributes

In valuation of non-market traits, the Lancasterian theoretical framework is usually adopted. Its empirical development can either be based on preference ranking/ rating, or on the random utility theory. Both of these are reviewed below.

2.2.1.1. Preference Rating and Ranking Model

The problem of estimating the marginal contribution of specific animal characteristics to overall performance can be approached theoretically from a production function perspective or using the demand theory starting with the consumer (Sy et al., 1997). These two approaches are similar but from the empirical point of view, (Sy et al., ibid) gives the advantages of approaching the valuation of beef genetic characteristics from consumer demand. In the consumer demand approach, the Lancasterian theoretical framework is used: goods are not the direct objects of utility; rather, it is the characteristics of the goods from which utility is derived (Sy et al., ibid). The acknowledgement of intrinsic properties of a good as arguments of a utility function, and the possibility of confining an analysis to goods which yield common characteristics, is important to empirical demand analysis.

Sy et al. (ibid) proposes that the utility an individual derives from choosing a given cattle breed is a function of the characteristics of the breed, the individual's socio-economic background, the interaction between the individual's background and the characteristics of the breed. Since utility cannot be directly observed, choice variable representing ratings or rankings of animals is used in empirical work in place of utility. The choice variable is related to utility as follow:

$$R=1 \quad \text{if } 0<U<\gamma_1, \quad R=2 \text{ if } \gamma_1<U<\gamma_2, \; \ldots \; R=\omega \text{ if } U>\gamma_{\omega-2} \qquad U=u\left(X,\gamma\right) \qquad (1)$$

where U is the unobserved utility level, R's are the preference ratings and γ's are the threshold variables or cut-off points linking the respondent's actual preferences with the ratings. Using the choice variable R as a dependent variable, the empirical model takes the following general form:

$$R = \alpha + X\beta^1 + W\lambda + e \qquad (2)$$

Where R is a vector of preference ratings (0, 1, 2, …, ω), X is a vector of non-stochastic variables capturing the levels of traits embedded in the breed type, W is a vector of non- stochastic variables capturing the interaction between the levels of traits and farmer's background, β^l is a vector of marginal utilities for the levels of traits, λ is a vector of marginal impacts of the interaction between the levels of traits and individual's background and e is a disturbance term (Tano et al., 2003).

Let U represent utility for an individual. This utility is hypothesized to be a function of various factors including the characteristics of the product, S, the individuals' socioeconomic backgrounds, Z, and an interaction between the individuals' socioeconomic backgrounds and the products characteristics, μ. Since a decision maker obtains some relative happiness from each product chosen, the decision maker would choose the product which provides the greatest utility i.e. the decision maker will choose product *j* over *j*+1 only if $U_j > U_{j+1}$. The decision maker's theoretical utility model can be formally written as:

$$U_j = f\left(S_{1j}, S_{2j}, ..., S_{gj}; Z_1, Z_2, ..., Z_i; \mu_1, \mu_2, ..., \mu_g \mid \Theta_g\right) + e \tag{3}$$

$$j = 1, 2, ..., m;\ g, i = 1, 2, ..., n.$$

The variables *S* and *Z* are main effect variables representing product attributes and individuals' profiles, respectively. The term $\mu_g = S_{gj} \bullet Z_i$ is the interaction variable between individuals' profiles and product characteristics. Since only a portion of the arguments in equation (3) are observed, the equation is stochastic and the *e* is a spherical disturbance term (Kennedy, 1985). The vector Θ_g represents the parameter estimates.

It is commonly assumed that the overall utility of a profile is constructed by adding the attributes' preferences. This means that a compensatory preference model is used, where "low" scores on a certain attribute can be compensated by a "high" score on another attribute. Other, non-compensatory, preference models are possible, that assume, for instance, that (certain) attributes must have a minimum or maximum level before a profile is considered attractive. In conjoint experiments the contribution of an attribute (level) to the total utility, also referred to as "*part-worth*", and the total utility of a profile in a compensatory, additive preference model is equal to the sum of the part-worths (Haaijer, 1999). The partial derivative of the consumer's utility of the j^{th} product characteristic, $\partial U(s^*)_j / \partial s_{gj}$ gives the value or the part-worth that the consumer assigns to the g^{th} characteristic level of the j^{th} product. Since the utility of a product to an individual is a function of both product characteristics and the individual's profiles, the part-worth is a joint effect of the two variables. The relative importance of products for the respondents can be computed by using estimates from equation (3). For instance, to establish the importance of one genetic attribute relative to all other genetic characteristics, the following formula is used:

$$\psi_a = \frac{\left[\max\left(v^*_{ga}\right) - \min\left(v^*_{ga}\right)\right]}{\sum \omega_a} \tag{4}$$

where v^*_{ga} is the marginal value of the g^{th} level of the a^{th} attribute; ψ_a represents the relative importance for the a^{th} attribute; $\sum \omega_a$ is the sum of the ranges, $\left[\max\left(v^*_{ga}\right) - \min\left(v^*_{ga}\right)\right]$, across all attributes (Sy et al., 1997).

2.2.1.2. Random Utility Models

The random utility approach (underlying the Choice Modelling technique) provides the theoretical basis for integrating choice behaviour with economic valuation (Rolfe et al., 2000). From Haaijer (1999), in random utility choice models (also known as discrete choice models) a subject j chooses between M distinct choice alternatives, and it is assumed that he will choose the alternative that gives maximal utility. The (Mx1) vector of (unobserved) utility that the j^{th} individual derives from the M alternatives, U_j is equal to:

$$U_j = X_j\beta + e_j, \tag{5}$$

Where X_j is a matrix of variables representing characteristics of the M choice alternatives for the j^{th} individual, β is a vector of unknown parameters, and e_j is the error term that also may include effects from attributes not specified in the matrix X. In a more general specification, the parameter vector β can depend on j or can contain different elements for different alternatives M or both, and the matrix X need not depend on j or may have equal rows for all M. Furthermore, it can contain, for instance, quadratic main effects and interaction effects. When the X-matrix does not depend on M, the model in (5) is called an alternative specific model and β then has to depend on M. For each individual j, it is assumed that the alternative with the highest utility is chosen. The variable Y_{jm} describes the observed choices and is defined as:

$$Y_{jm} = \begin{cases} 1 \ \ when \ \ U_{jm} > U_{jn} \ \ \forall \ \ n \neq m \\ 0 \ \ when \ \ \exists \ n \neq m : U_{jn} > U_{jm} \end{cases} \quad ' n = 1, \ldots, M. \ , \tag{6}$$

Let P_{jm} be the probability that Y_{jm} equals one. Then, when there are J individuals, the likelihood function is equal to:

$$L = \prod_{j=1}^{J} P_{j1}^{y_{j1}} P_{j2}^{y_{j2}} \ldots P_{jm}^{y_{jm}} \tag{7}$$

Maximum likelihood (ML) estimates of the parameters in (5) are obtained by maximizing (7). In most cases not the likelihood itself is evaluated but the log-likelihood instead:

$$l = \sum_{j=1}^{J} \sum_{m=1}^{M} Y_{jm} \ln\left(P_{jm}\right) \tag{8}$$

The estimation model for equation (7) or (8) depends on the assumption of the distribution of the error term in (6).

With the assumption of independent random errors (Independence of Irrelevant Attributes (IIA) property) and equal variances for the choice alternatives, the multinomial logit (MNL) model can be applied. In Scarpa et al. (2003a), if the unobservable component in each choice occasion is identically and independently distributed (iid[2]) as extreme value type 1, then:

$$\Pr\left(j^*\right)=\frac{\exp\left(\Delta\theta' q_{j'} \big/ \sqrt{k}\right)}{\sum_{j}^{J}\exp\left(\Delta\theta' q_{j'} \big/ \sqrt{k}\right)} \tag{9a}$$

where $\sqrt{k}=\pi/\left(\lambda\sqrt{6}\right)\approx 1.3/\lambda$ is the standard deviation of the error term and λ is the usual scale parameter (Train, 2003). k indices the attributes and j the observed choices whereas q_j are the given measurable attributes (Scarpa et al., 2003a). According to Haaijer (1999), this can also be expressed as:

$$P_{jm} = \frac{\exp\left(X_{jm}\beta\,\mu\right)}{\sum_{n=1}^{M}\exp\left(X_{jn}\beta\mu\right)} \tag{9b}$$

where μ (an equivalent of $\sqrt{k}$ in equation 9a) is the scale parameter of the MNL model. P_{jm}, which is the equivalent of $\Pr\left(j^*\right)$ in 9a is a set of the choice probabilities. In a MNL model the scale factor is usually assumed to equal 1 so that the $\beta's$ can be identified. The choice model in equation 9b assumes homogeneity of preferences which follows from the assumption that the deterministic component of the utility function is invariant across individuals (i.e. $\beta_n X_i = \beta X_i$). This further implies that the variance of the error term is assumed to be the same for all individuals and that there is no correlation across occasions for a given respondent. This is one major constraint to the MNL model.

Compared to a MNL model, a Random Parameter Logit (RPL) model takes into account possible heterogeneity among individuals hence the probabilities do not exhibit IIA. From Hensher and Greene (2001), like any random utility model of the discrete choice family of models, assuming that a sampled individual *q* (*q=1,…, Q*) faces a choice amongst *I* alternatives

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[2] A term used to describe the joint distribution of two or more random variables; each has the same probability distribution as the others and all are mutually independent indicating that they are not correlated to one another

in each of T choice situations[3]. An individual q is assumed to consider the full set of offered alternatives in choice situation t and to choose the alternative with the highest utility. The (relative) utility associated with each alternative i as evaluated by each individual q in choice situation t is represented in a discrete choice model by a utility expression of the general form:

$$U_{qit} = \beta_q X_{qit} + e_{qit} \qquad (10)$$

X_{qit} is a vector of (non-stochastic) explanatory variables that are observed by the analyst (from any source) and include attributes of the alternatives, socio-economic characteristics of the respondent and descriptors of the decision context and choice task itself (e.g. task complexity in stated choice experiments) in choice situation *t*. Parameter β_q and error term e_{qit} are not observed by the analyst and are treated as stochastic influences. Within a logit context the condition that e_{qit} is iid extreme value type 1, is imposed. However, to allow for the possibility that the information relevant to making a choice that is unobserved may indeed be sufficiently rich in reality to induce correlation across the alternatives in each choice situation and indeed across choice situations, one way to do this is to partition the stochastic component into two additive (i.e. uncorrelated) parts. One part is correlated over alternatives and heteroskedastic, and another part is independently, identically distributed (iid) over alternatives and individuals as shown in equation (11) (ignoring the *t* subscript).

$$U_{iq} = \beta'_q X_{iq} + [\eta_{iq} + \varepsilon_{iq}] \qquad (11)$$

where η_{iq} is a random term with zero mean whose distribution over individuals and alternatives depends in general on underlying parameters and observed data relating to alternative i and individual q; and ε_{iq} is a random term with zero mean that is iid over alternatives and does not depend on underlying parameters or data. For any specific modeling context, the variance of ε_{iq} may not be identified separately from β, so it is normalised to set the scale of utility. The RPL class of models assumes a general distribution for η and an iid extreme value distribution for ε. That is, η can be normal, lognormal or triangular; described in Hensher et al. (2005). Denote the

[3] A single choice situation refers to a set of alternatives (or choice set) from which an individual chooses one alternative. They could also rank the alternatives but the focus here is on first preference choice. An individual who faces a choice set on more than one occasion (e.g. in a longitudinal panel) or a number of choice sets, one after the other as in stated choice experiments, is described as facing a number of choice situations.

density of η by $f\ (\eta \mid \Omega)$ where Ω denotes the fixed parameters of the distribution. For a given value of η, the conditional choice probability is logit, since the remaining error term is iid extreme value:

$$L_i(\eta) = \exp(\beta' x_i + \eta_i) / \sum_j \exp(\beta' x_j + \eta_i) \tag{12}$$

Since η is not given, the (unconditional) choice probability is this logit formula integrated over all values of η weighted by the density of η is as shown in equation (13).

$$P_i = \int L_i(\eta)\ f(\eta \mid \Omega) d\eta \tag{13}$$

According to Hensher and Greene (2001), the choice probability of models of this form (mixed logit or RPL) is a mixture of logits with f as the mixing distribution. Different substitution patterns are obtained by appropriate specification of f and the RPL model recognises the role of such information and handles it in two ways (both leading to the same results only when the random effects model has a non-zero mean). The first way, known as random parameter specification, involves specifying each β_q associated with an attribute of an alternative as having both a mean and a standard deviation (i.e. it is treated as a random parameter instead of a fixed parameter). The second way, known as the error components approach, treats the unobserved information as a separate error component in the random component. Since the standard deviation of a random parameter is essentially an additional error component, the estimation outcome is identical.

2.2.1.3. Welfare Measure for Trait Valuation

The most important economic tool in a trait valuation exercise is that of welfare measurement. For policy analysis, it is pertinent for the researcher to observe the magnitude of the change in quality of a good that is associated with a particular policy. A change in the attributes of a farm animal or the change between farm animal breed kept by a livestock-keeper can have an impact on the livestock-keepers' welfare that is important to assess. For instance, deprivation of the level of disease resistance of a farm animal harms the livestock-keepers in their income generation due to lower productivity, animal deaths and income drain from veterinary drug expenses. Consequently, the livestock-keepers would no longer be willing to keep this type of farm animal leading to dwindling numbers of a certain breed and dwindling genetic resources as a biodiversity asset. Measuring this harm in monetary terms is a central element of setting up policy implications against the loss of genetic resources (Zander, 2006).

According to Bateman et al. (2003), benefits and costs are defined in terms of individuals' preferences. An individual receives a benefit whenever s/he receives something in return for which s/he is willing to give up something else that s/he values. Benefit to any given person is measured by the maximum amount of money that that person would be willing to pay in return for receiving the benefit (willingness to pay - WTP). Similarly, the measure of cost is willingness to accept compensation (WTA); measured by the minimum amount of money that that person would be willing to accept as compensation for incurring the cost.

Theoretically, the welfare of a consumer or a household should be measured by the level of utility. But since utility functions are used only to rank preferences and the actual values of the levels or change in utility are not really meaningful, such functions cannot give a measurable indicator of welfare. Alternative measures of welfare include a number of monetary measures based on concepts of consumer surplus, compensated and equivalent variation and real income (Sadoulet and de Janvry, 1995). Two measures commonly applied for eliciting welfare indicators for changes in environmental or public goods (i.e. not only of attributes of goods but of whole bundle of goods) is compensating variation, and compensating surplus (Freeman, 2003). Compensating variation is the amount of money which, when taken away from the consumer after a price and income change, leaves the consumer with the same level of utility as before the change (Bateman et al., 2003; Sadoulet and de Janvry, 1995) while compensating surplus can be interpreted as the consumer's maximum WTP in order to gain a quantity or quality increase and still maintain his level of utility, or as the minimum level of compensation the individual is willing to accept for obtaining the decreased quantity/quality of a good (Freeman, ibid).

According to Rolfe et al. (2000), welfare estimates can be estimated from MNL models using the following formula:

$$CS = -1/\alpha \left(\ln \sum \exp v_{i0} - \ln \sum \exp v_{i1} \right) \qquad (14)$$

where CS is the compensating surplus welfare measure, α is the marginal utility of income (generally represented by the coefficient for thee monetary opportunity cost attribute in an experiment), and v_{i0} and v_{i1} represent indirect utility functions before and after the change under consideration. Consequently, the marginal value of a change within a single attribute, *W,* can be represented as a ratio of coefficients where equation 14, according to Rolfe et al. (2000) reduces to:

$$W = -1\left(\frac{\beta_{attribute}}{\beta_{money}}\right) \quad (15)$$

The measure, *W,* provides effectively, the marginal rate of substitution between income change (β_{money}) and the attribute in question ($\beta_{attribute}$).

2.2.2. Breed Choice

Based on Besley and Case (1993), cited in Staal et al. (2002), a farmer and/or livestock producer adopts (chooses) a new technology if the derived benefits B_i is higher than a certain threshold T. The decision to adopt (choice) is thus written as:

$Y_i = 1$ if $B_i > T$ » farmer *i* decides to adopt; $Y_i = 0$ if $B_i < T$ » farmer *i* decides not to adopt (17)

where Y_i is the decision or choice to adopt. The model to be estimated is therefore of the form:

$$Y_i = L_i \beta_i^2 + \varepsilon_i \quad (18)$$

where L_i is a vector of explanatory variables derived from household survey with β_i^2 as the corresponding regression coefficient or a vector of constants to be estimated and ε_i is an iid farm specific errors or non-observable attributes of a given alternative. In this study however, the focus is not on adoption of a new breed but the choice to retain or have a particular breed type (based on trait levels within a breed) in the farm, by a livestock keeper. From Iqbal et al. (2005) and Ramji et al. (2002), according to the logistic model, the probability, *Pi*, of a livestock keeper deciding to keep a breed category is given by:

$$P_i = \exp^{Z_i} / 1 + \exp^{Z_i} \quad (19)$$

where Z_i is a random variable (i.e. the stimulus index) that predicts the probability of the i^{th} livestock keeper keeping the preferred breed category, and is given as:

$$Z_i = \ln\left(P_i / \{1 - P_i\}\right) = \beta_0^2 + \sum \beta_i^2 L_{ji}, \qquad i = 1, 2, \mathrm{K}\ n \quad (20)$$

Where L is the identified factor contributing to the decision to keep the priority breed. The unknown parameter β^2 associated with each contributing factor L is determined by an iterative process that makes use of a maximum likelihood estimate. The final form of the logistic model therefore becomes:

$$Z_i = \beta_0^2 + \beta_1^2 L_{1i} + \beta_2^2 L_{2i} + \mathrm{K} + \beta_n^2 L_{ni} \quad (21)$$

Ordinary least square estimation yields asymptotically biased estimates since sometimes, information on dependent variables from population is limited especially if some observations on the dependent variable corresponding to known values of independent variables are not observable or are missing. This limitation is overcome by using a censored tobit model that is estimated by maximum likelihood consisting of the product expressions of the probability of obtaining each observation (Obare et al., 2002).

2.2.3. Economic Status

Hill (2002) exemplifies the fact that among farm households, particularly among elderly farmers, there usually exists a 'high wealth-low income combinations'. According to Hill (ibid), the "economic status" of an individual, that is his potential consumption of goods and services, is related to both his current income and to his net worth. Wealth represents potential spending power, and two individuals with the same current income but different amounts of assets will have different consumption possibilities. In order to express income and wealth in a common measure the usual approach is to calculate the annuity value of net worth, that is, an annual income stream of equivalence to the lump sum. This is added to conventional income to give a parameter of the total flow of economic services at the command of the consumer unit. The determinants of this income-equivalent are the amount of net worth *NW*, the life expectancy of the recipient *n* and the rate of interest *r*, linked by the following formula:

$$NW\left[\frac{r}{(1-r)^{-n}}\right] \tag{22}$$

However, the problem of using the above formula in order to assess economic status is that it provides only a notional measure of economic welfare. Attempts at evaluating economic status at household level have to tackle the problem that farmers cannot in practice realise annuities based on net worths without losing the assets which form the basis for their current income. However modifications to the methodology are possible which allow for the retention of a current income-earning capacity. Hill (ibid) presents two principle ways of expressing the income equivalent of net worth while retaining agricultural assets to generate current income. These include forward sales contract arrangement under which a farmer mortgages his property in exchange for an annuity based on the net worth of the property, but the mortgagee only assumes title to the property after the death of the farmer; and land-retaining alternative, in countries which have a cash tenancy system where the farmer would sell the land on a sale-and-leaseback arrangement, remaining in occupation of the farm but paying a rent to the new owner. These procedures not withstanding and bearing in mind, the nature of the pastoral production system in the study area (communal land ownership and inapplicability of arrangements such as contracts), the data requirement for application of these procedure would be very difficult to get. As such this study will not go into the procedures of deriving the income-equivalents but will just use data collected on wealth and incomes in their current form.

2.3. Conceptual Framework

Figure 1 shows a flow diagram of the conceptual framework for this study. The conceptual framework can be operationalised as follows:

$$Y = f\ (w_1, w_2, w_3, m_1) \tag{23}$$

$$V = f\ (Y, m_1, m_3\ w_1, w_2, w_3,) \tag{24}$$

Where in equation (23) the dependent variable Y = breed categories kept in a household, w_1 = household characteristics, w_2 = farm characteristics, w_3 = external factors, m_1 = contribution to livelihood. Further, equation (24) postulates that total production (herd size) V, is a function of or occurs as a result of factors such as breed categories (Y), the contribution of the breeds to the household livelihood (m_1), the assets held in the household which complement production (m_3), Household characteristics (w_1), Farm characteristics (w_2) and external factors (w_3).

The consumer theory developed by Lancaster (1966)[4], imply that overall utility of a good can be decomposed into separate utilities for its constituent characteristics or traits. This permits the analysis of farmers' preferences in terms of the utility they perceive to result from various characteristics or traits (Ouma et al., 2007). Consequently, the conceptual framework in this study hypothesises that the values attached to the non-market traits of small ruminant categories is influenced by household, farm and external characteristics. These characteristics in turn influence the types of breed categories kept and also the levels of production (herd sizes kept). The level of production is also hypothesised to be influenced by assets (agricultural) holding which serve the purpose of aiding production. Much as contribution to livelihoods of the breed categories positively influences the types of breed categories kept and the production levels, the

[4] Also mentioned in section 2.2.1.1.

production levels are also hypothesised to have a positive influence on the contributions to livelihoods.

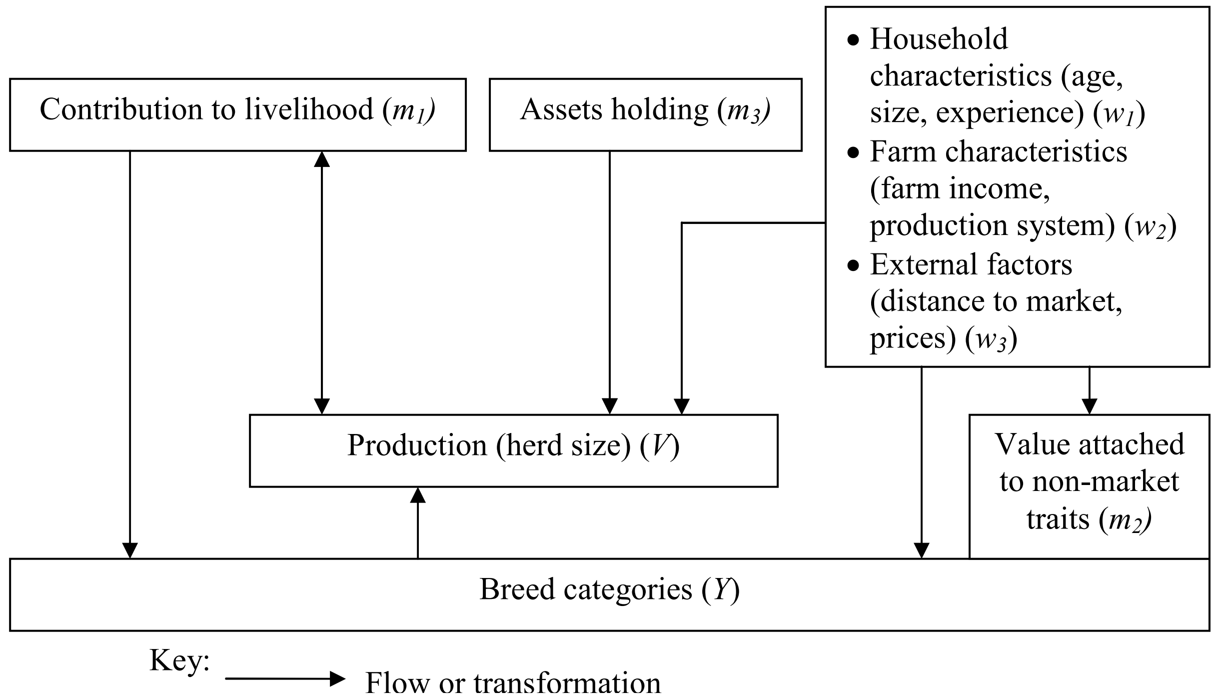

Figure 1: Conceptual Framework

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CHAPTER THREE

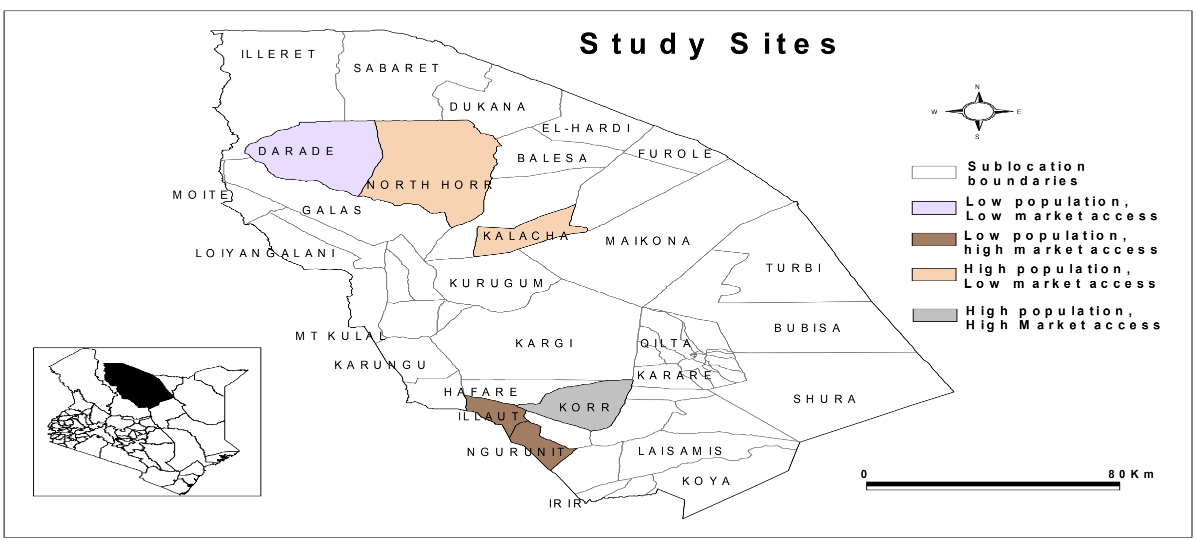
RESEARCH METHODOLOGY

The study area, procedures for selection of study sites, data and data analysis are elaborated below.

3.1. Study Area

The selection of the study area was mainly based on two considerations: the area with high population of indigenous small ruminant breeds and the area with residents exhibiting a high dependence on small ruminants as a source of their livelihood. These two criteria deemed pertinent since this study would open up pathways into improving the livelihoods of poor livestock-keepers through management of their indigenous flocks. Marsabit district was therefore chosen as the study site on the basis of the two criteria.

Marsabit is one of the 13 districts that form Eastern Province of Kenya. It borders Samburu District to the south, Turkana District to the west, Isiolo District to the east, Moyale District to the northeast and the Republic of Ethiopia to the north. The district lies between latitude 01^{o} 15’ north and 04 ^{o} 27’ north and longitude 36 ^{o} 03’ east and 38 ^{o} 59’ east. It has an area of 66,000 Km^2, which includes 4,956 Km^{2}covered by Lake Turkana. The district is divided into seven administrative units with six divisions; Central, Gadamoji, Laisamis, Maikona, Loiyangalani, North Horr and Lake Turkana (GOK, 2002).



Source: ILRI GIS Database

Figure 2: Map of the Study area

According to (GOK, 2002), the district has a population of 127,560 persons with 63,636 males and 63,924 females with absolute poverty level at 88.18 percent. The district is located in the driest region of the country with low rainfall and high temperatures. Approximately 70 percent of its total land area lies in an agro-zone characterised by high evaporation and salt deposits making grass growth stunted and is only suitable for camel and shoats. It has no tarmac roads; nine airstrips and only two post/ sub-post offices. According to GOK (1997), livestock is the most viable way of utilizing the extensive rangelands of the district. The most important livestock kept in the district are camels, goats, cattle, and sheep. In 1995 the district had 165,000 cattle, 408,000 sheep, 548,000 goats and 106,000 camels. About 85 percent of the district population derive their livelihood from nomadic pastoralism.

3.2. Selection of Survey Sites, Survey Design and Sampling Procedure

Two ethnic communities, the Rendille and Gabra communities were surveyed. The sample unit constituted household. A stratified random sampling procedure was adopted with current household lists of all the households in both Rendille and Gabra areas, from Food for the Hungry International (FHI), forming the sampling frame. Since these pastoral ethnic groups under study predominantly occupy Marsabit district, inhabit two distinct parts of the district and utilise their range resources with minimal overlap (Nduma, 2003), sub-locations were first classified according to criteria that derive farming system (Waithaka et al., 2002). Two criteria were used in the selection of survey sites: human population density and market access. A third one, climatic characteristics, was not considered as all the areas in the studied sites are of comparable characteristics. This ensured that all the different variants of livestock systems in the study area are represented in the selection. Based on these 2 criteria, 4 groups of sub-locations emerged (Table 1).

Focusing on two ethnic communities in the area necessitated adequate representation of each ethnic community. From the four groups of sub-locations consisting of a total of forty sub-locations, six sub-locations were selected, three of each ethnic community. Since the study also entailed the application of choice experiment methodology which requires a minimum sample size of 50 decision makers choosing each choice alternative (Hensher et al., 2005), this criteria was used to determine the sample size to be studied. Based on the choice designs, a sample size of 300 (150 per region) respondents was deemed appropriate.

Table 1: Site Selection (Sub-locations)

Population Density	Market Access High		Market Access Low		Total
High	1. Merrille	5. South Horr	1. Mt. Kulal	7. Sabarei	
	2. Laisamis	6. Bubisa	2. Kalacha	8. North Horr	
	3. Koya	7. Kargi	3. Hurri Hills	9. Balesa	**20**
	4. Korr	8. Maikona	4. El Gade	10. El_Hardi	
			5. Dukana	11. Galas	
			6. Loyangalani	12. Illeret	
Low	1. Irir	7. Gudas/ Soriadi	1. Olturot	5. Furole	
	2. Lontolio		2. Kurugum	6. Gas	
	3. Lonyori Pichau	8. Illaut	3. Arapal	7. Moite	
		9. Turbi	4. Larachi	8. Darade	**20**
	4. Ngurunit	10. Hafare			
	5. Logologo	11. Karungu			
	6. Kamboye	12. Shura			
Total	**20**		**20**		**40**

Source: ILRI GIS Database

To obtain a representative sample of 300 households from the selected study sub-locations, a proportionate sample was derived from each sub-location's total number of households, culminating to 6 percent and 5.14 percent of the households in Rendille and Gabra areas respectively(presented in Table 2). A systematic random sampling procedure was used to identify the households to be interviewed based on the FHI lists that contained current list of all the households in the respective areas. Two hundred and five households were subjected to the whole study interview with an additional 109 answering a part questionnaire designed to elicit additional information for choice experiments (used in chapter 5). Consequently, a total of 314 households were surveyed. Though chapter three and four uses mainly data from 205 households (approximately 102 from each region), data from the part questionnaire is also used where applicable. Choice data from the whole study interviews plus those from the part questionnaire were collected and applied in chapter five.

Table 2: Study Sample Sizes Derivation

Area	Sub-location	Location	Number of households	Sample size*
Rendille	Korr	Korr	1778	107
	Illaut	Illaut/ Ngurunit	335	20
	Ngurunit	Illaut/ Ngurunit	380	23
	Sub-Total		*2493*	*150*
Gabra	Kalacha	Kalacha	1179	61
	North Horr	North Horr	1410	72
	Darade	North Horr	328	17
	Sub-Total		*2917*	*150*
Total			*10820*	*300*

3.3. Data and Analysis

The kind of data collected for the purpose of this study and the different types of analysis used to answer the study's research questions are explained in the methodology subsections of the subsequent chapters.

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CHAPTER FOUR

SMALL RUMINANT PRODUCTION: WHAT AND WHY?

4.1. Introduction

While the husbandry of goats and sheep is complementary, both species have some distinct characteristics and it is important that these are recognised in the choice of animals appropriate to individual production systems (Devendra, 2005). Both species are often run together in traditional management systems, but where there a specific demand for products from one or the other species or when the prevailing situation favours a particular species, the appropriate choice is therefore realistic; consequently, the choice of individual small ruminant species and indeed breeds within species is an important consideration (Devendra, ibid). In the case of Kenyan pastoralists, the use of mixed species (sheep, goats, camel and cattle) ensures some kind of complementarity in the benefits arising from raising these flocks. Small ruminants can utilise a wide variety of plant species and are therefore complementary to other livestock like cattle and camels (Kiwuwa, 1992). They generally do not compete directly with these species for feed. For instance, a mixture of animal species on semi-arid rangelands makes it possible to change the stocking rate from 26 hectares per TLU (250 kg live weight equivalent) for cattle alone to 13 hectares per TLU when cattle and goats are reared together and to 10 hectares per TLU when camels are included (Schwartz, 1983). Goats are more effective at selective browsing than any other domestic livestock species (Winrock International, 1976).

Most of the benefits produced by local livestock in marginal production systems are captured by producers hence livestock breeds have mostly been shaped by producers' preferences (Scarpa et al., 2003). This may be attributed to the fact that in marginal (pastoral) systems, pastoralists have shown to be mainly subsistence-oriented (Njanja et al., 2003) with small volumes transacted in livestock markets for the purpose of meeting households' immediate cash expenditure needs (Barrett et al., 2006). This implies that pastoralists are not really market-oriented and therefore a low proportion of the outputs reach the market. Consequently, given that livestock breeds are shaped by producer preferences, it is imperative to know not only which small ruminant breeds that livestock keepers consider to be the most suitable to their circumstances, but also, the factors that influence their decisions on which breed category to keep.

With the same trend of increase in demand for meat and milk almost doubling in SSA over the past decade (Delgado et al., 1999), being observed in Eastern Africa, there is an urgent need to improve livestock productivity in SSA in order to keep pace with expected increases in demand for livestock products (Ehui et al., 2002). Unfortunately, livestock productivity in SSA remains very low compared to other parts of the world because producers are beset by several technical, institutional and infrastructural constraints related to feeding, animal health and genotype. The severity of these constraints varies by the various systems under which livestock production takes place. The choice of production system is determined by agro-ecology and socio-economic factors (for instance, relative costs of factors of production and market access). These agro-ecology and socio-economic factors commonly differs in exhibiting various stress factors, such as water shortages, disease and parasites as well as temperature extremes. The constraints faced by livestock producers would need to be overcome or minimized in order for improved livestock productivity to be realized (Ouma et al., 2004).

Few studies have been done to determine the factors influencing the farming of small ruminants under traditional smallholder and pastoral production circumstances (Kosgey, 2004). In terms of small ruminant productivity, this calls for a closer scrutiny of the levels and the determinants of small ruminant production. This chapter seeks to bring to light some issues, on small ruminant production in the pastoral production system, that have been imprecise. The chapter sheds light on what is kept in terms of the levels and the determinants of production and marketed surplus of the various small ruminant breed categories kept by the pastoralists. The chapter further explores why these categories are kept by analysing the producers preferences and factors influencing the choice of indigenous small ruminant breed categories in the pastoral production system.

4.2. Literature Review

Small ruminants are essential components of farming systems in tropical Africa; they are raised mainly for meat, milk, and skin providing a flexible financial reserve (social security) in bad crop years for the rural population (Sumberg and Cassaday, 1985). Morand-Fehr and Boyazoglu (1999), in a review of the present and future state of the small ruminant sector, argue that a detailed analysis of the distribution of sheep and goats shows that sheep tend to take roots in areas of variable agro-climatic characteristics, and with large and extensively managed pasture lands; goats tend to be more concentrated in dry tropical and subtropical areas of poor agricultural potential and even on marginal lands.

Morand-Fehr and Boyazoglu (1999) state that correlations between the numbers of sheep and goats per inhabitant and the mean income of populations around the world, clearly suggest that the old saying of ``the goat is the poor man's cow" still holds true in the majority of developing countries, but is now far less true for sheep. They explain that sheep are relatively well represented in commercial flocks for economic profitability by selling products in established trade circuits found mostly in developed countries; however, sheep and goat farmers in developing countries are often among the poorest classes on the social scale.

4.3. Research Methodology

The data and analysis carried out for the purpose of this chapter, are elaborated below.

4.3.1. Data and Analysis

An exploratory study including a reconnaissance to the study area and questionnaire pre-test revealed the different kind of breed of sheep and goat respectively, kept in the area and the different variants within the breeds as defined by the livestock keepers. Since this study aims at improving the livelihoods of the livestock keepers, instead of the classical definition of the breeds, the livestock keepers' perspective of their breeds was adopted. Consequently, the study was based on the perspective of the pastoralist, allowing them to define their flock in terms of the mixes of relevant traits and their levels (herein referred to as 'categories').

The traits of focus were body size, milk sufficiency and fat deposits for bucks, does and sheep respectively, and drought tolerance for all the three (does, bucks and sheep). Each of the three animal classifications was described by the respondents in terms of a mix of two traits, drought tolerance and milk sufficiency for does, drought tolerance and body size for bucks and, drought tolerance and fat deposits for sheep. Each of the traits had two levels (high and low, in relative terms). This categorisation culminated into 4 categories for each of the animal classes (presented in Table 3). Primary data on the herd sizes, herd dynamics and perceived values of these animal categories was collected using a structured questionnaire. A preferred (dominant/ priority animal) was to be identified based on the numbers kept of such animals at the household level. Socio-economic data, on household size, head's age, household composition and household income in addition to other primary data on products, utilisation, ownership, off-take/

sales, decision-making, household consumption, common production technologies and producers' practices were also collected during the survey. Additional information on household vulnerability, shocks and economic status was incorporated in the same questionnaire administered to the households in the study area. In order to ensure that quality data was collected, more time (than was necessary under a normal household survey, considering the data requirements) was spent in the households during data collection, in order to confirm the data collected, at the expense of the sample size.

Table 3: Description of the Animal Categories

Animal class	Category 1	Category 2	Category 3	Category 4
DOE (she-goat)	High milk sufficiency, to kid and household with strong/ good body condition in drought	Low milk sufficiency, to kid only with weak/ poor body condition in drought	High milk sufficiency, to kid and household with weak/ poor body condition in drought	Low milk sufficiency, to kid only with strong/ good body condition in drought
BUCK (he-goat)	Tall/ big, relative to bucks in the flock with strong/ good body condition in drought	Short/ small, relative to bucks in the flock with weak/ poor body condition in drought	Tall/ big, relative to bucks in the flock with weak/ poor body condition in drought	Short/ small, relative to bucks in the flock with strong/ good body condition in drought
SHEEP (not classified in terms of sex)	Body full of fat with strong/ good body condition in drought	Body not full of fat with weak/ poor body condition in drought	Body not full of fat with strong/ good body condition in drought	Body full of fat with weak/ poor body condition in drought

The data collected from a survey of the sample size arrived at in section 3.2., was subjected to both qualitative and quantitative analyses.

4.3.1.1. Qualitative Data Analysis

Descriptive statistics such as frequency distribution tables, cross tabulations among others were used to identify benefits and/ or reasons of keeping priority breed categories[5] and alternative genotypes which include the levels and determinants of production and marketed surplus (objective 2). Since the analysis had its background mainly based on economic status of the household, wealth and income groups were derived from the data collected. A statistical package, STATA, in addition to the spreadsheet software (Excel 2003), was used to manage and analyse the data.

4.3.1.2. Quantitative Data Analysis

A logit regression model was used to analyse producer's preference and breed category choice[6]. The model to be estimated was of the following form:

$$Z_i = \beta_0^2 + \beta_1^2 L_{i1} + \beta_2^2 L_{i2} + \ldots + \beta_n^2 L_{ik}\ , \qquad i = 1, \ldots, n \tag{25}$$

where Z_i = a random variable (i.e. the stimulus index) that predicts the probability of the i^{th} livestock keeper keeping the preferred animal type L_{in} is a vector of explanatory variables and includes farmer's characteristics, farm characteristics and external factors, and ε_i is an error term. The variables, L_{in} include ethnicity (L_{i1}), household head's religion (L_{i2}), household head's gender (L_{i3}), household head's age (L_{i4}), household head's education level (L_{i5}), occupation (L_{i6}), household size (L_{i7}), units of all livestock kept (L_{i8}), distance to the grazing sites (L_{i9}), distance to water points in dry season (L_{i10}), dry season watering frequency (L_{i11}), wet season watering frequency (L_{i12}), locality or GIS derived variable (L_{i13}), access to veterinary services (L_{i14}), access to veterinary drugs (L_{i15}), distance to the nearest livestock market (L_{i16}), distance to the nearest livestock market three years ago (L_{i17}) and perceived market prices (L_{i18}). All these variables are also presented in Table 4 alongside their respective expected signs (where applicable).

[5] See Table 3 for detailed description
[6] objective 1

Table 4: Variables and Expected Signs

Independent Variables		Expected Sign Logit	Expected Sign Tobit
Household Characteristics	Ethnicity (L_{i1})		
	Religion (L_{i2})		
	Head gender (L_{i3})		
	Head age (L_{i4})	+	+
	Head education years (L_{i5})	+	+
	Head occupation (L_{i6})		
	Household size (L_{i7})	+	+
Farm Characteristics	All livestock (TLU) owned in 2006 (L_{i8})	+	+
	Distance to pasture in dry season (L_{i9})	+	+
	Distance to water points in dry season (L_{i10})	-	-
	Dry season watering frequency (L_{i11})	+	+
	Wet season watering frequency (L_{i12})	+	+
External characteristics	GIS-derived market access variable (travel time in hours to the nearest urban centre) (L_{i13})	+	+
	Access to veterinary services (L_{i14})	+	+
	Access to veterinary drugs (L_{i15})	+	+
	Distance to the nearest livestock market (L_{i16})	-	+
	Distance to the nearest livestock market 3 years ago (L_{i17})	-	+
	Perceived market values (L_{i18})	+	+

Note: The expected signs are based on the study hypotheses. Occupation is a variable introduced as an instrument (applied as a single-equation linear model) for income (farm, non-farm, and also a proxy measure for value of farm assets) i.e. Y (income) = *f* (occupation). This therefore removes the problem of having endogenous variables (farm income, non-farm income and value of farm assets) in the model. The dependent variable (Qi) is the total herd size and including those sold in the reference period (for each animal categories defined).

Discrete choice models (a tobit) were used to analyse the determinants of production and marketed surplus of priority breed categories and alternative genotype[7]. The model estimated was of the following form:

$$Q = \beta_0^3 + \beta_1^3 L_{i1} + \beta_2^3 L_{i2} + ... + \beta_n^3 L_{in} + \varepsilon_i, \quad i = 1, ..., n \tag{26}$$

Where Q, the dependent variable, is the total herd size at the beginning of the study period including those sold in the study reference period (production including marketed surplus of breeds). The inclusion of the reference period is meant to cover for the effect of the preceding drought on the production levels, which producers have very limited control of. The variables, L_{in} are the same variables listed above under the logit regression model. The herd sizes, by animal categories will then be correlated and cross tabulated with the contributions of the animal categories[8] to livelihood to further explore the relationships between the two. The descriptions of the independent variables are found in section 4.3.1.3.

4.3.1.3. Rationale for Inclusion of Specific Variables in the Logit and Tobit Models

In addition to the description of variables in Table 4, Table presents a further description of the variables indicating the names of the variables (as used in the tobit and logit models) and their descriptions. Briefly describing these variables, ethnicity is a categorical variable used to represent socio-cultural differences based on ethnic communities that respondents belongs to and religion (also a dummy categorical) reflects religious affiliations of a household (whether Christian, Islam or any other). Head gender and head occupation are also a categorical variables which distinguished male-headed from female-headed household, and presents the different household heads' occupations (means of earning a living), respectively. Head age describes the age of household heads in years while head education years describes the level of formal education received in terms of years of attending school. Household size describes the total number of members of the households. In terms of livestock holdings the variable "all livestock (TLU) owned in 2006" gives the total number of all livestock (adult-equivalent sheep, goats cattle and camel), in terms of tropical livestock units (TLU) held by a household at the time the survey was done (2006). The calculations of the TLU values follow what is used by other studies such as Wilson (2003).

[7] objective 2
[8] objective 3

Table 5: Variable Names and Descriptions

Name of variable	Variable description
Ethnicity 1	dummy variables for Rendille
Ethnicity 2	dummy variables for Gabra
Ethnicity 3	dummy variables for other ethnicity (Samburu and Somali)
Religion 1	dummy variables for Christianity
Religion 2	dummy variables for Islam
Head gender 1	dummy variable for male-headed households
Head age	the household head's age in years
Head education years	formal education level in years
Head occupation 1	dummy household head's occupation as a livestock keeper
Household size	the total number of people living in a particular household
GIS travel time	GIS-derived market access variable in terms of travel time in hours to the nearest urban centre
All livestock	the number of all livestock (Tropical Livestock Units) owned in 2006
Total wealth	the value of household assets owned in 2006
Dry pasture	dry season pasture distance in kilometres
Dry distance	dry season watering distance in kilometres
Dry watering	the frequency of watering in dry seasons
Wet watering	the frequency of watering in wet seasons
Vet access 2	dummies for occasional access to veterinary services
Vet access 3	dummies for no access to veterinary services
Vet access 1	dummies for constant access to veterinary services
Drug access 2	dummy variable for occasional access to veterinary drugs
Market distance	distance to the nearest livestock market
Market distance 3 years	distance to the nearest livestock market 3 years before the survey date
Doe 1 value	the perceived market value for doe category 1
Doe 2 value	the perceived market value for doe category 2
Doe 3 value	the perceived market value for doe category 3
Doe 4 value	the perceived market value for doe category 4
Buck 1 value	the perceived market value for buck category 1
Buck 2 value	the perceived market value for buck category 2
Buck 3 value	the perceived market value for buck category 3
Buck 4 value	the perceived market value for buck category 4
Sheep 1 value	the perceived market value for sheep category 1
Sheep 2 value	the perceived market value for sheep category 2
Sheep 3 value	the perceived market value for sheep category 3
Sheep 4 value	the perceived market value for sheep category 4

The distance to pasture and watering points describes some of the producer practices which include largest distance covered in search of pasture and the distance to watering points from where the animals are feeding, respectively. The watering frequencies (dry season and wet season) describe how frequent the animals are taken to the watering points and watered either during the dry season or the wet season. Using GIS measures, the distances to the nearest urban centres in terms of the travel time in hours (the GIS-derived market access variable) is obtained. Access to veterinary services and drugs are categorical variables deducing the possibility of accessing (monetary and also physical) veterinary services and drugs by the households. The distances to the nearest markets (including 3 years ago) describe access to markets based on the distances (kilometres) between a household's settlement and the nearest market.

The inclusion of the specific variables in both logit and tobit models was not *adhoc*, rather, was based on some rationale. Several studies for instance Staal et al. (2002); Benin et al. (2004), investigated several of the household, farm and external characteristics (such as years of education, access to animal health services, distance to the nearest market centres and GIS derived variables; age, gender, household size, total livestock units-TLU) and found some of them to be significant in influencing particular aspects of livestock and crop production. Such studies provided motivations for inclusion of particular variables in the logit and tobit models under this study. Household ethnicity and religion were included to explore the effects of socio-cultural aspects where as household head age's was included to explore the learning effects (experience).

Household head's gender was included for the purpose of focusing on the effects of gender roles particularly in decision making. Head's occupation was included as a proxy for household income (to remove the effect of the endogenous household income variables. Household size indicated a measure of household labour availability while producer practices such as distance to pasture and water in dry seasons, frequency of watering in dry and wet seasons were included as measures of access to livestock production support resources. Livestock holding (in TLU) was included as an indicator of the household's wealth; perceived market prices were considered to explore the effect of market information on the variables under study while distance to nearest livestock market 3 years before the study was included to explore whether there is a difference in impacts of development activities for instance, FHI established formal livestock markets in the area in order to improve market accessibilities for the producers. The FHI markets had not been established three years before the study.

4.4. Empirical Results and Discussion

The findings of the analyses discussed in section 4.3.1. are presented in this section.

4.4.1. Socio-economic Characteristics of the Households

In bid to derive the economic status of the households surveyed, wealth and income measures were explored. Total wealth, in terms of assets (livestock and productive) values held was calculated per household. To eliminate some bias which might arise from the difference in dependency ratio in households, per capita wealth was derived based on household sizes, per household. From the per capita wealth values, a median value was obtained (Ksh.30400) which was used as a focal point in categorizing the households into two wealth groups, poor and well-off. Households with per capita wealth below the median value were categorized as poor while those with per capita wealth above the median value were categorized as well-off. The same procedure was used to categorize households in terms of income groups. The median value of annual per capita income (from non-farm sources, and sale of livestock and livestock products) was identified (Kshs.4203.3) and used to categorise the household in terms of "poor" (those whose annual per capita income fell below the median) and "well-off" (those whose annual per capita income fell above the median). In addition to these measures of economic status, producers' self assessment of their own economic status (relative to others in the same area) presented another measure of economic status. The wealth and income measures are used in this chapter and chapter five whereas the self-assessment measures are used in chapter six.

An extremely statistically significant difference (χ^2=52739.39, 202 df, $P < 0.00$) was found between the two measures of household economic status, income and wealth in terms of thousands of Kenya shillings (Table 6). Based on the derived economic status, some socio-economic characteristics of small ruminant pastoral households interviewed for the purpose of this study, are shown in Table 7. The characteristics are shown in terms of economic status (grouped into two, well-off and poor) of the households based on both household annual income and household wealth during the study's one year reference period (May 2005 to May 2006). From the results, apart from income and wealth considerations, all the other household characteristics have similar values for both income and wealth groupings. The "poor" have higher household size, higher head age in years, number of children aged 16 years and above, lower education levels and lower number of livestock as compared to the "well-off" category of households. Stemming from the similarity in household characteristics in both wealth and income – based economic status considerations, the rest of the chapter and subsequent chapters proceed with analysis based on the wealth-based economic status.

Table 6: Household Economic Status Categories and Frequencies

Wealth group	Income Group Well-off	Income Group Poor	Total
Well-off	66	35	101
Poor	35	67	102
Total	*101*	*102*	203
χ^2 =52739.39, 202 df, $P < 0.00$			

Table 7: Summary of Socio-economic Characteristics of Households by Economic Status

Characteristics	Economic Status (Mean Values)							
	Wealth Groups				Income Groups			
	Well-off	n	Poor	n	Well-off	n	Poor	n
Household size	5 (2.7)	101	6 (2.2)	102	5.5 (2.5)	101	6.0 (2.4)	102
Head age in years	50 (15.7)	101	52 (14.1)	102	49 (14.9)	101	53 (14.9)	102
Head education level in years	0.8 (2.6)	101	0.6 (2.2)	102	1.2 (3.2)	101	0.2 (0.9)	102
Children of age 16 years and below	2 (1.7)	101	3 (1.9)	102	2 (1.9)	101	3 (1.7)	102
Household annual cash income (KShs.)	47707 (43273.2)	101	20900 (20734)	102	58657 (36907.1)	101	10058 (10469.1)	102
Per capita household annual income (KShs.)	9347 (8140.2)	101	3740 (4040)	102	56745 (43064.3)	101	1596 (1277.7)	102
Household wealth in 2006 (KShs.)	387341 (262550.3)	101	102020 (57614.1)	102	283263 (224528.3)	101	205078 (243903.2)	102
Per capita household wealth in 2006 (KShs.)	79175 (59386.5)	101	17236 (7902.8)	102	11513 (6866.3)	101	39446 (59121.5)	102
Number of cattle owned in 2005	30 (23.4)	88	15 (15.0)	74	31 (24.4)	82	15 (13.3)	80
Number of cattle owned in 2006	7 (8.3)	88	2 (2.2)	74	6 (7.1)	82	3 (6.2)	80
Number of camels owned in 2005	1 (7.0)	98	6 (3.4)	72	10 (6.9)	90	8 (5.9)	80
Number of camels owned in 2006	9 (6.5)	98	3 (2.0)	75	7 (6.6)	90	5.7 (4.8)	80
Number of goats owned in 2005	124 (92.5)	101	77 (53.7)	102	122 (84.4)	101	80 (67.5)	102
Number of goats owned in 2006	34 (40.5)	101	16 (15.9)	102	33 (35.3)	101	18 (26.1)	102
Number of sheep owned in 2005	78 (68.5)	97	44 (36.1)	101	67 (66.0)	98	54 (45.9)	100
Number of sheep owned in 2006	24 (26.5)	97	10 (9.0)	101	20 (25.4)	98	14 (14.4)	100

Note: n represents number of observations or households. Standard deviations are presented in parenthesis.

4.4.2. Drought Effect on Small Ruminant Holdings

The most recent detrimental recurrent droughts that occurred from December 2005 to April/ May 2006 in East Africa, to which 80 percent of the animals fell prey (Zander, 2006), also had its toll on the small ruminant kept in the study area. This analysis did not include households that did not keep particular livestock species during the period of consideration for this study. As such, out of the total households interviewed, all of the households kept at least some goats while approximately 2 percent of the household either did not keep sheep or could not account for the sheep kept in the household.

As shown in Table 8, each small ruminant keeping household lost on average, 40 and above heads of goats and above 20 heads of sheep representing more than 70 percent of their initial herd sizes. The "well-off" households, having relatively more heads of sheep and goats, lost on average 50 and 30 heads of goats and sheep respectively, with the maximum loss of more than 300 goats and more than 230 sheep being recorded. From a regional point of view, the Gabra region of Marsabit district suffered more relative loss to drought than the Rendille region, with regard to both sheep and goat deaths. While the Rendille region experienced mean drought deaths of 21 and 40 with a maximum of 152 and 338, sheep and goat, respectively, the Gabra region recorded a mean of 38 and 52 with maximum record of 232 and 371 deaths for sheep and goats respectively.

Table 8: Small Ruminant Drought Death by Economic Status and Ethnic Region

		Wealth Groups			**Income Groups**			**Ethnic Regions**		
Groups		**Well-off**	**Poor**	***t-value***	**Well-off**	**Poor**	***t-value***	**Gabra**	**Rendille**	***t-value***
Goats	Min	4	1		3	1		3	1	
	Max	371	160	*1.7 (200 df, P=0.10)*	338	371	*1.0 (200 df, P=0.3)*	371	338	*1.7 (200 df, P=0.1)*
	Mean	52 (58.9)	40 (52.9)		50 (49.1)	43 (49.2)		52 (52.9)	40 (44.7)	
	n	100	99		100	102		99	103	
Sheep	Min	0	0		0	0		0	0	
	Max	232	187	*2.1 (196 df, P=0.0)*	232	187	*0.1 (196 df, P=0.9)*	232	152	*3.2 (196 df, P=0.0)*
	Mean	35 (43.6)	24 (30.9)			29 (40.9)		38 (45.8)	21 (26.1)	
	n	97	101		98	100		97	101	

<u>Note</u>: n represents number of observations or households, Min represents minimum and Max represents maximum. Robust standard deviations are presented in parenthesis.

Comparisons of means (*t*-tests), to explore the significance versus the possibility of random occurrences, revealed statistical significant differences (at 95 percent level) in mean drought deaths of sheep for both wealth and regional considerations. For goats however, the differences in the mean drought deaths were found not to be statistically significant in all the economic status and ethnic region considerations. While the difference in effect of drought between the two regions, Gabra and Rendille, cannot be explained by the results of this study, there is a general feeling that the socio-cultural contrasts between the two communities and the slight difference in the vegetation and biomass production in the distinct parts occupied by the communities can explain the difference. The Rendille culture allows large-scale co-operation between households (Spencer, 1973; O'Leary and Palsson, 1992) while the Gabra promotes greater acceptance of independent action, a social-cultural contrast reflected in settlement patterns. The average size of a Rendille camp is 24 households, and some camps have up to 70 households (O'Leary and Palsson, ibid). This is approximately four times larger than a typical Gabra camp (usually of ten to fifteen families (Tablino, 1999)). Further, in the Rendille area, the dominant vegetation is "bushed grassland", with a tree- and shrub-coverage of less than 10 percent while most of the land in the Gabra area is barren with stretches of "bushed grassland" or "dwarf-shrub/ annual-grassland" (Schwartz et al., 1991).

4.4.3. Animal Categories Kept and Purpose or Reasons for Keeping

Figure 3[9] shows the mean numbers of animal categories kept by the livestock keepers in both years 2005 (before the drought) and 2006 (after drought), by wealth groups. It's clearly evident that the small ruminant herd sizes drastically reduced after the drought. Based on the numbers kept, the well-off group of households seem to be keeping more of category 3, 1 and 1 for does, bucks and sheep respectively, than any of the other respective categories in both years. The poor households had more of buck category 2 in 2005 but more of category 4 in 2006. Sheep category 2 was found to be dominant among the poor households in 2005 but after the drought, its numbers dropped as compared to the number of all the other sheep categories in 2006.

[9] Refer to Table A1 in Appendix 1, for more elaborate information

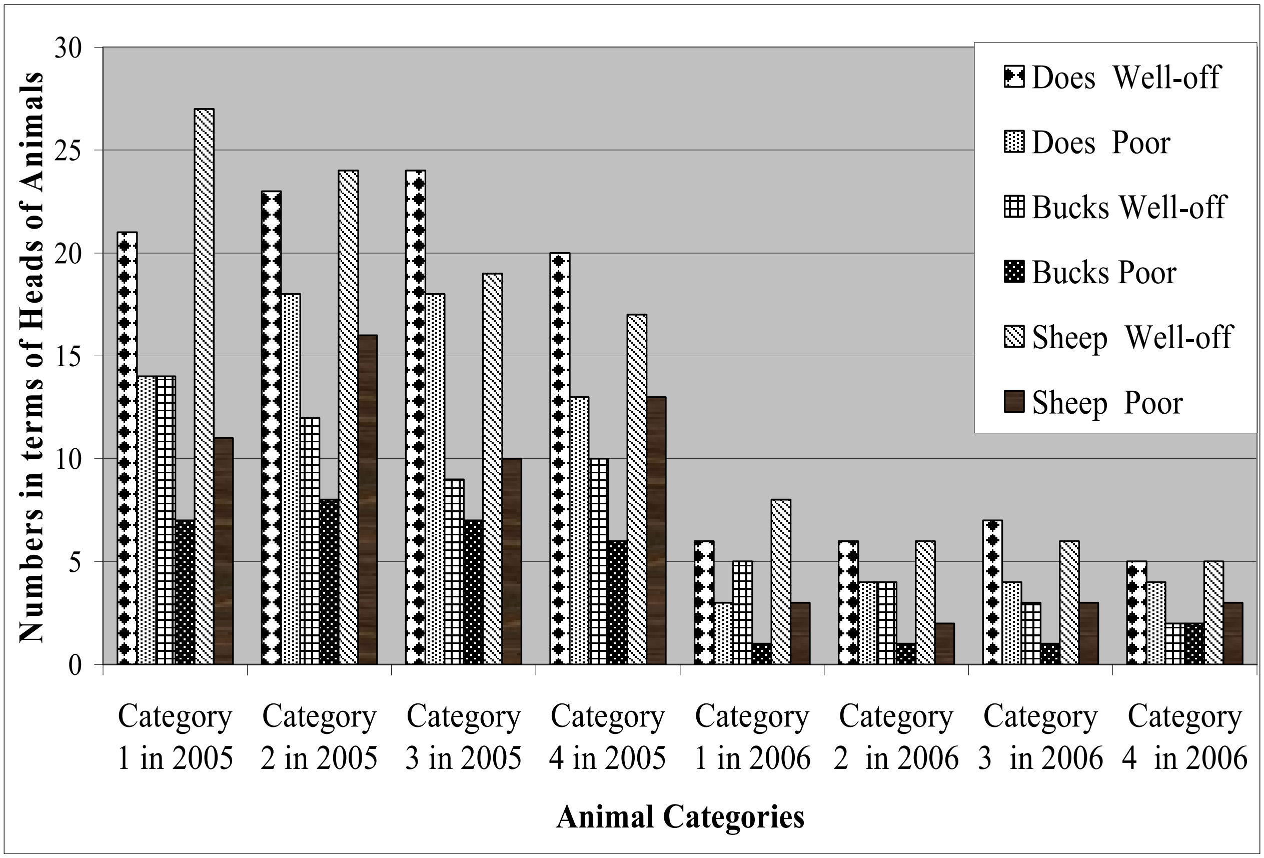

Figure 3: Average Numbers of Small Ruminant Animal Classes in 2005 and 2006 Based on Income Groups

Across all the household types, as defined by wealth groups, the households' purpose or reasons for keeping all the does and sheep categories was identified as mostly for home consumption. Buck categories on the other hand were said to be kept for household income. Home consumption here include consumption of both the livestock and the livestock products at home whereas household income include sale of livestock and livestock product either in cash or barter for the purpose of meeting household expenditure needs.

The purposes and reasons given by the respondents for keeping particular breed categories is inadequate in understanding the small ruminant production in the pastoral system. Further analysis of the producers' preferences and choice goes a long way in giving a detailed insight of the production systems and the animals kept.

4.4.4. Producer's Preference and Breed Category Choice

The identified priority (dominant) animal categories were doe category 3, buck category 1 and sheep category 2 based on the numbers kept (see Figure 4 for the numbers of the categories and Table A25 in appendix 1 for more elaboration; also see Table 3 in section 4.3.1 for the description of the animal categories). The logit model results (Table 9) show that several household characteristic, farm characteristics and external factors influence the producer's preference and breed categories choice as reflected in the numbers kept of the categories. These include ethnicity, religion, head education level, access to veterinary drugs, distance to the nearest livestock market, distance to the nearest urban centre (GIS derived travel time), producer practices such as frequency of watering animals and perceived market value of other small ruminant categories. Other variables that were found to be highly insignificant were dropped from the models[10]. The models are strongly significant with pseudo R^2s ranging between 0.35 and 0.49. Likelihood ratio test was used to measure the goodness of fit of the models.

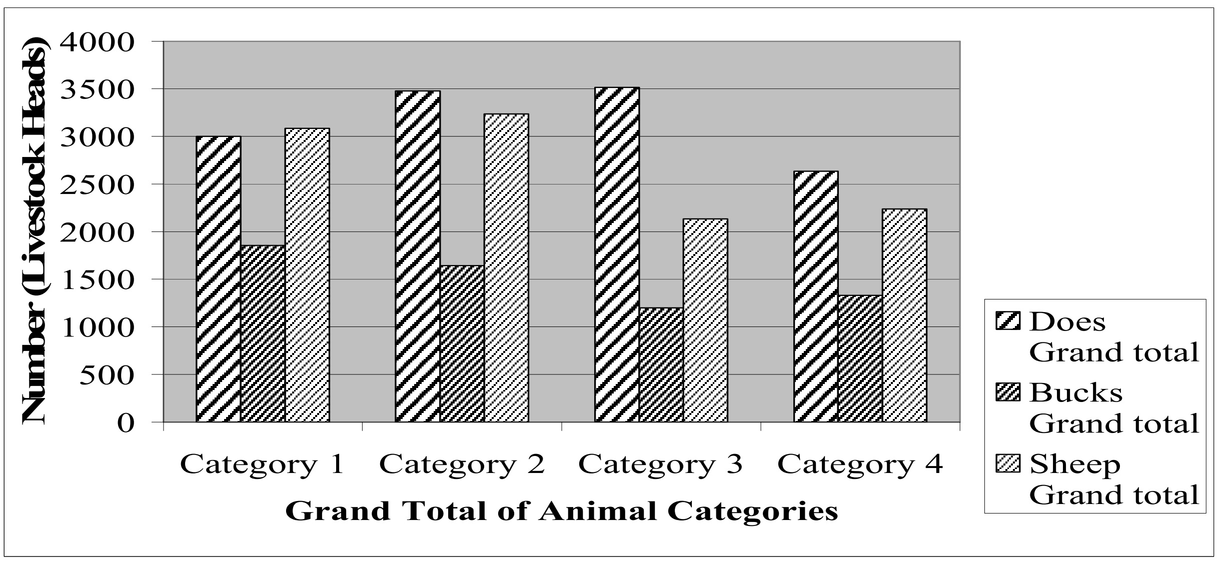

Figure 4: Grand Totals of Animal Categories Kept by Households Considered in the Breed Choice Analysis

[10] Care was taken not to include variables that were found to be collinear for instance, dry season water distance and dry season watering frequency were not considered in the same model (one had to be dropped).

Table 9: Regression Results on Determinants of Producer Preference and Breed Category Choice

(Dependent variable – Dominant categories)

Variables[11]	Does		Bucks		Sheep	
	Coefficient	P>|t|	Coefficient	P>|t|	Coefficient	P>|t|
Ethnicity 1	2.82	0.20			2.47	0.27
Ethnicity 2	-3.92	0.20	6.66	0.04		
Ethnicity 3			3.67	0.06		
Religion 1	2.98	0.02	0.37	0.66	0.10	0.92
Religion 2	-0.05	0.98	0.65	0.58	-3.87	0.02
Head gender 1			0.42	0.74	-1.86	0.20
Head age	-0.04	0.22	0.04	0.20	-0.05	0.13
Head education years	0.10	0.78	0.64	0.01	0.47	0.07
Head occupation 1	7.71	0.02				
Household size	0.28	0.17	-0.36	0.07		
GIS travel time	2.05	0.05	-0.10	0.90	-0.14	0.78
All livestock	-9.70e-07	0.63	0.02	0.56	2.91e-03	0.95
Dry pasture			4.15e-04	0.42		
Dry distance					-0.01	0.52
Dry watering	0.60	0.14	-0.07	0.84		
Wet watering			-2.22	0.01		
Vet access 2	-2.73	0.10	-3.71	0.08		
Vet access 3					1.65	0.20
Vet access 1	16.24	.	18.01	.		
Drug access 2	12.45	0.00	17.45	0.00		
Market distance	-0.05	0.27	2.84e-04	0.74	0.02	0.01
Market 3 years	0.05	0.25	-9.41e-04	0.39		
Doe 1 value	-1.57e-03	0.24	-3.62e-04	0.73	-2.14e-03	0.20
Doe 2 value	-4.51e-03	0.11	-4.70e-03	0.04	-6.54e-03	0.01
Doe 3 value	2.54e-03	0.21	2.88e-03	0.10	3.70e-03	0.10
Doe 4 value	-9.26 e-04	0.40	5.53e-04	0.72	1.22e-04	0.41
Buck 1 value	2.59e-03	0.02	1.43e-03	0.13	-3.58e-04	0.70
Buck 2 value	-5.62e-04	0.52	6.46e-04	0.46	8.44e-04	0.36
Buck 3 value	5.72e-04	0.57	7.71e-04	0.39	5.90e-04	0.53
Buck 4 value			-1.18e-03	0.30	1.39e-04	0.19
Sheep 1 value	-2.58e-04	0.81	2.51e-03	0.02	-1.60e-03	0.27
Sheep 2 value	-1.36e-04	0.95	3.42e-03	0.14	1.94e-03	0.51
Sheep 3 value			-2.68 e-03	0.15	-5.77e-04	0.77
Sheep 4 value	-3.66e-04	0.80	-1.69 e-03	0.25	-1.03e-04	0.95
Constant	-47.62	0.00	-25.63	0.00	3.84	0.56
Observations	104		99		99	
LR $\chi^2(28)$	55.64		43.68		49.64	
Log likelihood	-29.54		-40.46		-31.12	

Note: The description of the variable names used in this Table can be found in Table 5.

For does, it was found that Christians keep more of the dominant category (3) as compared to the African traditional believers. Households with access to veterinary drugs keep more of doe category 3 than households with no access to veterinary drugs. In terms of the GIS derived variable of travel time to the nearest urban centre, households living far from urban centres are seen to keep more of the dominant doe category than the household living nearer to the urban centres. The perceived market value for buck category 1 (which is also a dominant category in bucks) positively influences the keeping of doe category 3 in that the higher the perceived value of buck category 1, the more the doe category 3 is kept. For Bucks, the results show that Rendille households keep more of the dominant buck category than other ethnic communities living in the study area such as Samburu and Somali (there was no significant difference between Gabra household and other communities, in this respect).

The results also indicate that frequency of watering in wet season negatively influences the keeping of buck category 1 implying that the buck dominant category might not need frequent watering in wet seasons. Like does, drug access also positively influence the keeping of buck category 1 relative to other buck categories. Formal education is seen to have a positive influence on the keeping of buck category 1. The perceived value of doe category 2 has a negative influence on keeping of buck category 1 while the opposite is for the keeping of the sheep dominant category (2). Muslim households in the study area were found to be keeping less of the dominant category of sheep than the African traditional believers. The distance to the nearest livestock market has a positive influence while the perceived market value of doe category 2 has a negative influence on the keeping of more of the dominant category of sheep relative to other sheep categories.

From these results, one can deduce that since the ethnic communities surveyed occupy distinct areas of the district, ethnicity appeared to be an important factor. This can be explained by the differences in the vegetation between the Rendille and Gabra areas as explained in Schwartz et al. (1991) and pointed out in section 4.3.2. Religion, being an important factor in these results, seems to reflect the effect of religious beliefs and practices (socio-cultural) on animals kept. According to the communities of the area, there are religious practices and ceremonies that are performed such as ritual blessings and sacrifices of animals 'sorios' (Tablino, 1999) which require specific kinds of animals hence influencing the kinds of animals a household keeps in relation to its religious inclination. Another important result is the positive and significant influence of the household head's education level. This is seen here as a relative factor to the understanding of market information. A more educated household head will be in a better position to understand and make better household decision based on market signals. The importance of the relation between education and market signal is reinforced by the fact that education level variable is only significant for bucks, animals that are mainly targeted for markets (sale).

Market information is also seen critical due to the positive and significant influence of distance to the nearest livestock market and distance to the nearest urban centre (GIS derived travel time) as seen in sheep and does respectively. Access to veterinary drugs, also a positively significant variable, reflect what Njanja et al. (2003) put forth as one of the major and common general constraints to pastoral livestock production in the study area, disease challenges. In the study area, it's a common practise not to frequently water animals especially small ruminants during the wet season since pasture is normally green (wet) as opposed to the dry season. This reflects the importance of producer practices such as frequency of watering animals. The perceived market value of other small ruminant categories, seen as important in breed category choice reflects the element of competition on available resources and the complementarity between the categories such as the positive relation between buck category 1 and doe category 3. While doe category 3 is kept mainly for home consumption (meat and milk), buck 1 is kept for household income.

Farmers breeding strategies evolve and respond to external influences such as disease risk (Gbodjo et al., 2000), drought incidences and socio-economic environment. This is evident in the fact that the livestock keepers keep a variety of livestock species and strains within the species. As Ruto et al., (2008) puts it, the diversity of this 'genetic resource' is a key component of the ability of a pastoral agricultural system to overcome destabilising factors such as disease, drought or conflict. As such, the question of choice of variants within breed in the pastoral set up cannot be answered in the conventional way since the different variants are kept in most households to fulfil different purposes in the livelihood of the livestock keepers at different times. Consequently, the difference exist only in the volume kept of a particular variant kept, which reflects the inclination of different households to certain benefits and challenges of keeping such breed variants. This is a clear indicator that some diversity exists in the small ruminant breeds kept by the pastoralist and surprisingly, even after a devastating drought, the diversity is seen to still exist. According to Köhler-Rollefson, (2005) pastoral livestock production systems inherently conserve genetic diversity since remote ASALs have given rise to a disproportionately large number of different breeds, which also have a great degree of intra-breed diversity.

It pays to note here that though conventional science disputes the existence of particular combinations of different traits in an animal, livestock keepers, in their description of their herd in terms of the combination of traits the animals exhibit, sends a different signal. This is seen, for instance, where the livestock keepers describe the existent of animals with both high productive and adaptive capabilities such as doe category 1. Interestingly, livestock keeper's description of their stock based on traits match the local names given to these animals by the local communities that derive from their adaptation and performance based on the traits. Mbuku (2006) mentioned these naming (referring to them as ecotypes) in camel. The naming is concurrently applied to small ruminants by the same communities. Though the difference (between conventional science and producers' perspective) might be as a result of differences in perspectives relating to relative measurements and intensities of the described traits, as Lebbie and Ramsay, (1999) argue, majority of the African SRGR are indigenous but unlike the fewer exotic and the synthetic breeds, very little information exists on most of these important genetic resources. Consequently, in the bid to adequately characterize the African SRGR, there is need to synchronize the livestock keepers' perspective of their animals with conventional science.

4.4.5. Levels of Production and Marketed Surplus

The results of tobit models for the different animal categories identified are shown in Tables 10, 11 and 12. Several household, farm and external characteristics were regressed against the total number of animal categories after identifying the priority animal category for each and every household interviewed. The identification of the priority animal categories (also referred to as dominant/ preferred animal category here) was based on the numbers kept where the category with the highest number was taken as the dominant category. Effort to have this analysis divided into two sections, one of production and the other of market surplus proved futile since the nature of the data collected on the animal categories cut across seasons (drought and some normal period). Consequently, the data could not be clearly classified in order to separate the sales of animals during the drought period. Sales of animals during the drought period might or might not be a form of marketed surplus since some households could have been forced to dispose of the animals due to the drought effect, which might not be the case under normal (non-drought) conditions. As such the numbers of animals held, sold, slaughtered and died of drought and disease during the survey's reference period were lumped together resulting to only one analysis of production and marketed surplus.

Most of the variables included were found to be strongly significant wit either positive or negative influence on the dependent variable (keeping of a particular dominant animal category i.e. the herd size of the dominant category). Other variables that were found to be collinear, for instance, dry season water distance and dry season watering frequency, were not considered in te same model (one had to be dropped). Variables such as household head occupation and total wealth were found not to be highly correlated hence both were included in the models. The models are strongly significant with pseudo R^2s ranging between 0.18 and 0.94. Likelihood ratio tests were used to measure the goodness of fit of the models.

The results indicate that the probability of a household keeping more of category 1 of Doe animals is positively and significantly influenced by ethnicity (being a Rendille as opposed to being another tribe for instance, Somali and Samburu), the frequency of watering in dry season, access to veterinary services and drugs, distance to the nearest livestock market three years before the survey, household head's age, education years and the perceived market value of itself (doe category 1), doe category 3, buck category 2 and 3, and sheep category 1 and 3. On the other hand, other variables like ethnicity (being a Gabra as opposed to other ethnic groups for instance, Somali and Samburu), religion (being either a Christian or a Muslim as opposed to being an African traditional believer), dry season pasture distance, distance to the nearest livestock market at present head gender (being a male as opposed to being a female), travel time to the nearest urban centre (GIS-derived), perceived market values of does category 2 and 4 and buck category 1, have a negative and significant influence on the probability of keeping more of doe category 1.

Table 10: Tobit Regression Results on Factors Affecting the Levels of Production in Does

(Dependent variable – Dominant category)

Variables	Category 1		Category 2		Category 3		Category 4	
	Coeff	P>|t|	Coeff	P>|t|	Coeff	P>|t|	Coeff	P>|t|
Ethnicity 1	-11.46	0.02	-28.70	0.06			84.31	0.01
Ethnicity 2	84.20	0.00	52.29	0.00	-6.20	0.78		
Religion 1	-6.89	0.05	-6.72	0.11	-68.20	0.00	-0.97	0.79
Religion 2	-44.92	0.00			23.96	0.08	-15.02	0.04
Dry pasture	-0.02	0.01	0.19	0.01	0.10	0.03	-0.02	0.14
Dry distance			-0.96	0.02	-0.39	0.01	0.30	0.01
Dry watering	5.52	0.00						
Wet watering	-8.09	0.00	-18.97	0.01	-47.62	0.02	-0.59	0.32
Vet access 2	12.26	0.00	100.22	0.00	-51.77	0.00	84.52	0.01
Vet access 1	-20.17	0.01					57.70	0.00
Drug access 2	13.98	0.03	10.09	0.25	32.72	0.00	23.36	0.02
Market distance	-1.49	0.00	0.03	0.16	0.09	0.17	-0.34	0.04
Market 3 years	1.05	0.00	-0.05	0.41	-0.23	0.02	0.289	0.00
Head gender 1	-4.15	0.01	-34.79	0.00	33.52	0.02	0.62	0.01
Head age	1.10	0.00	0.35	0.03	-0.35	0.07	-3.38	0.19
head education years	18.50	0.00	-5.53	0.00	2.29	0.15		
head occupation 1	1.52	0.09	-6.20	0.52	-73.48	0.00		
household size					-1.41	0.22		
GIS travel time	-7.46	0.00	-7.60	0.01	25.30	0.00	23.09	0.00
All livestock			1.48e-4	0.01	1.00e-4	0.00	4.00e-5	0.01
Doe 1 value	0.03	0.00	8.42e-3	0.04	4.5e-3	0.79	0.03	0.01
Doe 2 value	-0.03	0.00	4.64e-3	0.14	0.19	0.00		
Doe 3 value	0.01	0.00	-0.05	0.02	-0.08	0.01		
Doe 4 value	-0.02	0.00	0.03	0.02	0.06	0.03	-0.01	0.15
Buck 1 value	-0.02	0.00	0.02	0.0			0.03	0.02
Buck 2 value	0.01	0.00	0.02	0.08	-0.02	0.13		
Buck 3 value	0.02	0.00	-0.02	0.10				
Buck 4 value			-0.01	0.14	-0.07	0.00	-0.03	0.02
Sheep 1 value	0.01	0.00	-0.02	0.05	-0.01	0.39	-0.03	0.01
Sheep 2 value	-0.01	0.10	-0.03	0.01				
Sheep 3 value	0.01	0.06						
Sheep 4 value							0.06	0.00
Constant	-18.55	0.03	89.42	0.02	-172.91	0.02	-417.04	0.00
/sigma	0.54		0.71		4.57		3.30	4.63
Observations	31		29		28		25	
LR χ^2(28)	204.88		167.13		98.89		76.22	
Prob > χ^2	0.00		0.00		0.00		0.00	
Pseudo R^2	0.81		0.74		0.38		0.38	
Log likelihood	-23.88		-30.13		-79.34		-63.28	

Note: The description of the variable names used in this table can be found in Table 5.

Table 11: Tobit Regression Results on Factors Affecting the Levels of Production Bucks

(Dependent variable – Dominant category)

Variables	Category 1		Category 2		Category 3		Category 4	
	Coeff	P>|t|	Coeff	P>|t|	Coeff	P>|t|	Coeff	P>|t|
Ethnicity 1	-64.90	0.00	9.84	0.18	-23.33	0.03	53.05	0.00
Ethnicity 2	-70.66	0.00						
Religion 1	-23.82	0.00	-9.07	0.09	-3.87	0.18	0.42	0.91
Religion 2	3.78	0.55	-31.99	0.00	-7.00	0.06	-12.24	0.03
Dry pasture	-0.13	0.01	-0.08	0.01	0.06	0.01	0.03	0.05
Dry distance			0.65	0.00	0.25	0.01	0.47	0.00
Dry watering	-11.43	0.00						
Wet watering	-14.42	0.01	6.39	0.00	-14.43	0.01	-3.31	0.39
Vet access 2	-103.21	0.00	28.11	0.01	-2.76	0.37	-15.85	0.06
Vet access 1	24.82	0.00	-77.77	0.00				
Drug access 2			-70.64	0.00	-6.92	0.07	10.92	0.06
Market distance			-2.18	0.00	0.055	0.02	0.06	0.03
Market 3 years	0.19	0.01	2.43	0.00			0.14	0.00
Head gender 1	-5.30	0.16	-57.82	0.00	-10.85	0.03	-17.75	0.01
Head age	0.67	0.00	0.50	0.00	-0.15	0.05	-0.23	0.06
Head education years	4.55	0.05	6.97	0.00	1.08	0.10	-1.22	0.40
Head occupation 1	-10.91	0.50	62.28	0.00	-3.00	0.12	-38.42	0.01
Household size							1.98	0.02
GIS travel time	10.94	0.04	-7.45	0.05	-1.70	0.31	0.84	0.71
Total wealth	-9.61e-6	0.15	6.43e-5	0.00			-7.17e-6	0.34
Doe 1 value	-.054	0.00	3.01e-3	0.46	1.05e-3	0.63	-0.01	0.02
Doe 2 value	-.03	0.01	-0.03	0.01	-0.01	0.04	-0.01	0.11
Doe 3 value	-.059	0.00	0.03	0.01			-4.92e-3	0.48
Doe 4 value	0.12	0.00	-0.01	0.03			0.02	0.02
Buck 1 value	0.04	0.00	-0.01	0.02	-0.01	0.04	-2.95e3	0.56
Buck 2 value	-.02	0.03	-0.01	0.01			4.74e-3	0.11
Buck 3 value	-.03	0.00	4.58e-3	0.13				
Buck 4 value	.02	0.04	-0.02	0.00			6.77e-3	0.14
Sheep 1 value	.02	0.00	-0.01	0.15				
Sheep 2 value	-.03	0.01	0.01	0.23				
Sheep 3 value	.05	0.02						
Sheep 4 value	-.03	0.01						
Constant			145.62	0.02	81.84	0.02	18.28	0.53
/sigma							3.32	
Observations	33		31		20		30	
LR χ^2 (28)	137.73		80.84		41.19		70.01	
Prob > χ^2	0.00		0.00		0.00		0.00	
Pseudo R^2	0.46		0.35		0.36		0.32	
Log likelihood	-80.17		-76.53		-36.97		-73.35	

Note: The description of the variable names used in this Table can be found in Table 5.

Table 12: Tobit Regression Results on Factors Affecting the Levels of Production Sheep

(Dependent variable – Dominant category)

Variables	Category 1		Category 2		Category 3		Category 4	
	Coeff	P>|t|	Coeff	P>|t|	Coeff	P>|t|	Coeff	P>|t|
Ethnicity 1	-5.51	0.47	-50.12	0.19			-13.74	0.00
Ethnicity 2	-19.43	0.20	-64.92	0.10	-108.89	0.12	4.82	0.01
Religion 1	-18.27	0.00	3.78	0.39	24.30	0.02		
Religion 2	-5.30	0.28	-9.53	0.26	14.37	0.13		
Dry pasture	0.03	0.21	-0.05	0.17	0.20	0.10	0.14	0.00
Dry distance								
Dry watering	-4.33	0.10	1.03	0.50	-4.80	0.16	-31.62	0.00
Wet watering	-4.43	0.32	-6.65	0.62	22.69	0.03	-11.78	0.00
Vet access 2	38.95	0.00	-20.20	0.27	8.32	0.448	17.25	0.00
Vet access 1	-1.69	0.84			-1.13	0.92		
Drug access 2	2.90	0.72	-41.73	0.00			-33.20	0.00
Market distance	-0.08	0.18	-0.04	0.82	-0.66	0.01	0.23	0.00
Market 3 years	0.08	0.10	0.10	0.28			4.08	0.00
Head gender 1	-14.60	0.13	13.53	0.14			13.10	0.00
Head age	-0.05	0.73	-0.26	0.22	-0.22	0.36	0.23	0.00
head education years	7.97	0.01	-4.11	0.00	-15.56	0.08	-1.14	0.00
head occupation 1			-11.58	0.39			56.02	0.00
household size	1.43	0.15	-2.53	0.28				
GIS travel time	5.70	0.09	6.84	0.19	23.11	0.17		
All livestock	0.00	0.29	1.57e-5	0.21	2.96e05	0.19		
Doe 1 value	0.00	0.71	-0.03	0.01			0.04	0.00
Doe 2 value	0.00	0.84	-0.05	0.01			-0.13	0.00
Doe 3 value	-0.04	0.00	0.04	0.01			0.01	0.00
Doe 4 value	0.02	0.00	0.02	0.01			0.08	0.00
Buck 1 value			1.02e-3	0.92	-3.51e-3	0.40		
Buck 2 value	0.01	0.23	-0.01	0.16				
Buck 3 value	-0.01	0.01						
Buck 4 value	0.01	0.03	0.02	0.07				
Sheep 1 value	0.01	0.20			-0.03	0.14		
Sheep 2 value	-0.01	0.22						
Sheep 3 value	-0.01	0.38						
Sheep 4 value	0.01	0.08						
_constant	5.02	0.89	61.81	0.33	-148.10	0.19	-11.74	0.03
/sigma	8.32		5.30		6.07		0.32	
Observations	49		31		18		20	
LR χ^2(28)	70.41		63.46		41.32		171.54	
Prob > χ^2	0.000		0.00		0.00		0.00	
Pseudo R^2	0.18		0.25		0.28		0.94	
Log likelihood	-169.57		-93.05		-53.44		-5.06	

Note: The description of the variable names used in this table can be found in Table 5.

The results indicate that the probability of a household keeping more of category 1 of Doe animals is positively and significantly influenced by ethnicity (being a Rendille as opposed to being another tribe for instance, Somali and Samburu), the frequency of watering in dry season, access to veterinary services and drugs, distance to the nearest livestock market three years before the survey, household head's age, education years and the perceived market value of itself (doe category 1), doe category 3, buck category 2 and 3, and sheep category 1 and 3. On the other hand, other variables like ethnicity (being a Gabra as opposed to other ethnic groups for instance, Somali and Samburu), religion (being either a Christian or a Muslim as opposed to being an African traditional believer), dry season pasture distance, distance to the nearest livestock market at present, head gender (being a male as opposed to being a female), travel time to the nearest urban centre (GIS-derived), perceived market values of does category 2 and 4 and buck category 1, have a negative and significant influence on the probability of keeping more of doe category 1.

For bucks, several variables were found significant in influencing the level of production and marketed surplus of category 1. These include access to veterinary drugs, distance to the nearest livestock market three years before the study, household head's age, household head's education level, proximity to urban centre (GIS-derived), the perceived market value of itself, doe category 4, buck category 4 and sheep categories 1 and 3 all of which have a positive influence. Variables with a negative influence on the level of production and marketed surplus of buck category 1 include ethnicity (being a Gabra or a Rendille as opposed to being from another ethnic community), religion (being a Christian), dry season pasture distance, dry season watering frequency, wet season watering frequency, access to veterinary services and the perceived market values of doe categories 1, 2, and 3, buck categories 2 and 3, and sheep categories two and 4. In sheep, the variables that show a positive and significant influence on the level of production and marketed surplus for sheep category 1 include access to veterinary services, household head's education and the perceived market value of both doe and buck category 4. On the other hand, religion (being a Christian) and the perceived values of both doe and buck category 3, have negative influence on the level of production and marketed surplus of sheep category 1.

The results hitherto indicate the importance of household, farm and external characteristics in influencing the levels of small ruminants kept (numbers). The explanation of the effect of variables such as ethnicity, religion, household head's education distance to the nearest livestock market, proximity to an urban centre and perceived market values follow the same argument as presented in section 4.4.4. In addition, household head's age being positive and significant in influencing the levels of production and marketed surplus several small ruminant categories presents the relevant of experience (learning process) in livestock husbandry which is reflected in terms of decision making and active involvement of household head's in taking care of livestock.

4.5. Conclusion

In this chapter, the various categories kept in the production system in the area of study based on the description of the mixes of traits embedded on the animals were explored with the realisation that the most dominant animals include: does with high milk sufficiency (for both its kid and some surplus for the household) and not very drought tolerant, bucks which have big body sizes with high levels of drought tolerance, and sheep with no body fats yet poor in terms of drought tolerance. This study has also shown several household, farm and other external characteristics that influence the levels of small ruminants' production and producer preferences. This kind of information could be of much importance to government and development agencies that seek to improve livelihoods of the pastoralist in terms of areas of interventions such as education, access to market and market information through infrastructure such as road networks.

The small ruminant livestock producers certainly derive certain benefits from keeping their small ruminant breeds. Based on the levels of production of small ruminants, small ruminant household derive subsistence from consuming small ruminant products and also income from the sale of both the small ruminants and their products. Small ruminants also perform social cultural functions in the livelihood strategies of small ruminant producers. Having seen that the different variants (as defined by the small ruminant producers based on traits) of the small ruminant breeds kept by the pastoralists all exist in almost very household, albeit at different levels, it is interesting to note that there exists some form of diversity within this breeds as seen by their producers. However there is need for characterisation of these breeds in order to match the conventional definitions of the breeds (and variants) with the perspectives or indigenous knowledge (I.K) of the livestock keepers. It would also be interesting to expose the different categories of the breeds to further molecular studies to establish the genetic basis of their perceived differences.

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CHAPTER FIVE

SMALL RUMINANTS' CONTRIBUTIONS TO LIVELIHOODS AND THE RELATIONSHIP BETWEEN HOUSEHOLD VULNERABILITY AND LIVESTOCK ASSET HOLDINGS

5.1. Introduction

Small ruminants (goats and sheep) form an important economic and ecological niche in agricultural systems throughout the developing countries. Their current contribution is not commensurate with the potential capacity for higher levels of production. The context for productivity enhancement and increased socio-economic contribution relates to large population size, wide distribution across various agro-ecological zones and production systems and diversity of breeds (Devendra, 2005). Small ruminants are ranked closely behind cattle in their importance to livelihoods (Kosgey, 2004). This can be attributed to the fact that due to their short generation intervals and high reproductive rates, they have high production efficiency (Makokha, 2002). Their early sexual maturity, younger age at slaughter (Winrock International, 1976) and small size give them several distinct economic advantages in smallholder situations (Njoro, 2003) due to a faster turnover of capital (Winrock International, ibid). They can efficiently utilise marginal and small plots of land (Njoro, ibid). The risk on investment is reduced by their small individual sizes, allowing more production units per unit of investment; besides, smaller carcasses are easier to market and can be consumed in a short period of time, which is important as most rural areas lack proper storage facilities (Kosgey, ibid). This means that they may be a better pathway out of poverty than most of other domestic animals, especially for the poor.

By and large, the importance and extent of the contributions of small ruminants, especially to the poor in the rural areas, are inadequately understood, meaning that their valuable genetic resources continue to be generally neglected (Devendra, 2005). In addition, the relative importance of the tangible and intangible benefits of small ruminants are poorly understood (Kosgey, 2004). Devendra (ibid) enumerates the advantages and disadvantages (economic and ecological niche) of keeping small ruminants in agricultural systems throughout the developing countries whereby, the advantages clearly and widely outnumbers the disadvantages.

The current study aims at assessing and comparing contributions to livelihoods of small ruminant breed categories. This is critical not only in understanding the producer responses that lead to either loss or conservation of genetic resources embedded in particular breeds, but also, in understanding how small ruminants affect, and how their incremental production would impact on the livelihoods of poor livestock keepers, an area this study explores by assessing the relationship between household vulnerability and livestock (especially small ruminants) holding. This study therefore, seeks to build upon the current emphasis on the importance of assets in increasing the productivity and reducing the vulnerability of poor peoples' livelihoods. This will consequently promote more integrated consideration of different assets held by the poor (particularly livestock asset, which is more predominant in the study area), and hence facilitates analysis for policy, capacity building and technological interventions to expand livelihood opportunities for the poor (Doward et al., 2001).

5.2. Literature

This section presents a brief literature review touching on issues that are of particular importance in this chapter. These include the aspects of small ruminant contribution to livelihoods and livestock functions as assets, which are discussed below.

5.2.1. Small Ruminant Contribution to Livelihoods

The erroneous stigmatization of goats as the major culprits for environmental degradation is unfortunate because available evidence shows that when managed properly, especially in mixed species grazing, goats contribute to sustainable natural resource management (Rege and Agyemang, 1992; Schwartz, 1983). As pointed out by Ledin (1997), small ruminants are generally kept by poor people and are often tended by women, who seldom have any influence on the situation. Small ruminants and the people who keep them are held in low esteem and given few priorities in development. In Namibia (and Africa at large), goats are used as a source of milk in time of drought or when the owner has no cows to milk. However, when the owner has enough cows, goats are milked only during the dry season. Goats and sheep are sold when cash is needed. In addition, they are used in a number of traditional ways such as gifts and are slaughtered at weddings and funerals (Degen, 2007).

As argued by McCabe (1997), sheep and goats have been taking on a more prominent role in the livestock shepherded and milked by pastoralists in Africa. According to Devendra (2005), there are a number of important development imperatives (with regard to small ruminants) that need to be urgently pursued. These include *inter alia*: choice of species and better use of available breeds, official support and increased resource use, choice of production systems, matching production to available feed resources, build up of numbers, knowledge of markets and marketing systems, linking production, products and by-products to markets, and targeting poverty and improved livelihood.

5.2.2. Asset Functions

Gamba and Mghenyi, (2004) outline the importance of access to resources (in terms of various asset holdings such as land) in the process of poverty reduction and poverty dynamics. Insufficient access to assets is the main determinant of poverty (de Janvry and Sadoulet, 1995). Assets support consumption by contributing to overall production and income; and allowing exchange and/or consumption in periods when there is no income. Asset and livelihood diversification therefore have important consumption smoothing, risk management and productive functions. Consequently, in an analysis of assets in rural livelihoods it is imperative to examine the functions of different asset types within the asset portfolios held by poor people with different livelihood strategies. In this case, it is important to question the role of different livestock in the livelihood strategies of the poor: whether livestock production bolsters climbing out of poverty; the importance of livestock as a form of savings of income from other sources and how this importance vary between different livestock types and different livelihood strategies and strata; how livestock production and savings compare with other productive and savings activities; and how livestock keeping complement cropping and non-farm activities in its contributions to and demands for income and assets. Such questions require a systematic analysis of asset functions in the varied livelihood strategies of the poor (Doward et al., 2001).

5.3. Research Methodology

5.3.1. Data and Analysis

The kind of data collected for the purpose of this chapter, has been elaborated in section 4.3.1. In analysis, descriptive statistics, for instance cross-tabulations and frequency tabulations, were preformed to assess the contribution of the priority animal versus alternative breed categories to livelihoods in terms of household income, nutrition, investment and other social functions (objective 3). To establish the relationship between household vulnerability and livestock asset holding and management (objective 4), data analysis drew on the asset function framework (AFF) methodology. The methodology involves the use of AFF indicators which generally consider measures of livestock and other asset holdings including the value of such assets, the proportion of total asset value held in different categories (e.g. livestock classes, productive physical assets such as tools or vehicles), variations in asset holdings within/ between seasons, timing of use (i.e. seasonality), susceptibility to loss (lack of security of tenure, diseases, theft) and perceived important role (Dorward et al., 2001).

Weighted ranking indices were also calculated for observations that were in form of ranks or scores (where the respondent evaluated questions by giving numerical scores of ranks indicating importance or priority). For instance, the survey responses of the ranking exercise for the different livestock livelihood functions, where respondents were asked to give a rank of 1 to 6 per animal in order of importance of particular animal specie in fulfilling particular livelihood function. The survey responses were numerically coded for the purpose of computer entry and for the subsequent quantitative analyses. A spread-sheet programme in MS Excel 2003 was used to calculate the indices according to the formula: Index = sum of [6 for rank 1 + 5 for rank 2 + 4 for rank 3 + 3 for rank 4 + 2 for rank 5 + 1 for rank 6] for a particular livelihood function divided by total sum of [6 for rank 1 + 5 for rank 2 + 4 for rank 3 + 3 for rank 4 + 2 for rank 5 + 1 for rank 6] for all the livelihood functions in question. In this case, indices represent weighted averages of all rankings of particular livestock specie in a particular livelihood function. The rankings were based on the all the six most common livestock species found in the study areas. The interpretation of the ranking indices is that the higher the index, the more weight or important the variable under consideration is. This procedure of ranking or scoring data follows the methodology described in Stern et al. (2004) and has been applied in several studies, for instance, Kosgey (2004) and Mbuku (2006).Further the same wealth groupings (see section 4.3.1 for details about the derivation) used in chapter three is also used in this chapter.

5.4. Empirical Results and Discussion

The results of this study are presented in the subsequent subsections of this section. Being a comparative study, out of the total households surveyed, households that were, for some reason, unable to define their herds in terms of the traits in consideration, were left out during the analysis stage. In this regard, 96, 90 and 92 percent, for bucks, does, and sheep herds respectively, of all the households who responded to the whole study questionnaire were successfully able to describe their buck herd in terms of the mix of traits and trait levels. Other household who, despite being able to describe their herds in terms of the mix of trait levels under consideration, were unable to account for their herd sizes (yet it was also difficult physically assess the herd due to large distances between the households and the pasture where the animals stayed) were also left out during analysis. Such cases were minor and only accounted for 1 percent for both bucks and does in the herds respectively, of the total households who answered the whole study questionnaire.

5.4.1. Importance of Livestock Activities to Livelihood

The ranking indexes (explained in section 5.3.1.) in Table 13 indicate the respondents' view of the importance of livestock activities to their livelihoods and/ or household income. In this case, the ranking was based on four livestock livelihood activities: sale of livestock, sale of livestock products, home consumption of livestock and livestock products, and socio-cultural functions. Home consumption of livestock and livestock products was ranked as the most important livestock activity in terms of its contribution to the livestock keepers' livelihoods/ income, irrespective of the wealth status of the households. The insignificant association between the livestock activities and wealth groupings (χ^2 = Chi^2=2.31, 3 df, P = 0.51) shows a general consensus among all the livestock keepers in regards to the importance of the livestock activities. It is evident that sale of livestock products, sale of livestock and socio-cultural functions of livestock, were ranked second, third and forth, respectively, among all the income groups.

Table 13: Ranking of Importance of Livestock Activities to households by Wealth Groups

Livestock Activities	**Wealth Groups**					
	Well-off (n = 101)		**Poor (n =102)**		**Pooled (All households) (n = 203)**	
	Households*	Ranking Index	Households*	Ranking Index	Households*	Ranking Index
Sale of livestock	3	0.22	2	0.21	5	0.22
Sale of livestock products	2	0.28	1	0.27	3	0.27
Home consumption of livestock and livestock products	96	0.40	99	0.40	195	
Socio-cultural functions e.g. ceremonies, dowry payments	0	0.10	0	0.12	0	0.11

Source: Primary data collected in this study

Note: * indicate households that ranked the activity as most important to livelihood/ income

This ranking gives an insight into the economic orientation of the pastoralist production system under study. With home consumption and sale of livestock products ranking high in terms of their importance to household livelihood/ income, the implication is that this production system exhibits a high subsistence orientation. The pastoralists seem to be keeping their livestock mainly for subsistence purposes and not for commercial purposes. These results concur with the findings of Njanja et al. (2003) whose results on utilization of livestock and their products indicate that milk for household use was ranked the most important product in the pastoralists' livelihood for subsistence while its sales and that of, meat, eggs, live animals, hides and skins contributed to the cash economy.

Section 4.4.3 highlighted the responses in terms of frequencies of the reasons and/ or purposes the respondents enumerated for keeping particular small ruminant breed categories[12]. The respondents only gave the main reason, for instance, all the buck categories were mainly considered for household income - sale in the market for cash and money equivalent trade while the doe and sheep categories were highly considered for home consumption in terms of provision of meat, milk and fats. The purposes and reasons given by the respondents for keeping particular breed categories is in adequate in understanding the small ruminant breed categories in the pastoral system. Further analysis of the small ruminants' contribution to livelihoods goes a long way in giving a detailed insight of the production systems and the livelihoods of the people. This analysis is explored in section 5.4.3 below.

5.4.2. Contributions to Livelihoods

The contributions of livestock, particularly small ruminants, to livelihoods, discussed in the subsequent subsections of this section include investment, income and nutrition.

5.4.2.1 Small Ruminant Contribution to Investment

The frequency cross-tabulation results presented in Table 14 depicts the relative importance of small ruminant categories and other livestock in terms of livestock investment. Livestock investment was measured in terms of perceived animal value by each household for a specific animal category and specie. The proportions of average contributions to investment in livestock all add up to 1, for instance, the proportion of all doe categories added together with all buck categories, sheep categories, cattle, and camel, all add up to 1.00 under any of the wealth

[12] refer to Table 3 of section 3.3 for elaborate information on breed categories

groups considered. This analysis was only carried out for households with at least some livestock in the year 2006. For more elaborate explanation of how the wealth groups were derived and details regarding the categories, refer to section 4.3.1.

Table 14: Average Contribution to Investment in Livestock (Percent)

Animal Classes	Wealth Group	Small Ruminant Categories				
		1	2	3	4	All (Pooled)
Does	Poor (n=102)	0.06	0.04	0.05	0.04	0.19
	Well-off (n=101)	0.04	0.02	0.02	0.02	0.10
	All wealth groups (n=203)	0.05	0.03	0.04	0.03	0.15
Bucks	Poor (n=102)	0.04	0.02	0.01	0.02	0.09
	Well-off (n=101)	0.03	0.01	0.01	0.01	0.06
	All wealth groups (n=203)	0.04	0.02	0.01	0.02	0.09
Sheep	Poor (n=102)	0.05	0.03	0.03	0.03	0.14
	Well-off (n=101)	0.04	0.01	0.02	0.01	0.08
	All wealth groups (n=203)	0.05	0.02	0.03	0.02	0.12
Cattle	Poor (n=102)					0.14
	Well-off (n=101)					0.16
	All wealth groups (n=203)					0.15
Camel	Poor (n=102)					0.41
	Well-off (n=101)					0.59
	All wealth groups (n=203)					0.50

Note: n is the number of observations

Generally, camels exhibit the leading average investment in all livestock with up to 50 percent of the total investment in livestock in all the wealth groups. This is followed by goats where does and bucks carry up to 15 and 9 percent respectively (totalling to 23 percent). Cattle carry a mean investment of 15 percent with sheep trailing at 12 percent. The mean investment in both camel and cattle increases as the economic status (wealth groups) increases from the poor to the well-off. The converse is seen in small ruminants where the contribution to investment is generally higher in the poor than in the well-off. This shows that the poor greatly depend on their small ruminant hence small ruminants can provide a likely pathway of intervention in the livelihood of poor livestock keepers.

The results in Table 14 shows that in all the wealth groups, the largest livestock investment in doe categories, was in category 1 followed by category 3. From section 4.3.4., doe category 3 was identified as the dominant category based on being kept in larger numbers compared to the other doe categories. Consequently, the results in here give an indication that though doe category 3 is kept in relatively high numbers, they are less valued than doe category 1. In other word, doe category 1 is the most valued category of does for the pastoralists. Generally, does contribute 15 percent of the total investment in all the pastoral households. Specifically, in the poor group, does contribute 19 percent while in the well-off group, 10 percent of the total investment in livestock.

In all the wealth groups, buck category 1 contributes the higher proportion of investment in livestock than all other buck categories. In section 4.3.4 buck category 1 was identified as the dominant category since it was found to the kept in relatively large numbers. The results here indicate that much as buck category 1 is kept in larger numbers, it is also the most valued among the buck categories kept. In all income groups and also in the poor group, bucks contribute 9 percent of the total investment in livestock while it contributes 6 percent in the well-off group. The relatively lower contribution of bucks to total livestock investment can be viewed to stem from the fact that bucks are often reared for the market (sales) hence households generally keep a lower proportion of bucks in the herd compared to does.

The same scenario as in does presents itself in sheep. In all the wealth groups, sheep category 1 contributes the highest proportion of sheep in livestock investment. Sheep category 2 in section 4.4.4 was identified as the dominant category. The results in here suggest that much as the sheep category 2 is the dominant category, it is less valued among the sheep categories. In all income groups, sheep contribute 12 percent of the total investment in livestock while it contributes 14 and 8 percent in the “poor” and “well-off” group respective.

5.4.2.2 Small Ruminant Contribution to Income: Sale of Livestock and Milk

As shown in Figure 5[13], in all the wealth groups, small ruminants lead in terms of their contribution to annual household income from sale of livestock. This analysis was only considered for household that sold at least some livestock in the reference period (May 2005 to May 2006). The proportions of average contributions to sale of livestock presented in Table 15,

[13] also see Table 25 in Appendix 1

all add up to 1 for instance the proportion of all doe categories added together with all buck categories, sheep categories and other livestock all add up to 1.00 under any of the wealth groups considered. "Poor" households seem to be benefiting most from the sale of small ruminants as they derive higher income from the sale as compared to the "well-off" households. Specifically looking at small ruminant classes (in this study – does, bucks, and sheep) versus other livestock, bucks contribute the highest income followed by other livestock then does and lastly sheep (not categorised by sex). A very high proportion of "poor" households' income from sale of livestock comes from bucks unlike the case of the "well-off" households whose highest proportion of income from the sale of livestock is derived from other livestock. Other livestock referred to in here include cattle, camel and to a minor extent, chicken. The later results are shown in Figure 6[14].

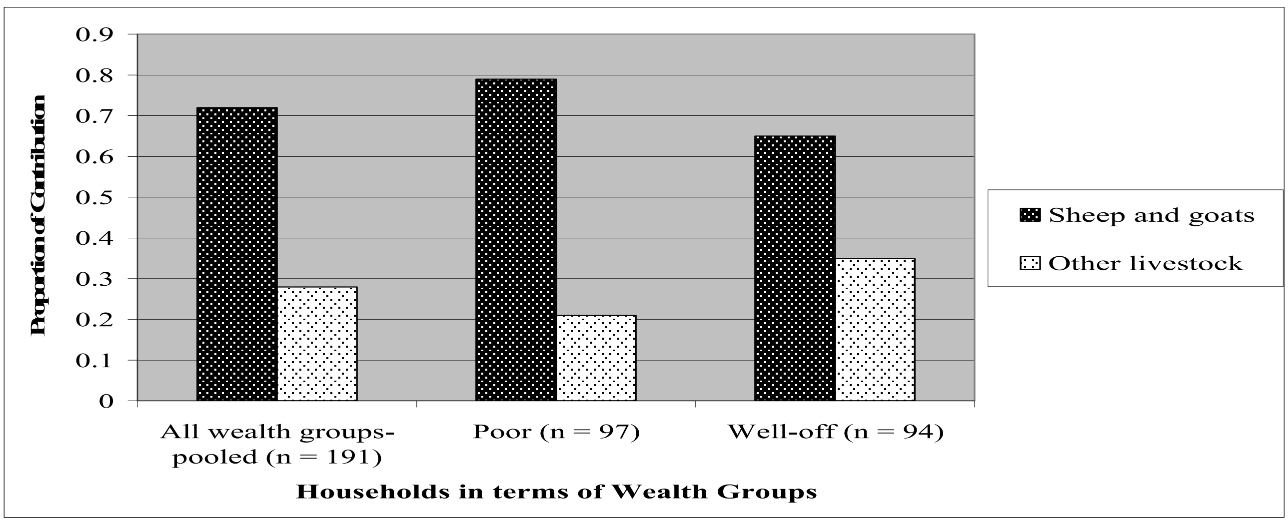

Figure 5: Average Proportion of Contribution of other Livestock versus Small Ruminants to Annual Income from Sale of Livestock

[14] also see Table 24 in Appendix 1

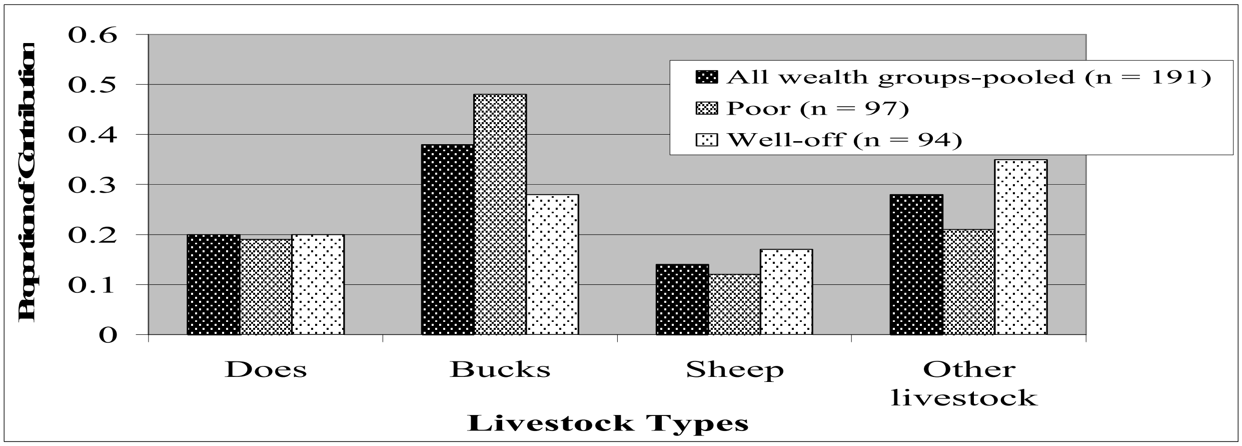

Figure 6: Average Proportion of Contribution of Small Ruminant Classes versus Other Livestock to Annual Income from Sale of Livestock

Table 15: Contribution to Annual Income from Sale of livestock

Animal Classes	Wealth Group	Small Ruminant Categories				
		1	2	3	4	All (pooled)
Does	Poor (n=97)	0.06	0.04	0.04	0.05	0.19
	Well-off (n=94)	0.06	0.05	0.04	0.05	0.20
	All – pooled (n=191)	0.06	0.05	0.04	0.05	0.20
Bucks	Poor (n=97)	0.24	0.07	0.10	0.07	0.48
	Well-off (n=94)	0.15	0.06	0.03	0.04	0.28
	All – pooled (n=191)	0.19	0.07	0.06	0.06	0.38
Sheep	Poor (n=97)	0.06	0.01	0.03	0.02	0.12
	Well-off (n=94)	0.07	0.02	0.04	0.04	0.17
	All – pooled (n=191)	0.06	0.02	0.03	0.03	0.14
Other livestock	Poor (n=97)					0.21
	Well-off (n=94)					0.35
	All – pooled (n=191)					0.28

The results presented in Figure 7[15] show that in terms of income from sales of milk, the contribution of goats is second, from camels. Though the contribution is less during the dry season compared to the wet season the general trend among all the income groups is that camel milk contributes highly to income from sale of milk followed by goats then cow milk. Sheep milk trails behind all the rest in contribution to income from sale of milk. In dry seasons, camel milk sales give higher contribution to total milk sale income than in wet season. Striking revelation here is that goats' milk contributes more to income for the poor in all the seasons. Again, the mean contributions to sale of milk, all add up to 1 for instance the proportion of all

[15] also see Table 28 in Appendix 1

goat, sheep, cow, and camel, all add up to 1.00 under any of the wealth groups considered. This analysis only considered households that sold at least some milk in the reference period (May 2005 to May 2006).

The contribution exemplified in here is commensurate to the contribution to total milk production summarized in Figure 8[16] which only considered households that at least produced some milk in the reference period (May 2005 to May 2006). In wet season, camel milk production is higher than in dry season in all wealth groups. For “poor” households, there is more goat milk produced in dry season than in wet season meaning that “poor” households depend more on goat milk in dry season than wet season. The variation in contributions shown here indicates that the pastoralists depend more on income from goats and sheep milk during the dry season. These results concur with FAO (1990) which states that the camel is an important source of milk in arid and semi-arid areas while sheep and goats are often kept for their meat but can be important for milk in the dry season.

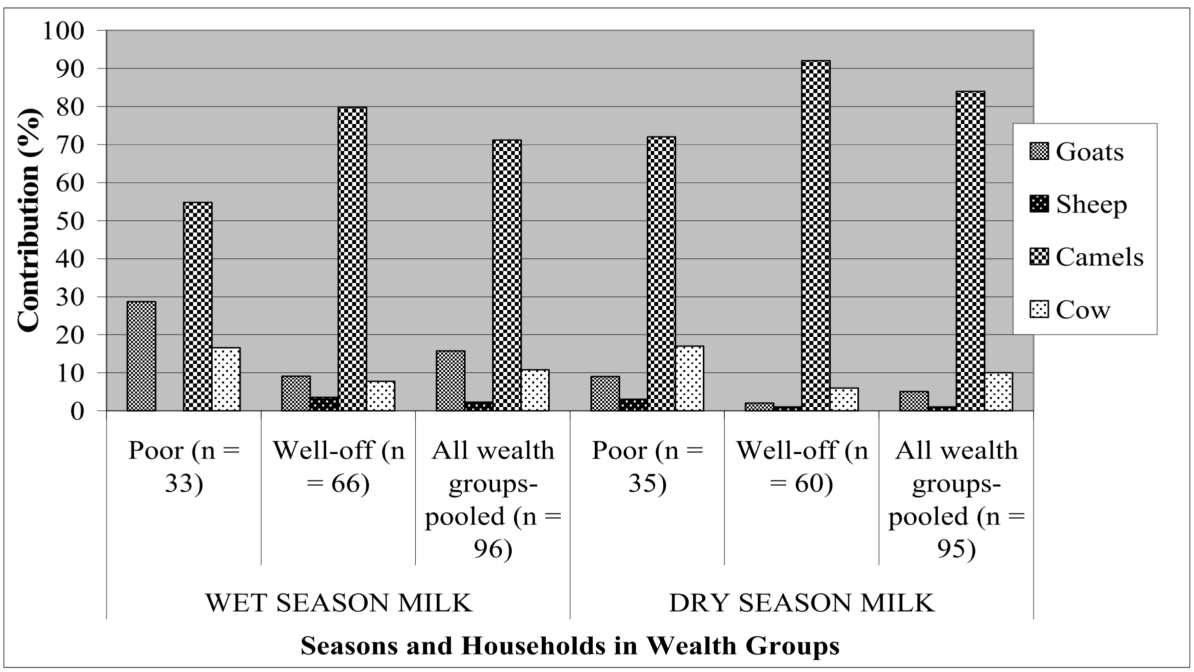

Figure 7: Mean Contribution to Household Income from Daily Milk Sales (Percentage)

[16] also Table 27 in Appendix 1

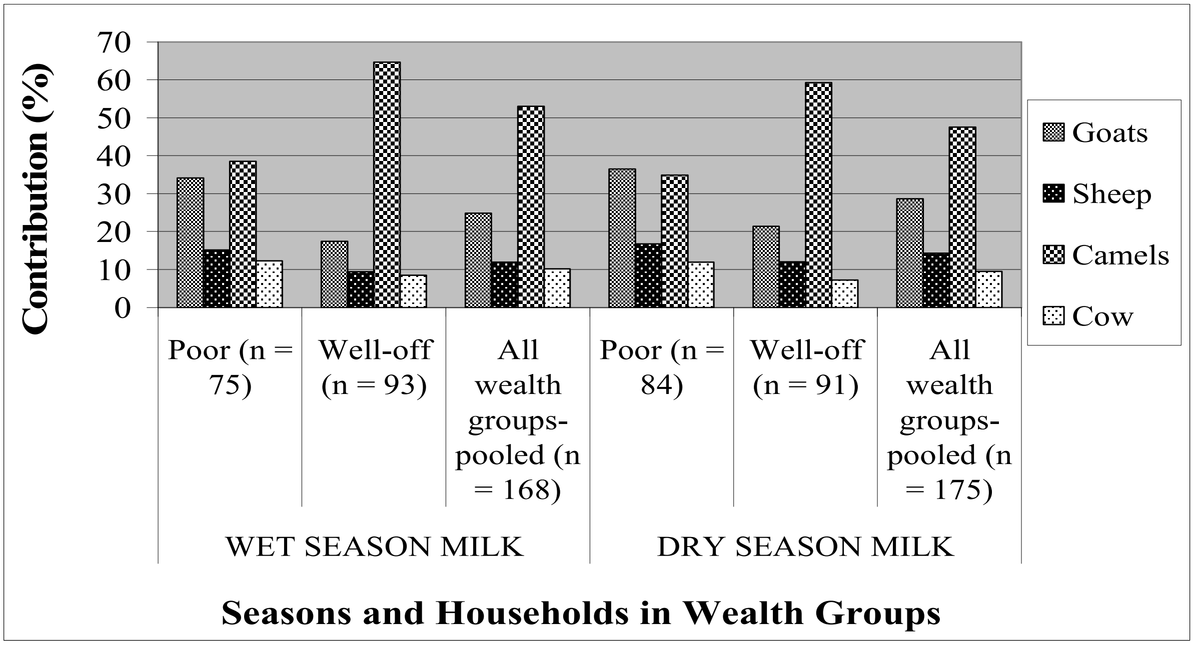

Figure 8: Mean Contribution to Household Daily Milk Production (Percentage)

5.4.3.2. Small Ruminant Contribution to Nutrition

The contribution of small ruminant to household nutrition is reviewed in terms of milk and meat consumption. The results presented in Figure 9[17] considered households that at least produced some milk in the reference period (May 2005 to May 2006) since the consumption of milk in here is only related to the consumption of own farm produced milk. Though camel milk contributes the highest daily household milk consumption in wet season, it is evident as shown in that the contribution of goat milk is not only second to camel considering the pooled wealth group across all the seasons but also outperforms camel milk's contribution to daily household milk consumption in poor household during the dry season. In other words, goat milk contributes the most in poor households' nutrition through milk consumption during the dry season.

[17] Also presented in Table 29 in Appendix 1

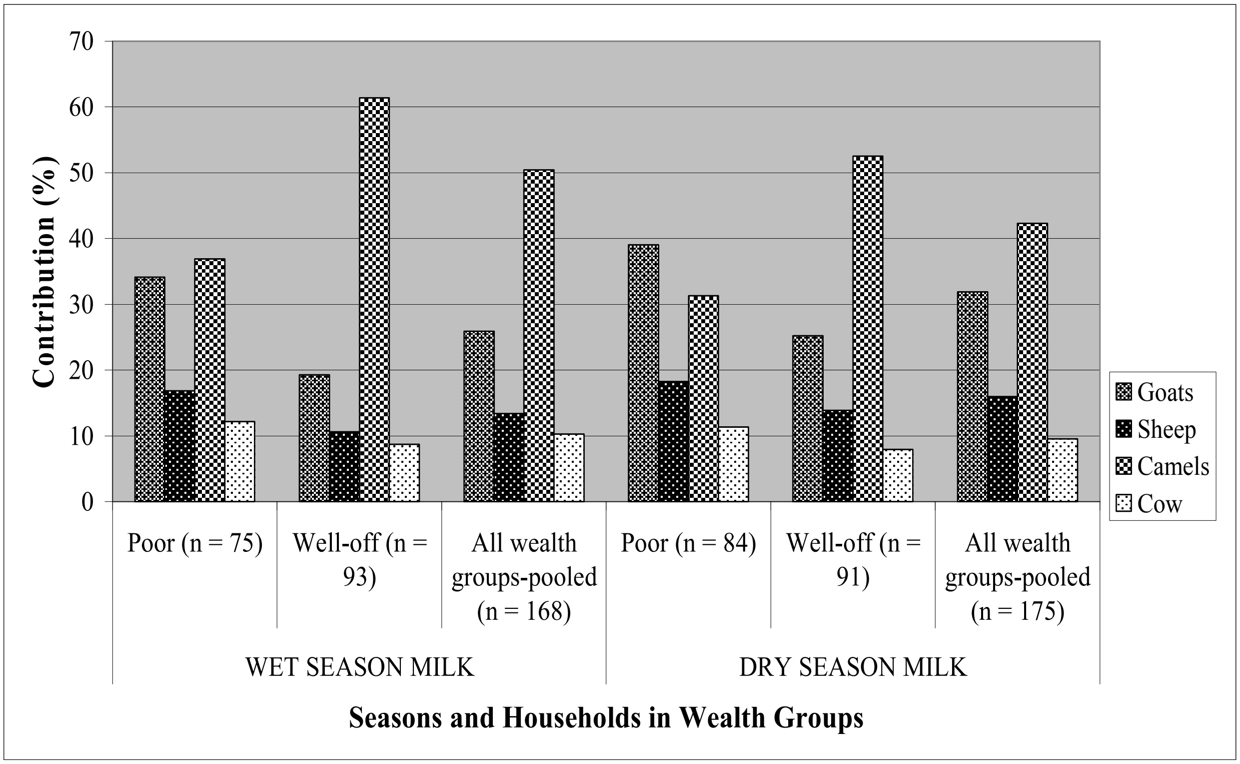

Figure 9: Mean Contribution to Household Daily Milk Consumption (%)

Figure 10[18] shows the average annual consumption of small ruminant meat in terms of the slaughter for household consumption of the different small ruminant categories described as kept by each household interviewed. The households were asked to recall, under each category, how many animals had been slaughtered for the purpose of household consumption within a period of 1 year before the survey. Out of the 203 households interviewed, 72 did not slaughter any small ruminant during the period of consideration. Data from the remaining 131 household was used in the analysis presented below in both Figure 10 and Table A31. Poor households slaughtered more of doe category 2 than the other doe categories. The well-off household show the same level in terms of numbers of the categories slaughtered but generally, the poor consumed less than the well-of in terms of the doe categories slaughtered. This is also true for bucks and sheep where the well-of show a higher number of animals slaughtered than the poor. The “well-off” consumed more of buck category 1 and 4 and sheep category 1 than the rest of the respective categories while the poor had the same level of consumption for all the categories of buck and sheep. The indication that the poor consumed more sheep than either does or buck stems from the fact that sheep was lumped together in terms of their sexes unlike goats.

[18] elaborated in Table 30 in Appendix 1

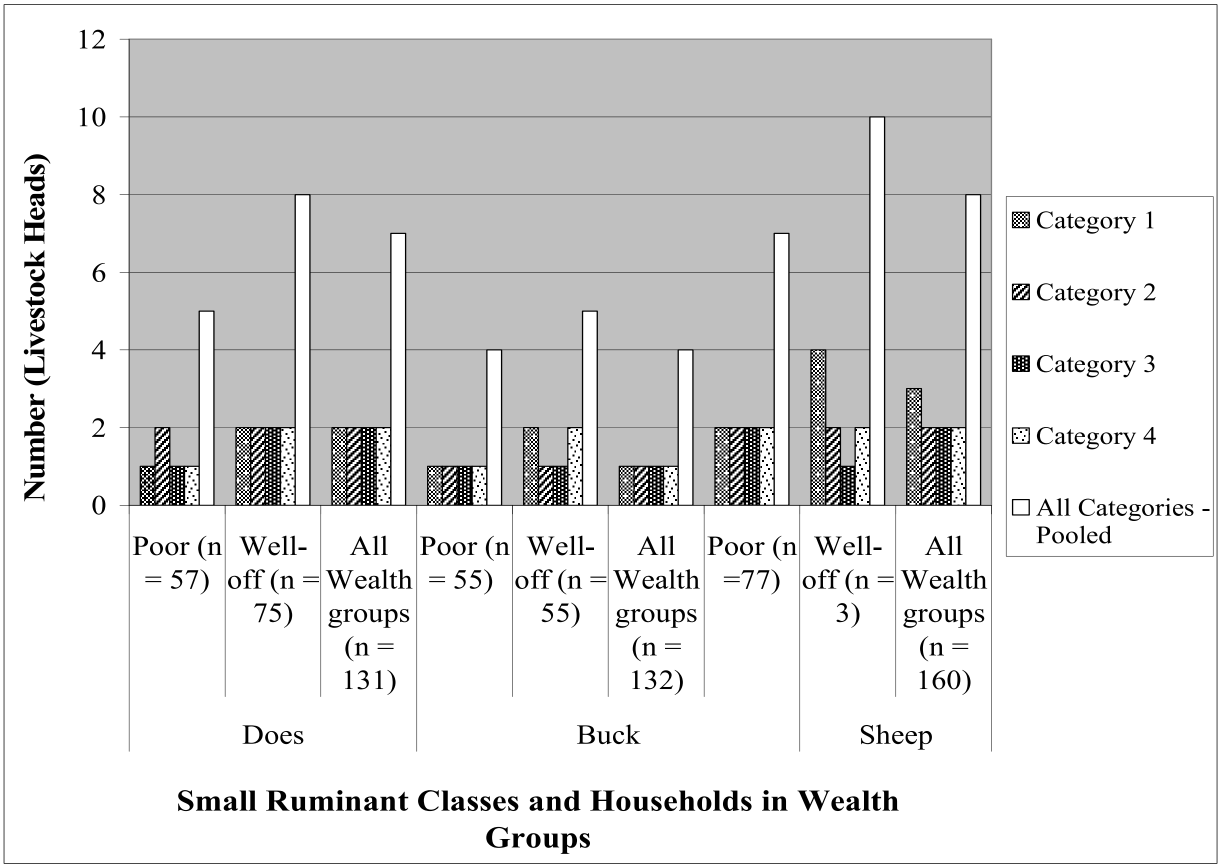

Figure 10: Contribution to Meat Consumption (Numbers Slaughtered in a Period of 1 Year)

5.4.3. Contributions to Livelihoods versus Herd sizes

This sub-section tries to explore the relationship between the levels of contribution and respective herd sized of each of the breed categories considered in the study. The average contributions were obtained from previous results (Table 14 under all wealth group considerations for contribution to investments; Figure 10 (also Table A31 in Appendix 1) for the numbers of slaughter; Table 15 under 'All-pooled' considerations for contribution to income from livestock sales). These have been tabulated in here (Table 16) along with the average herd sized in 2005 and 2006 (data at the beginning of the reference period (2005) and at the end of the reference period (2006)). The two periods were considered because the analysis for the contributions to livelihoods covered a span of a whole year.

Table 16: Average Contribution (in Proportions) and Average Herd Sizes

Animal Classes	Source of Contribution	Means (statistics)	Animal Categories 1	2	3	4
Does	Income from animal sales	Average Contribution	0.06	0.05	0.04	0.15
		Average Herd Size in 2005	18	21	21	17
		Average Herd Size in 2006	5	5	6	5
	Nutrition (numbers Slaughtered)	Average Contribution	2	2	2	2
		Average Herd Size in 2005	19	23	23	19
		Average Herd Size in 2006	6	6	6	5
	Investment	Average Contribution	0.05	0.03	0.04	0.03
		Average Herd Size in 2005	18	21	21	17
		Average Herd Size in 2006	5	5	6	5
Bucks	Income from animal sales	Average Contribution	0.19	0.07	0.06	0.06
		Average Herd Size in 2005	11	10	8	8
		Average Herd Size in 2006	3	2	2	2
	Nutrition (numbers Slaughtered)	Average Contribution	1	1	1	1
		Average Herd Size in 2005	13	12	9	9
		Average Herd Size in 2006	4	3	2	2
	Investment	Average Contribution	0.04	0.02	0.01	0.02
		Average Herd Size in 2005	11	10	8	8
		Average Herd Size in 2006	3	2	2	2
Sheep	Income from animal sales	Average Contribution	0.06	0.02	0.03	0.03
		Average Herd Size in 2005	19	20	15	15
		Average Herd Size in 2006	6	4	5	4
	Nutrition (numbers Slaughtered)	Average Contribution	3	2	2	2
		Average Herd Size in 2005	20	21	15	16
		Average Herd Size in 2006	6	5	5	4
	Investment	Average Contribution	0.05	0.02	0.03	0.02
		Average Herd Size in 2005	19	20	15	15
		Average Herd Size in 2006	6	4	5	4

The contribution of milk to household nutrition and income was not considered here since it was not possible to allocate milk production to the different breed categories under study. The results presented in Table 16 do not indicate any consistent trends between the contributions to livelihoods and herd sizes of the different breed categories. Though one would expect, for instance, that the more animals one has, the more he/she is able to sell and gain income from the sales, such a scenario is not been clearly evident here. This could be attributed to several issues that interplay within household decisions and livestock management such as herd replacement through births, which could not possibly be captured under this study. However, the analysis of livestock livelihood functions and the relationship between livestock asset holding and household vulnerability, presented in sections 5.4.5 and 5.4.6 gives a better picture of the scenario.

5.4.5. Livestock Livelihood Functions

Data on the functions of different livestock species kept by each household interviewed was analysed by the calculation of ranking indices (elaborated in section 5.3.1.). This involved a ranking exercise for the different livestock livelihood functions captured in the questionnaires. In this case, indices represent weighted averages of all rankings of livestock livelihood functions. Ranks were based on the all the six livestock species found in the study areas (sheep, goats, camels cattle, donkey and chicken). Where a particular respondent did not own a particular species, the rank would be 'zero' and consequently a 'zero' weight was attached.

Table 17 presents the results of the ranking of important livestock species in fulfilling particular livelihood functions. Apart from transport and social functions where camel and donkey, and camel and cattle, respectively, were considered the most important species, goats followed by sheep were considered to be the most important livestock species in fulfilling all the other livelihood functions. There was a significant association between the livelihood functions and livestock species (χ^2 =6756.44, 30 df, $P < 0.00$).

Table 17: Importance of Livestock species in Fulfilling Particular Livelihood Functions

Function	Species/ Ranking Indices					
	Sheep	Goats	Cattle	Camel	Donkey	Chicken
Consumption	0.31	0.32	0.20	0.16	0.00	0.01
Income	0.27	0.33	0.20	0.16	0.04	0.01
Buffering	0.25	0.31	0.22	0.17	0.04	0.01
Insurance	0.25	0.31	0.21	0.17	0.04	0.01
Transport	0.00	0.00	0.10	0.48	0.43	0.00
Social	0.19	0.23	0.24	0.29	0.04	0.01
Accumulation	0.30	0.28	0.20	0.16	0.06	0.01

Chi^2=6756.44, 30 df, P < 0.00

5.4.5.1. Rating of Income from Sheep and Goats

From the data collected, among the respondents who fall within the "well-off" group of households, 82 per cent rated their income from sheep and goats as unsatisfactory while 15 percent felt the income was very inadequate. Only about 3 percent felt it was satisfactory. Seventy eight percent of those falling within the "poor" group of households felt that their income from sheep and goats was unsatisfactory. The major reason the respondents gave for their rating (as presented in Table 18) is lack of market and market information.

Table 18: Frequencies of Sheep and Goats' Income Rating (Percent)

Sheep and Goat Income Rating	Poor (n = 102)	Well-off (n = 101)	All (n = 203)
Very satisfactory	1.19	0	0.50
Satisfactory	0	2.97	1.49
Unsatisfactory	78.22	82.18	80.20
Very inadequate	20.59	14.85	17.82
Total	100	100	100
Reasons for Sheep and Goats' Income Rating			
Lack of good breeds	22.25	9.90	16.26
Lack of good husbandry skills	26.47	13.86	20.20
Lack of market/ market information	33.33	38.61	35.96
Others (e.g. drought effects)	17.65	37.62	27.49

5.4.6. Asset Holding and the Associated Relationship with Household Vulnerability

Having seen the importance of small ruminants to pastoral livelihoods arising from income, investment and nutrition, this chapter would not be complete without exploring the relationship the holding of livestock assets and household vulnerability. Household vulnerability in here is indicated by the economic status of the households where "well-off" households are considered less vulnerable to livelihood shocks such as drought and deaths of livestock as compared to "poor" households. In this analysis, household self assessment of their economic status, whether "well-off", "not so poor", "poor" or "poorest", was used as opposed to the wealth grouping that has been used in other parts of this chapter. The thresholds used in Table 19 to classify the asset holdings as either high or low do not reflect a particular bench mark, rather, a measure of relativity considering the data results in question

Table 19: Asset Holdings and Attributes by Well-Being Ranking for Marsabit Pastoralists

Asset Type		Well-being Ranking (Economic Status Groupings) and Asset Holding			
		Well-off	**Not so poor**	**Poor**	**Poorest**
Natural Capital	Cattle	High	Moderate	Low	Lowest
	Camels	High	Moderate	Low	Lowest
	Donkey	Moderate	Moderate	Low	Lowest
	Sheep	High	Moderate	Low	Lowest
	Goat	High	Moderate	Low	Lowest
Physical Capital	Radio	Mod.	Moderate	Low	None
	Solar panel	None	Moderate	None	None
	Battery	None	Moderate	None	None
	Wheel Barrow	High	Moderate	Lowest	None
	Television	None	Moderate	None	None
	Mobile Phone	High	Low	None	None

The results exemplified in Table 19 show that the "well-off" hold high levels of natural capital (in terms of livestock) and the holding decreases as the income status decrease from "well-off" to "poor". The same scenario is seen with the holding of physical assets. With higher household economic status (less vulnerability), asset holding is also high. This exhibits a positive relationship between well-being status and asset holding. These findings are similar to those of

Dorward et al. (2001) which show that the value of asset portfolio and the range of assets held decreases as one moves down the well-being status from well-off to the poorest.

5.5. Conclusion

Several key points that have emerged in this chapter include the subsistence nature of pastoral production and lack of market and market information. Small ruminants have been seen to contribute greatly toward the livelihoods of pastoralist and especially the poor who are more vulnerable to livelihood shocks such as drought which seem to be recurrent phenomena in the area. Though development of markets is, however, limited by factors such as remoteness of the area and poor road infrastructure (Njanja et al., 2003), there are several avenues that could be explored in order to improve the livelihoods of the poor pastoral livestock keepers.

According to World Bank, (2000), there is increasing recognition that vulnerability to shocks is one of the defining characteristics of poverty. In addition, there is growing recognition of the influence household asset endowments have on poverty dynamics (Zimmerman and Carter, 2003; Carter and May, 2001). Having identified that there exists, positive relationship between well-being status and asset holding, with sheep and goats contributing significantly to their livelihoods, a focus on proper utilization and management of these breeds would go along way in achieving the objective of improving the livelihoods of the poor livestock-keepers. This can be done by targeting both governmental and development agencies policies and efforts toward encouraging and building the communities' capacities toward conservation and proper utilization of their livestock. Making of such policies and incentive structure would require information on the economics of these SRGR for instance, the values of these genetic resources and traits of importance to the pastoralists. Chapter six proceeds to give insight to the value system and traits of importance to the pastoralist.

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CHAPTER SIX

PRODUCER PREFERENCES AND VALUATION OF SMALL RUMINANT NON-MARKET TRAITS

6.1. Introduction

Of all the forms of biodiversity, the one that is most important to humankind is probably that upon which it relies for food. The conservation and correct assessment of existing biodiversity of plants and animals employed in agriculture is paramount for sustainable development. The management of AnGR require many decisions that would be easier to make if information on economic value of populations (e.g. breeds), traits and processes for instance, alternative breeding and/ or conservation programmes, were available. Preferences regarding phenotypic attributes of livestock differ across regions, countries, communities and production systems. Most valuable livestock attributes are often those that successfully guarantee multifunctionality, flexibility and resilience in order to deal with variable environmental conditions, in developing countries where important functions are embedded in traits that are not traded in the market (Scarpa et al., 2003a).

Considering the importance of indigenous AnGR, particularly in developing countries, and their endangered status, there is an urgent need to develop strategies for the conservation and sustainable management of these resources. The analysis of the emerging intensified animal production eco-systems and the valuation of AnGRs in less favourable environments are the first steps to conservation and utilization (Wolly, 2003). The economic valuation of AnGRs could contribute to this need by providing a basis for decision-making and could provide important inputs into priority setting and policy formulation. For instance, information on the economic values of populations (e.g. breeds) or traits could help determine incentive structures that may need to be put in place to conserve threatened or endangered breeds that may not be supported by market forces, but which play an important role in the sustainability of farming systems (Ruto et al. 2008). With the detrimental recurrent droughts, the most recent having occurred from December 2005 to April/ May 2006 in East Africa and to which 80 percent of the animals fell prey, exposing the high demand and prospect for sound conservation and restocking management, coming up with "fair" monetary values for livestock breeds might also guide policymakers in drought periods (Zander, 2006). The knowledge of the most valued traits from the derivation of the producers' monetary values of the traits gives an easier, efficient and effective way to restocking, a livelihood recovery strategy after natural calamities such as droughts, by resultantly seeking to provide to the livestock keepers, animals that match their trait preferences.

Since most of the benefits produced by local livestock in marginal production systems are captured by producers, as a consequence, the genetic resources of breeds have been shaped by producers' preferences. In these (marginal) areas where livestock performance is valued by producers, but assessed mostly in non-market terms, research must therefore turn to the identification and characterisation of these preferences in order to identify implicit values of the genetically determined traits as a first approximation to the value of indigenous AnGRs (Scarpa, 2003b). The question on the values attached to specific non-marketed traits of small ruminant would be very pertinent when considering involving livestock keepers in conservation and sustainable use of existing small ruminant diversity while at the same time ensuring that their livelihood is taken care of. Moreover, lack of data on the values of indigenous AnGRs contributes to the undervaluation of the values and as a result, the erosion of biodiversity (Rege and Gibson, 2003; Wollny, 2003) which should not be the case considering the importance of indigenous AnGRs to livelihoods.

As earlier stated, livestock genetic resources underlie the productivity of local agricultural systems and also provide a resource of genetic variation that can be exploited to provide continued improvements in adaptation and productivity. They also provide important gene pool for future use and a conduit for overcoming unseen catastrophes yet genetic erosion, a gradual process from loosing traits (or the diversity within the breed), is of particular concern because of its implications for the sustainability of locally adapted agricultural practices and the consequent impact on food supply and security. Though biodiversity loss pathways are many and include population pressures, ecological changes, natural catastrophes and adverse economic conditions, the value of an attribute to the households may play a lead role in influencing the producer responses that may lead into either loss or conservation of AnGR. Knowledge on associated factors that influence AnGRs values is limited just as much as the role of the market. In bid to determining possible factors that are likely to explain erosion of biodiversity, this study aims at deriving the economic values of small ruminant traits in the pastoral production system in Kenya through the assessment of small ruminant trait preferences.

6.2. Literature

There is increasing global concern about the potential long term consequences of the loss of domestic animal biodiversity. Of particular interest is the situation in developing countries where on one hand, livestock make the greatest contribution to human livelihoods while on the other, genetic erosion has placed important indigenous breeds at risk of extinction (Ruto et al. 2008). The Convention on Biological Diversity is encouraging a series of actions aimed at supporting or promoting conservation, sustainable use and fair and equitable sharing of the benefits arising from the use of genetic resources. Economic valuation of these AnGR would improve decision making regarding their conservation and sustainable utilization (Mendelsohn, 2003; Rege and Gibson, 2003) and thereby necessitating the assessment of economic value of biological diversity, particularly of biological resources important for livelihood (Scarpa et al., 2003a).

Farmers' knowledge about specific attributes of different breeds under local conditions can help to focus scientific research on particular traits and identify needs for further farmer education through extension programmes. It can also help to determine incentives that may need to be put in place for farmers to be involved in the conservation of threatened or endangered breeds that may not be supported by market forces (Jabbar and Diedhiou, 2003). Valuation can guide resource allocation among biodiversity conservation and other socially valuable endeavours, as well as between various types of genetic resource conservation, research and development. It can also assist in the design of economic incentives and institutional arrangements for farmers, genetic resource managers and breeders (Drucker et al., 2001).

According to Kosgey (2004), in pastoral communities where both individual and livestock survival is crucial, survival traits[19] and reproductive traits[20] are held important. In his results, a range of traits; growth rate, size, shape, drought tolerance, meat quality, fertility, disease and heat resistance, prolificacy and temperament were all considered important for both sheep and goats in both pastoral and smallholder systems.

[19] E. g., pre-weaning, post-weaning and adult animal traits
[20] E. g., litter size and lambing frequency

6.3. Research Methodology: The Choice Experiment Technique

The theoretical framework of the random utility model formed the basis of valuation of non-market traits using CE. The kind of methods used and data collected to be analyzed by employing the theoretical framework of random utility models (Anderson et al., 1992) are explained in subsequent sections in here.

6.3.1. Traits for the Choice Experiment

The decision on which traits to include in the choice model and hence valuation was systematic. First, a review of the available literature was done to get a feel of the kind of traits that could be of importance to a livestock keeper. This resulted into a list of 11 traits for both sheep and goats, that were then included in the pre-test questionnaire administered during the reconnaissance study. Previous characterization study, which is part of the overall project that supported this study, collected information on the breed performance and adaptation types in the study area. This included data on important traits that were collected using some consultative participatory processes. The processes included key informants, semi-structured interviews and community-based meetings with a final confirmation of the traits with the livestock keepers themselves through two feedback seminars in September 2005, having more than 30 livestock keepers in attendance (personal communication with Mr. Harun Warui on the characterization studying being carried out in the area). Both the information from the feedback seminars and the pre-test formed the basis of selection of the traits which were included in the choice experiment (Table 20).

The choice tasks are usually designed to elicit the trade-offs that individuals make between traits and to facilitate estimation of values for each trait (Ouma et al., 2005). The attributes were chosen so as to reflect a set of relevant breed-related small ruminant rearing traits. A total of nine traits were considered for this study. Unlike the previous chapters where the animals were classified in terms of categories based on the mixes of traits and their levels, in this chapter the animals were classified in terms of species (either sheep or goat) and also in terms of sexes (either male or female). Consequently, three small ruminant classes were considered; doe (female goat), buck (male goat) and ram (male sheep), each having 5 traits assessed.

Table 20: Traits Considered in the Choice Experiments

Aggregate Trait	Focus trait	Animal class(s) considered	Levels
Milk Production	Milk sufficiency	Doe	1. Sufficient for the kid only 2. Sufficient for the household (owner) and kid - < half a cup per milking per day in wet season 3. Sufficient for the household (owner) and kid - ≥ half a cup per milking per day in wet season
Health	Health status	Doe, Buck, Rams	1. Never gets ill in the rainy season 2. Gets ill at least once in the rainy season
Prolificacy/ fertility	Kidding rate	Doe	1. 3 times of kidding in a period of 2 normal years 2. 2 or less times of kidding in a period of 2 normal years
Drought tolerance	Body condition during the dry season	Doe, Buck, Rams	1. Strong/good (*pin bones and ribs not outstandingly visible*) 2. Weak/poor (*bony with very conspicuous ribs*)
Market value	Purchase Price at the age of 3 years	Doe, Buck, Rams	Doe: 1.Kshs. 1500 2.Kshs. 1100 3.Kshs. 700 Buck: 1. Kshs. 2000 2. Kshs. 1400 3. Kshs. 800 Ram: 1. Kshs. 2000 2. Kshs. 1350 3. Kshs. 700
Body size	Standing height (relative measure amongst bucks in the flock)	Buck	1. Tall 2. Short
Strength/ Meatiness	Overall body condition	Buck	1. Strong (meaty/body full) 2. Weak (less meaty/loose body)
Rump conformation (fat deposits)	Rump shape and size	Ram	1. Big round and erect/raised towards the rear end 2. Small and sloping downwards towards the rear end
Fatness	Fat deposition	Ram	1. Body full of fat (mainly around ribs, brisket/breast, belly) 2. Body not full of fat

1. Milk production: Milk production, a performance trait, was found as one of the important trait especially in goats. From the pastoralists' view, "milk sufficiency" was used as a focus trait, proxy indicator for milk production. This was done so as to quantify production traits in terms of measurement which would be well understood by respondents. This trait was only considered for doe.
2. Health status: An indicator for general health (disease resistance) was used in terms of frequency of illness in an average rainy season: Disease resistance is an important attribute

in rearing all domestic animals. The focus was on the rainy seasons since this was the period when most diseases occur. This trait was considered for all the three animal classes.

3. Prolificacy/ fertility: A performance trait that was used in terms of kidding rate. The trait was only considered for doe.
4. Drought tolerance: This appeared as an important trait based on the harsh environmental conditions and the frequent droughts in the study area. The indicator trait here (for the purpose of better understanding and communication with the pastoralists) was “condition of the body in dry season”. This is an attribute that assesses the drought tolerance trait in the perspective of the pastoralists under study. It varied from weak to strong (as indicated by the pastoralists) where a weak animal was described as bony (pin bones, ribs very conspicuous) as opposed to strong animal where pin bones and ribs are not outstandingly visible. The trait did cut across all the three classes of small ruminants considered in this study.
5. Market value: Purchase price was used as a proxy indicator for the market value. The idea was to measure the importance a small ruminant producer would attach to the market value of a particular type of an animal. Though most producers sell more than they buy, purchase price was used and not sales price since being a post drought study, the presentation of the situation, of buying, would make sense for the pastoralists after having lost their animals to drought. The prices used to develop price levels for the profiles were based on realistic price bands that existed in the markets in the study area and varied in different animal categories for the CE. This value was considered since it was an important factor in establishing the marginal contributions hence the economic values of non-market traits. The prices were set at a particular age where most pastoralists would consider a market transaction.
6. Body size: This trait was considered for only bucks in terms of standing height (a relative measure amongst bucks in the flock). The trait was considered at two levels; tall and short.
7. Fatness: Also considered for rams only and expressed in terms of fat deposition i.e. whether or not the body is full of fat deposits.
8. Body conformation: This is a trait that described the shape of the animals as opposed to body size, that would otherwise be measurable in terms of weight, for instance, in kilograms. This trait was considered, from the pastoralists’ perspective, in terms of two traits; overall body condition for bucks and rump shape and size for sheep. Overall body condition indicated strength or meatiness where a strong buck was described as one with a full or meaty body as

opposed to a weak animal with loose body (less meatiness). Rump conformation in sheep had two levels; big rump that is round and erect/ raised towards the rear end, and small rump that is sloping downwards towards the rear end

The CE focused on rams (male sheep) since the trait considered would have been similar if also considered for ewes (female sheep). Moreover, rams would better represent both the producer and market situations since its mostly male animals that are marketed.

6.3.2. Choice Experimental Design

Since in normal circumstances, a livestock keeper, in choosing to keep a particular breed of domestic animals, makes trade-off between the different traits embedded in a particular breed or variants within the breed, it was necessary to develop profiles with a combination of the traits for each animal class, which can then be presented to respondents. Each animal class had 4 traits plus a market value. For does, price and milk sufficiency attributes at 3 levels and the rest at 2 levels, would result in ($3^2 * 2^3$) 72 combinations of the traits. For bucks and rams, price at 3 levels and the rest at 2 levels each, would result in ($3^1 * 2^4$) 48 combinations. A choice task from such a wide number of profiles would be a real challenge for the respondents to rank or score in a meaningful way (e.g. Bateman et al., 2003). Therefore, fractional factorial designs were constructed to limit the total number of profiles in the analysis, while the main effects and first order interaction effects can still be estimated independently. To achieve a randomized selection of the profiles (Ouma et al., 2007), the number of profiles was reduced to a manageable size using an orthogonal or fractional factorial design (see Hensher et al., 2005; Bateman et al., ibid; Louviere et al., 2000) which treated all attributes as independent and precluded collinearity between them in an empirical model (Mackenzie, 1993). The fractional design in SAS statistical package (Kuhfeld, 2003), resulted in a randomized selection of 18 animal profiles for does, and 12 each for both bucks and rams. These animal profiles were further blocked into pairs of two and an opt-out alternative was added. These two profiles and together with the opt-out alternative, that prevents respondents from being forced to make a choice which could bias the results (Banzhaf et al 2001), were considered a choice set. Six choice sets per animal were presented to each respondent for choosing. Respondents were required to choose an animal profile that they would prefer to buy for rearing from the two profiles presented for each choice task. If neither of the two were found satisfactory, the respondents were allowed to choose the opt-out (or "zero") option to state that they preferred neither.

Each profile was shown in the form of a card representing a hypothetical breed that was described in terms of the levels of traits included in the experimental design (Tano et al., 2003). Following Tano et al. (ibid) and Ouma et al. (2007), cards with pictorial representations of the differences in the levels of traits were used to demonstrate each small ruminant trait profile to survey respondent (an example of the cards is found in Appendix 2). The advantage of pictorial presentations is that they help respondents to process the information, thereby facilitating the interpretation and choice of the profile (Green and Srinivasan, 1978).

Choice data was collected from 314 respondents on the choice sets presented to them. In addition, household socio-economic data was collected. These included household size, head's gender, education and social responsibilities, household non-farm income, herd sizes and household assets. NLOGIT version 3.0 was used to manage data where both MNL and RPL models were explored following conjoint CE technique to value the specific non-marketed traits of small ruminant[21].

6.4. Empirical Results and Discussion

The empirical results presented in subsequent subsections of this section are results of modelling data using discrete choice models based on the CE methodology. Section 6.3.1 presents the results of the basic MNL models while section 6.3.2 presents an extension of the basic MNL models towards modelling heterogeneity in preferences using RPL models. The MNL and RPL models were estimated in NLOGIT 3.0 (Greene, 2002).

6.4.1. Results of the Basic MNL Model

The maximum likelihood parameter estimates from the MNL model are presented in Table 21. With 2-3 levels for each trait, one level was left out during estimation, as the 'status-quo' (or the comparison group) in order to achieve welfare measures that are consistent with demand theory (Bateman et al., 2003). The models' overall explanatory powers are good with a pseudo-R^2 ranging between 0.3 and 0.5. The parameters estimated by the model are strongly significant ($\rho < 0.01$) and exhibit the expected signs except bucks model where the coefficient for price attribute in Gabra region is insignificant; possess a positive sign for Rendille and whole

[21] objective 2

region; and significant at $\rho < 0.05$ for the whole region. The coefficient for standing height for Rendille region is significant at $\rho < 0.05$.

Table 21: Maximum Likelihood Estimates for Traits according to Production System

(Dependent variable = Choice of Animal Profile)

Attributes (Traits)	**Production Systems/ Animal classes**								
	Does			**Bucks**			**Rams**		
	Gabra	**Rendille**	**Pooled**	**Gabra**	**Rendille**	**Pooled**	**Gabra**	**Rendille**	**Pooled**
B.C	0.44 (0.06)**	0.37 (0.06)**	0.39 (0.04)**	0.79 (0.09)**	0.88 (0.11)**	0.80 (0.07) **	0.95 (0.11)**	0.54 (0.10)**	0.72 (0.07)**
H.S	0.71 (0.06)**	0.90 (0.07)**	0.76 (0.04)**	0.93 (0.12)**	1.00(0.13)**	0.92 (0.08)**	1.03 (0.11)**	1.20 (0.11)**	1.10 (0.08)**
PRICE	-0.4e-3(0.1e-3)**	-0.9 e-3 (0.2 e-3)**	-0.7 e-3 (0.1 e-3)**	-0.3e-3 (0.2e-3)	0.1e-2 (0.2e-3)**	0.3e-3 (0.1e-3)*	-0.1e-2(0.2e-3)**	-0.5e-3 (0.2e-3)**	-0.7e-3 (0.1e-3)**
K.R.	0.38 (0.06)**	0.83 (0.09)**	0.56 (0.05)**						
Milk (> 1/2 cup)	Not significant	0.54 (0.16)**	Not significant						
Milk (Kid only)	-0.82 (0.11)**	-0.47 (0.17)**	-0.80 (0.08)**						
O.B.C				0.22 (0.08)**	0.47 (0.09)**	0.31 (0.06)**			
Standing height				0.20 (0.07)**	0.19 (0.09)*	0.20 (0.06)**			
Rump							0.37 (0.11)**	0.45 (0.10)**	0.39 (0.07)**
Fat deposition							0.53 (0.12)**	0.59 (0.12)**	0.56 (0.08)**
n	936	900	1836	468		942	468	474	942
Log-likeliood	-470.45	-409.34	-899.91	-194.18		-370.60	-176.01	-189.46	-374.58
Pseudo-R^2	0.27	0.34	0.29	0.40		0.43	0.46	0.42	0.42

Note: **, * indicate that coefficients are statistically significant at 1% and 5% levels, respectively, using P-values in maximum likelihood estimation. Robust standard errors are indicated in parenthesis.

K.R= Kidding rate; H.S=Health status; PRICE=Price at the age of 3 years; B.C =Body condition in dry season; Milk (Kid only)=Milk sufficient for kid only; =Overall body condition; Milk (> 1/2 cup)=Milk sufficiency-> 1/2 cup/ day in wet season; Rump=Rump shape and size

The traits which bear positive utility (influence) on the choice of a doe for the Gabra pastoralists are "health status", "drought tolerance" and "kidding rate". This implies that disease resistance, drought tolerance (animal's "body condition during the dry season") and prolificacy ("kidding rate") within the herds are of prime concern for the Gabra pastoralists. Out of the three levels of milk sufficiency attribute, "sufficient for kid and household (greater than half a cup per day in wet season)" was dropped from the Gabra and whole region models for does since it was found to be insignificant at 5 percent level, signifying no difference in utility of this level from the 'status quo'/ 'comparison group' of "sufficiency to kid and household (less than or equal to half a cup per day in dry season)". "Milk sufficiency for kid only", bears a negative utility on the choice of a doe for all the pastoralists. This indicates some kind of rationality among the producers implying that an animal with milk production level for only its kid with no surplus for the household is less desirable. This kind of animal gives negative utility to the household because it deprives the household some utility that the household would have derived from the animal's milk which could be either consumed by the household members or sold for some cash income. Similar results, positive or negative utilities for the same traits, though with different magnitudes of coefficients, are observed for the Rendille pastoralists and also for the whole region. In addition "milk sufficiency to kid and household (greater than half a cup per day in dry season)" level, which is insignificant for both Gabra pastoralists and the whole region at large, bears a positive and significant utility for Rendille pastoralists.

For the buck and ram models, except price, all the traits considered in the models (overall body condition and standing height for bucks, fat deposition and rump shape and size for Rams, and body condition in dry season and health status for both) bear positive utility in the choice of the respective animals. The insignificance of "price" attribute for buck model in Gabra region is surprising, meaning that price does not influence purchase decisions and Gabra pastoralists assign the same utility to lowly priced bucks as to highly priced bucks. With an insignificant "price" attribute, welfare measures for the buck traits in Gabra region cannot be meaningful, hence no WTP figures were calculated for the bucks (see Table 22). On the contrary, the positive and significant "price" attribute coefficient for bucks in both the Rendille and whole region models signifies a positive utility derived from "price" attribute. This means that both the Rendille pastoralists and the region as a whole have their buck purchase decisions positively influenced by the prices of bucks. Under normal market conditions, this behaviour is not usual and might be presenting a case of a giffen good which is also a phenomenon in the case of luxury goods.

Giffen good (the converse of a 'superior' good), a special type of inferior good for which quantity demanded rises when price rises, presents a phenomena contrary to general experiences and common sense where a rise in price would normally induce a reduction in the quantity demanded of a product. In the case of the buck results in this study, an essential requirements for a giffen good: the existence of a 'superior' good which shares one or more of the characteristics of the inferior good, can be said to have been fulfilled by the existence of other types of livestock or goods that would be seen as substitute for bucks, implying that there are some want-satisfying characteristics shared by the two (bucks and the other livestock) in respect of which substitution takes place (see Garrat, 1997; Lipsey and Rosenbuth, 1971). Such characteristics would include disease resistance, drought tolerance and others not explicitly included in the CE such as breeding and meat production. In this case, bucks appear to be a cheaper source of supply for these characteristics than the other substitute livestock else the substitution would not depend on rise (or fall) in income (through price movements). The giffen characteristic would imply that a small rise in income, from the fall of buck prices, would force the livestock-keeper to economise on the expenditure on acquiring bucks in order to acquire more of the other substitute livestock hence less bucks are acquired. The converse is also true in that for the poor livestock keepers, a rise in the price of bucks makes so large a drain in their resources and raises so much the marginal utility of money to them so that they would be forced to curtail their acquisition (purchase) of the other substitute livestock. Bucks being still considered the cheapest in supplying the characteristics in consideration, they would therefore acquire (purchase) more and not less of it. The results of this study do not reveal what kind of animal would be 'the other substitute livestock' though it might just be does.

Again, there exists a possibility that the price phenomenon revealed in bucks might not be related to other animals in the market and there might be other various reasons behind such a phenomenon. The findings of Radeny et al. (2006) show that traders look for different traits in drought versus normal years and prices vary across season. The positive price attribute could be related to drought effects where after a devastating drought, pastoralists are eager to restock regardless of the price of the animals. Another explanation could be that the producers simply view expensive animals as better than cheaper ones with the view that a buck from a special breed is always of very high price or that all their characteristics are reflected in the price. However, on the basis of the rigor with which the CE designs were derived, the results of other models (for instance, the doe model where the all the coefficients were found to exhibit the expected signs) and the validity of the trait values from both the buck and the doe models as shown in the proceeding paragraphs of this section, the later argument is null. Consequently the phenomenon revealed in buck is highly unlikely to be a result of bias arising from the CE itself hence the remaining analysis in this paper remains valid.

The welfare measures derived from the MNL model is presented in Table 22 which indicate that the Gabra region residents are willing to pay up to KShs.1595 for disease resistance trait and loose KShs.1823 with loss in milk sufficiency trait in does. They are willing to pay KShs.571 more than what the Rendilles are willing to invest in a unit increase in the drought tolerance trait in does. The Rendille pastoralists are more keen on prolificacy hence are willing to pay more for high prolificacy. In sheep traits, the Rendille pastoralist are willing to pay up to KShs. 2220 for disease resistance trait and up to KShs. 835 for an extra unit of the fat deposition trait. This is unlike the Gabra who are more willing to invest more on health status and drought tolerance though even in drought tolerance, the Rendille would pay more than the Gabras are willing to part with. In general, disease resistance is the most highly valued trait among all the animal classes. This means that the livestock keepers derive the highest utility from animals with good health status (those who never get ill especially in the rainy season when diseases are rampant).

As far as the whole pastoralist production system is concerned, in order of importance, milk, disease resistance and prolificacy traits are highly valued for does; disease resistance, drought tolerance and meatiness (overall body condition) for bucks and; disease resistance, drought tolerance and fat deposition for rams. The underlying rationality behind the results hitherto is that the livestock keepers under study, being subsistence producers (see Njanja et al., 2003; also expressed in the results of section 5.4.1), are primarily concerned with their food security hence the importance of milk, meatiness and fat deposits for does, bucks and rams respectively. The subsistence nature of the production system gives rise to the desire for animals that are more adapted i.e. can both perform and survive in the harsh ecological terrain that characterise the production system, hence the emphasis on milk, disease resistance, prolificacy, drought tolerance, meatiness and fat deposits.

Table 22: Implicit Willingness-To-Pay for Small Ruminant Traits in KShs.

Animal Classes	Small Ruminant Attributes	Gabra Region Production System	Rendille Region Production System	Whole Region Production System
Doe	Body condition in dry season (strong/ good)	981.56 (346.36)**	410.87 (97.72)**	567.35 (104.82)**
	Kidding rate (Three times of kidding in a period of 2 normal years)	855.93 (278.51)**	922.20 (161.73)**	817.39 (124.75)**
	Milk sufficiency- (> 1/2 cup/ day in wet season)	-	603.60 (227.27)**	-
	Milk sufficiency – (for kid only)	-1823.48 (655.30)**	-527.15 (190.00)**	-1162.70 (213.18)**
	Health status (never gets ill in the rainy season)	1595.39 (515.94)**	993.10 (181.63)**	1111.76 (170.72)**
Bucks	Overall body condition (strong - meaty/ body full)		461.51 (115.04)**	1034.01 (475.69)*
	Standing height (relative to other Bucks in the herd) – (Tall)		1034.01.76 (95.01)*	670.61 (311.64)*
	Body condition in dry season (strong/ good)		869.15 (162.27)**	2694.83 (1049.99)*
	Health status (never gets ill in the rainy season)		990.66 (222.10)**	3082.17 (1315.71)*
Rams	Rump shape and size (big round and erect/ raised towards the rear end)	367.37 (119.19)**	835.38 (326.87)*	529.79 (127.34)**
	Fat deposition	519.20 (152.81)**	1087.54 (381.44)**	748.05 (159.21)**
	Body condition in dry season (strong/ good)	931.03 (181.51)**	996.78 (362.84)**	973.00 (178.68)**
	Health status (never gets ill in the rainy season)	1014.02 (182.81)**	2220.08 (656.14)**	1479.50 (231.89)**

Note: **, * indicate that coefficients are statistically significant at 1% and 5% levels, respectively, using P-values in maximum likelihood estimation. Robust standard errors are indicated in parenthesis. Approximate dollar rate, US$1 = KShs. 72

6.4.2. Taste Variations among Livestock Keepers

From the relatively simple CE models (MNL) explored in the preceding sub-section, a further attempt to extend the results to more complex models (RPL) is made in this sub-section Though the movement from simple MNL to more complex models like RPL is usually validated by the Hausman test for violation of the independence of irrelevant attributes (IIA) (Hensher et al., 2005), the test was not carried out since the experimental design in this study is unlabeled. An unlabeled experimental design is defined by Hensher et al. (ibid) as one in which the heading or title of each alternative is 'generic or uninformative' to the decision maker such that no other information is available to the decision maker hence the only way of differentiating between each alternative is via the attributes and attribute level labels as assigned by the experimental design. For unlabeled designs, the test doesn't make any sense of the unlabeled alternatives since the logic of the test is based on the exclusion of a specific alternative from the data set.

Preferences regarding phenotypic attributes of livestock differ across regions, countries, communities and production systems (Scarpa et al., 2003). The RPL models for does, bucks and rams tested a number of socio-economic variables' interactions with the specific animal attributes. The results of the models (Table 23) indicate that several socio-economic variables, for instance, respondent gender, respondent's relation to the household head, household head's age, gender, social responsibility and education years, religion, ethnicity, size of the household's sheep and goats herd, size of the household's livestock herd, access to veterinary services and distance to the nearest urban centre (measured in terms of GIS derived travel time) have no impact on the choice of an animal. This finding is similar to that of Zander (2006) which also found that these (or rather, similar) socio-economic variables had no impact on the livestock-keepers preferences for different cattle attributes although some of them had a general impact on choosing one animal or picking the opt-out option. Since under the current study only about 1 percent of the respondents opted out in at least one choice set, the general impact on choosing one animal or opting-out, as done in Zander (2006), could not be explored.

However, other parameters such as market access (in terms of distance to the nearest livestock market), ethnicity, economic status, distance to pasture in the dry season, the frequency of watering livestock in dry season and drug access all exhibit significant impact on the livestock-keepers' preferences about some small ruminant attributes. Looking at these variables closely, most of them depict producer practises within a production system. These results too, reflect the same kind of result found in Zander and Holm-Mueller (2007) whose final RPL model only included the parameter "production system" as the only parameter having significant impact on the livestock-keepers' preferences about some cattle attributes. The results also attest to the Kosgey (2004)'s argument that the economic importance of each trait largely depends on the production circumstances.

Table 23: Taste Variation across Individuals in the Study Area

Statistics	Does		Bucks		Sheep	
	Variables	Coefficient	Variables	Coefficient	Variables	Coefficient
Random Parameter Utility Functions	K.R	0.45 (0.11)**	O.B.C	0.45 (0.19)*	B.C	0.56 (0.21)**
	H.S	1.58 (0.20)**				
Non-random Parameter Utility Functions	PRICE	-0.0007 (0.00)**	PRICE	0.0003 (0.00)**	Price	-0.0008 (0.0001)**
	B.C	0.58 (0.06)**	Standing height	0.22 (0.07)**	Rump shape and size	0.44 (0.08)**
	Milk (for Kid only)	-0.88 (0.11)**	B.C	0.89 (0.07)**	Fat deposition	0.60 (0.11)**
			H.S	0.99 (0.09)**	H.S	1.24 (0.10)**
Heterogeneity in mean with socio-economic parameters	K.R : Drug access2	0.00 Fixed	O.B.C: Hh econ status1	-0.27 (0.14)*	B.C: Ethnicity 2	0.42 (0.20)*
	K.R : Dry pasture	0.002 (0.001)**	O.B.C: Dry pasture	0.002 (0.00)**	B.C: Shoats (TLU)	-0.05 (0.03)
	K.R : Dry watering	0.002 (0.001)**	O.B.C : Dry watering	0.002 (0.00)**	B.C: Hh econ status 1	-1.03 (0.53)*
	K.R : Hh econ status3	0.00 Fixed	O.B.C : Drug access 2	-0.24 (0.17)	B.C: Roof type 4	0.86 (0.67)
	K.R : Market 3 years	0.00 Fixed	O.B.C : Ethnicity 2	-0.34 (0.14)*	B.C: Child total	0.11 (0.60)
	H.S : Drug access2	-0.54 (0.19)**				
	H.S : Dry pasture	0.00 Fixed				
	H.S : Dry watering	0.00 Fixed				
	H.S : Hh econ status3	0.56 (0.19)**				
	H.S : Market 3 years	-0.003 (0.001)**				
Standard Deviations of Parameter Distributions	K.R	0.37 (0.08)**	O.B.C	0.35 (0.12)**	B.C	0.54 (0.16)**
	H.S	0.89 (0.13)**				
Other statistical measures	Log likelihood	-837.00	Log likelihood	-353.28	Log likelihood	-354.36
	R-squared (R^2)	0.34	R-squared (R^2)	0.46	R-squared	0.45
	Observations	3672	Observations	1884	Observations	1884
	Halton draws	2000	Halton draws	2000	Halton draws	2000

Note: **, * indicate that coefficients are statistically significant at 1% and 5% levels, respectively, using P-values in maximum likelihood estimation. Robust standard errors are indicated in parenthesis. In addition to the independent variables elaborated in Tables 5, Shoats (TLU) = Total shoats owned in 2006 expressed in TLU, Child total = Number of household dependants below age 16 years, Drug access 2 = occasional access to veterinary drugs, Roof type 4 = Iron sheet used as roofing material, Hh econ status 1 = Household's perceived economic status as well-off, Hh econ status 3 = Household's perceived economic status as poor. The abbreviations K.R = Kidding rate, B.C = Body condition in dry season, O.B.C = Overall body condition, H.S = Health status.

In this study, the RPL models' estimated standard deviations were highly significant suggesting that the parameters actually vary in the population. For does model, it was found that for the parameters ("body condition in dry season", "kidding rate", "milk sufficiency for kid only", and "health status"), since the ρ-value was less than the analyst-determined critical value, the null hypothesis was rejected at the 99 percent level of confidence concluding that the mean of the random parameters is statistically different to zero. Apart from "milk sufficiency-for kid only" trait level (note that "milk sufficiency-greater than half a cup per day" was dropped out of the model since it was found to be insignificant), the derived standard deviation parameter estimates for all the other doe attributes were found to be insignificant (at $\rho < 0.05$) indicating that the dispersion around the mean of these parameters are statistically equal to zero. This suggests that all information in the distribution of "milk sufficiency-for kid only" trait level is captured within the mean of its parameter estimates. The parameter estimates for derived standard deviation of the other traits were found to be highly significant (at 99 percent confidence level, after fixing[22] the other non-significant parameters as non-random), suggesting the existence of heterogeneity in the parameter estimates over the sampled population around the mean parameter estimate. This means that different respondents possess individual-specific parameter estimates for the traits which may be different from the sample mean parameter estimates of the said traits. As such, a single parameter estimate (for, say "kidding rate" or "health status") is insufficient to represent the entire sampled population (Hensher et al., 2005).

Fixing the price parameter, to avoid positive values for price (under the normal circumstance where price is expected to be negative), the final doe model (exemplified in Table 23) has its random parameters' estimated standard deviations for "kidding rate" and "health status", highly significant. The preference of "kidding rate" has its heterogeneity based on the distance to pasture in the dry season, the frequency of watering livestock in dry season and occasional (as opposed to constant) access to veterinary drugs. Further, exploring this aspect of taste variation by looking at the distributions of the coefficients of these parameters and the percentages within the population[23] from the model results in Table 23, it was determined that

[22] A fixed parameter essentially treats the standard deviation as zero such that all the behavioural information is captured by the mean
[23] The percentages of populations were calculated using the following formula:

52[24] percent of the pastoralists who water their animals more frequently during the dry season show a positive preference for the "kidding rate" attribute. The same case applies to dry season pasture distances which also show a positive preference to the "kidding rate" attribute by 52 percent of pastoralists who cover large distances in search of pasture during the dry season.

These results are consistent with the producer practices in the study area where some pastoralist keep both a home (milk) herd and a foora herd (herd that stay away from home in pasture areas). The heterogeneity in "kidding rate" therefore can be explained to stem from aspects such as proximity to watering points which in most cases will enable the pastoralist to explore large distances in search of pasture while maintaining good care of the milk herd which is left back at home. This means that those who are able to water their animals regularly will definitely go for higher prolificacy in their herd since watering points are near meaning they can be able to take care of the kids which remain at home in the milk herd while at the same time have the rest of the herd exploring larger distances in search of pasture. Even in the far pasture areas, proximity to watering points will enable the herders take good care of kids in terms of watering hence such herders will show a positive preference to high kidding rates as opposed to herder in pasture areas with difficulty in accessing water for their young stock. However, during the wet season most of the pastoralists are not very keen on watering their animal since the pastures are wet and animals can easily find water lying on the grounds where they graze.

With regard to the "health status" trait for does, 27 percent of the population with occasional (as opposed to constant) access to veterinary drugs exhibited negative willingness to pay for the "health status" trait while the larger 73 percent with occasional access to veterinary

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$$\text{Prob } (\beta > 0) = \text{Prob } \left(Z > \frac{-mean}{std.dev} \right)$$

[24] For instance, this figure was arrived at as follows:

$$\text{Prob } (\beta > 0) = \text{Prob } \left(Z > \frac{-mean}{std.dev} \right)$$

$$= \text{Prob } \left(Z > -\frac{0.00184778}{0.36912624} \right)$$

$$= \text{Prob } (Z > -0.0050)$$
$$= \text{Prob } (Z < 0.0050)$$
$$= 0.5199 \ (52\%)$$

drugs show positive willingness to pay for the “health status” trait. This shows that the pastoralists with some effective demand for veterinary drugs have a positive preference for the disease tolerance trait. Further, 73 percent of the population who considered themselves poor, exhibit positive preference for “health status” trait while the minority 27 percent of the pastoralists show negative preference for the trait. Fifty percent of the population who lived large distances away from the nearest livestock markets 3 years from the date of this study had a negative willingness to pay for “health status” trait with the rest having a positive willingness to pay for the trait. The negative preference to “health status “trait may be attributed to the existence of indigenous knowledge (I.K) on animal husbandry, held by some of the pastoralists such that they are able to manage their livestock in such a way that disease is not a prime concern to them. Market access may be linked to the proximity to local centres where veterinary drugs (a means of improving herds’ health status) such that those far away form market centres find it difficult to access drugs from veterinary shops hence their willingness to pay for an extra unit of the “health status” (disease resistance) trait.

The results for the buck model show high significant preference heterogeneity existing for “overall body condition/ meatiness” trait. The results find that about 22 percent of producers who consider themselves “well-off” (as opposed to “poor”), have a negative preference for the “overall body condition/ meatiness” trait. The other larger percentage (78%) of the “well-off” are willing to pay for that trait. Further findings from the buck model results reveal that 50 percent of the population who cover large distances in search of pasture and also 50 percent of the population who water their animal more frequently during the dry season exhibit positive preference for “overall body condition/ meatiness” trait. Only seventeen percent of pastoralists from the Gabra ethnic community show negative preference for the trait while the majority of the Gabras (83 percent) are willing to pay for “overall body condition/ meatiness” trait.

For the ram model, the parameters (“rump shape and size”, “fat deposition”, “body condition in dry season” and “health status”), had their ρ-values less than the analyst-determined critical value hence the null hypothesis is rejected at the 99 percent level of confidence leading to a conclusion that the mean of these parameters are statistically different from zero. The derived standard deviation parameter estimates (the amount of spread or dispersion around the sample population) for “rump shape and size”, “fat deposition” and “health status” were found to be insignificant (at $\rho < 0.05$) indicating that the dispersion around the mean of these parameters is statistically equal to zero. This suggests that all information in the distribution is captured within the mean.

The parameter estimate for "body condition in dry season" for derived standard deviation was found to be significant (at 99 percent significance level, after fixing[25] the other non-significant parameters as non-random), suggesting the existence of heterogeneity in the parameter estimates over the sampled population around the mean parameter estimate. This means that different respondents possess individual-specific parameter estimates for the preference of the drought tolerance trait, which may be different from the sample mean parameter estimate of the said trait. As such, a single parameter estimate for "body condition in dry season" is insufficient to represent the entire sampled population (Hensher et al., 2005). With "price"[26], "rump shape and size", "fat deposition" and "health status" parameters fixed as non-random, the final ram model (Table 23) has its random parameters' estimated standard deviation of coefficients highly significant. From the results of the model, the preference heterogeneity for drought tolerance trait ("body condition in dry season") can therefore be significantly attributed to differences in household economic status ("well-off" as opposes to "poor" status) and ethnicity (being a Gabra as opposed to belonging to other neighbouring ethnic communities such as Somali and Samburu).

Exploring the aspect of taste variation by looking at the distributions of the coefficients of these parameters and the percentages within the population, the results show that ethnicity differences (being a Gabra as opposed to other ethnic backgrounds, for instance, Samburu and/ or Somali) has an opposite effect on heterogeneity in the drought tolerance trait. Seventy eight percent of Gabra pastoralist show higher preference for the drought tolerance trait than the other 22 percent of non-Gabra (Rendilles exclusive) pastoralists who live amongst them. It's worth noting here that these non-Gabra pastoralists are relatively very few in numbers hence 22 percent is really a very small number. It's worth noting here that these non-Gabra pastoralists are relatively very few in numbers hence 22 percent is really a very small proportion. The ethnical predisposition toward the drought tolerance trait is explained by the difference in the drought

[25] A fixed parameter essentially treats the standard deviation as zero such that all the behavioural information is captured by the mean
[26] the price parameter is also fixed to avoid positive values for price (under the normal circumstance price is expected to be negative)

effects incurred in the regions occupied by the different ethnic communities in the area where it was found in section 4.3.2 that the Gabra were more devastated by drought than the Rendille.

Further, 3 percent of the livestock keepers who consider themselves "well-off" show negative preference to drought tolerance trait whereas the larger 97 percent show positive preference to drought tolerance trait. The reverse of this scenario is true for the "not-so-poor" livestock keepers meaning that more livestock keepers with a moderate economic status compared to their neighbours, show negative preference for the drought tolerance trait. Economic status for pastoralist is often measured in terms of wealth which is in form of livestock. In safeguarding their wealth, wealthy livestock keepers are more likely to be primarily concerned about drought which can cause loss in the wealth in terms of livestock deaths. Thus, the wealthier producers seek stability, if not, improvement, in their *status-quo* by hedging themselves from drought loss that can render them poor. On the contrary, for the less well-off producers, though drought tolerance is a prime concern, they have less livestock and would therefore seek to improve their economic status first before they seek to maintain the acquired wealth status through the drought tolerance trait.

The results of this study in eliciting pastoralists' preferences and values they attach to non-market traits of small ruminants goes a long way in building the road-maps towards improving the livelihood of livestock–keepers through conservation and utilization of these important AnGR. The livelihood of pastoralists is exposed to many challenges such as recurrent droughts, disease and narrow income-base, mainly concentrated on livestock production. The pastoralist preferences, choices and decisions are therefore bound to be influenced by these challenges. The empirical results suggest that livestock producers are primarily concerned with increasing their herd life, survivability and productivity of their livestock which narrows down to food security concerns. This is evident in the fact that disease resistance, drought tolerance, body size ("overall body condition/ meatiness" and "standing height" together), and milk production traits are highly valued in the pastoral production system.

Further, the study results reveal pertinent SRGR sustainable utilization and conservation strategies for improving the livelihoods of poor livestock keepers, that is, how development activities and policy interventions should be targeted. For disease resistance trait in bucks and sheep, drought tolerance trait in both bucks and does, "rump shape and size" and "fat deposition" in sheep, milk trait in does, and body size in bucks, the resultant homogeneity, indicating universality, evident within the context of the pastoral population imply that policies and interventions targeting the improvement/ management of these traits should be not only be given priority, but be applied collectively within the pastoral population. Improvement in these traits would improve the pastoralists' welfare since, as revealed by the CE results, they derive high positive utilities from these traits.

Further, the empirical results of variations in the preferences for specific goat traits imply that, increasing the herd sizes of the livestock keepers and hence improve their livelihoods, through improvement in the reproduction (prolificacy or "kidding rate" trait) and production ("overall body condition/ meatiness" trait) potential of goats will not be successful unless issues concerning access to pasture and water resources are simultaneously addressed beforehand. This derives from the evidence of a positive influence on the prolificacy trait by both access to pasture and water. An improvement in the disease tolerance trait either through breeding programmes or the delivery of veterinary drugs and services should target those pastoralists with limited access to (and effective demand for) drugs and veterinary services since it is this group that would experience the maximum welfare improvement resulting from such interventions. These welfare improvements would arise as a result of the economic gain from the reduction in disease incidences and disease-related animal mortalities. An improvement in basic communication infrastructure would also contribute to reducing the cost of animal health services while improving market access at the same time.

Similarly, the findings from the empirical results of variations in the preferences for specific sheep traits imply that, though there is need for improving the drought tolerance trait (or the livestock keepers' capabilities to manage their livestock during drought spells), more concerted effort should be spent on regions that are more adversely affected by drought effects. In this case, the Gabra region was found to have experienced intense adverse drought effects than the Rendille region hence efforts targeting more of the responsive region would definitely produce maximum welfare effects. Though these efforts should equally target both the poorer and the wealthier households since both are devastated by droughts, the results imply that efforts to manage drought losses and hence secure livestock keeper's livelihoods should only come after other measures designed to improve livestock keeper's economic status, and this could for instance involve other measures and traits that increase livestock-asset holdings. This is because, it is only after improving the economic status that effort to stabilise the economic status can be embraced by all pastoralists.

Despite having carried out the study immediately after a devastating drought in the study area, drought tolerance does not take the centre-stage of concern, as might have been expected. This can be explained by the fact that drought is a major phenomenal occurrence in the area hence it's not new to the livestock-keepers. Also the fact that an animal's predisposition in terms of "health status" (disease tolerance), will play a pertinent role in determining whether it will succumb to poor nutritional conditions that is associated with drought conditions or not. This argument is supported by FAO (n.d) which argues that weakened animals (by drought) are more susceptible to pathogens. Consequently disease resistance takes precedence over drought tolerance as a prime concern of the pastoralists with regard to the survivability of their herds.

The findings of this study are very similar to the findings of Mbuku et al. (2006) in the same area of study which focused on characteristics producers are keen on when selecting their breeding stocks. According to the study, the most important characteristics for the Rendille are big body size, fat deposition, milk yield, and offspring quality; and for Gabra, big body size, drought tolerance hardiness and offspring quality. The slight difference in the order of importance between these two studies stems from the methodological differences between the two studies. As seen in chapter 4, the difference in drought perception may be linked to the magnitude of the loss experienced in the two different regions under this study where by the Gabra region experienced more losses to drought than their Rendille counterparts, explaining more of their predisposition towards drought tolerance trait in small ruminants. Kosgey (2004) also found that in pastoral communities where both individual and livestock survival is crucial, survival traits[27] and reproductive traits[28] are held important. Such findings also firmly attest to the results of this study.

With the RPL model presenting a more superior model fit to MNL model from its greater explanatory power (exemplified in the log-likelihood functions), the results of the RPL, and the underlying MNL model, presents a holistic picture of the value system and consequently, the avenues of possible loss of genetic resources in terms of traits. It also presents pertinent junctures

[27] E. g., pre-weaning, post-weaning and adult animal traits
[28] E. g., litter size and lambing frequency

where the policy makers need to focus on in the policy arena for sustainable utilisation and eventually, conservation of these important genetic resources in bid to improve the livelihoods of poor livestock-keepers through their indigenous SRGR.

6.4.3. Validation of the Choice Experiment Results

One concern that arises from the results of any choice experiment is the issue of validation of the results obtained from the choice models, i.e. are the values obtained from the choice models plausible. In as much as its not very easy to validate all the results, mainly due to constraints in obtaining the necessary empirical data, some of the small ruminant traits valued in this chapter can still be validated based on some available revealed preference data from the study.

A marginal increment in disease resistance (health status trait), for instance, is shown in section 6.3.1, to be valued by the producers at between KShs.990 and 3082 across the different production system considerations (whether Gabra, Rendille or the whole area considered as a whole) and animal classes considerations (doe, buck and ram). The particular values for each animal class under each of the production system considered add up to an average value of KShs. 1560.84. Considering the amount of money spent by producers with regards to health care of their stock (purchasing veterinary drugs, acquiring veterinary services and tick control, among others), this average value appears to be very close to the reality faced by the livestock keepers. From the data collected on the aforementioned costs, an average of KShs. 1898 was found as the annual spending of the livestock keeper on these costs. This amount was only derived from livestock keepers who incurred at least any one of the costs and indicated that the cost was spent on sheep and/ or goats, either in part or as a whole. Out of the 193 respondents who indicated to have spent at least some amount of money on these cost, this average was calculated for 164 respondents who positively attributed the whole or part of their costs to sheep and/ or goats.

These results reveal some very interesting findings about the animal health market. The consumers of the animal health products (livestock producers) seem to be incurring more costs than they are willing to pay for, negative consumer surplus. The negative consumer surplus can be explained to result from market imperfections caused by high transaction costs incurred by the players in the animal health products and services market. These transaction costs, which might be as a result of poor infrastructure that characterize the study area, are seemingly transferred to the livestock producers who resultantly pay more than they are willing to pay. According to Sadoulet and de Janvry (1995), grassroots organisations among others things become important policy instruments to achieve not only welfare but also efficiency gains. Consequently, involving the communities in some kind of community-based management (CBM) of their indigenous stock would go along way in not only ensuring continued conservation and sustainable utilisation of the breeds while at the same time ensuring livelihoods are enhanced by solving several production challenges such as access to drugs, water and pasture.

Looking at the milk attribute, the WTA the loss in milk attribute in does derived by the CE model as exemplified in Table 22 ranges between KShs.527.15 to 1823.48, the average of these being KShs. 1171.11. From the observations in the area, a small cup of milk (approximately 0.25kg) is sold at an average of KShs.10 though the price varies depending on the area, season and who it is sold to (relatives within villages or in a local market centre). With the assumption that a livestock keeper gets one such a cup of milk daily from a doe and supposing that the milk production lasts for 4 months in a year, then the sales of that milk at KShs.10 would yield a sum of KShs.1200. As compared to the average figure derived from the CE models, this figure does not seem far-fetched. The assumed figures for computation of the daily milk production concur with Degen (2007), who found out that sheep and goats in pastoral ASALS of Ethiopia, which is very much comparable to the Kenyan situation, are milked for 5.7 months (mainly in the wet seasons) yielding on average 0.24kg/ day. For the pastoralist, milk is not only consumed in the household with the surplus being sold in the market. In some cases, it serves as a means of promoting social capital. Some of the milk is not out-rightly sold but given away for free to relatives and neighbours who, from the kind gesture may in turn assist in other ways, for instance, helping in terms of emergencies and sharing food in times of scarcity. In other words, for the pastoralist the value of milk to them would be greater than the KShs.10 that is offered in the market hence the greater value derived by the choice experiment.

The WTP amount for drought tolerance in bucks derived from the choice experiment is indicate as KShs.869.15 and 2694.83 for the Rendille and whole area production system, respectively. These two figures culminate to an average value of KShs.1782. From the data collected on drought deaths incurred by the pastoralist during the 2005/ 2006 drought and the perceived monetary values of the animals, an average loss of KShs. 1761 per buck was revealed. The derived value of drought tolerance trait for does ranges between KShs.410.87 to 981.56 in all the three considerations (Gabra, Rendille and whole area), averaging to KShs.653.26. The range for Sheep (represented by rams) falls between KShs.931.03 and 996.78 averaging to KShs.966.94. From the data collected, the average loss incurred in the loss of an animal by the pastoralist during the drought period was found to be KShs.1159.18 and KShs.958.57 for does and sheep respectively. While the WTP for drought tolerance in sheep is almost equal to the loss incurred by the loss of a sheep to drought, the WTP for the drought tolerance trait in does is much lower than the actual loss incurred by from loss of a doe to drought.

To check the validity of the prolificacy attribute (kidding rate) whose derived values from CE were found to fall between KShs. 817.39 and 922.20 averaging at KShs.865.17, it was found necessary to explore the value of an additional animal to the pastoralists' herds. From the data collected, the median of the perceived values of a doe and a buck was found to be KShs. 1025 and 1575 respectively with the mean of these two figures culminating to KShs. 1300. With a value of an additional adult goat in the herd (whether a doe or a buck) being KShs. 1300, it is rational enough that the value of an additional kid (a young one of a goat) would be placed at a value lower than this, in this case, an average of KShs.865.17 since the kid is much younger than the adults and would fetch a lower price though it carries with it the potential benefits (which can be realised with time) that can be derived from an adult goat.

The rump conformation attribute in sheep can be said to be more or less, a socio-cultural trait since the pastoralist use it among other things to distinguish between sheep kept by the two ethnic communities under this study. Most pastoralists described the sheep kept by the Rendille (commonly known to them as the Rendille sheep) as ones with rumps that are small and sloping downwards towards the rear end while the sheep kept by the Gabra (commonly known to them as the Gabra sheep) are seen as ones with big round and erect rumps that are raised towards the rear end. The rump conformation carries with it an element of fat deposition though sheep may also exhibit fat deposition on other body parts for instance around ribs, brisket or breast and belly. From the CE valuation, fat deposit trait values fall between KShs. 519.20 and 1087.54 giving on average KShs. 784.95. While the data generated by this study cannot be used to derive revealed values of animal fats and the amounts of fats that can be obtained from a sheep, the respondents who at least sold some animal fats indicated a selling price of between KShs. 60 and 120 per litre. Though the 'would-be' difference in value could be attributed to the forces of demand and supply in the market for the product, there are also strong socio-cultural benefits derived from the use of animal fats. These include, among other things, the use of animal fats during prayers (anointing) and naming of a new born child (Tablino, 1999).

According to the data obtained from a market survey by Juma (2007) a grade 1 buck (an animal with big body size) is bought by primary traders from the producers at a sum between KShs. 600 and 2850, depending on different sale circumstances. These figures give an average of KShs. 1352. On the other hand, the derived market value of meatiness (overall body condition) trait in bucks fall between KShs.461.51 and 1034.01 (averaging to KShs.747.76) while that of standing height (relative to other bucks in the herd) falls between KShs.186.76 and 670.61 (averaging to KShs.428.69). These two traits, strong overall body condition/ meatiness and tall height relative to other bucks, together, make a good description of grade 1 animal (as popularly known in the small ruminant market). Considering this, the total of the averages of the two traits from the CE values (KShs. 747.76 and 428.69) gives a total of KShs.1176.45, a figure which is safely within the market price of grade 1 buck.

6.5. Conclusion

This chapter has made a good attempt to derive monetary attach values of important small ruminant traits in the perspective of producer in the pastoral production system's context. Several issues pertaining to the distribution of the population in terms of tastes and preferences of the said small ruminant traits that could be of significance to the players in the livestock industry including the government, policy makers and animal breeders have been discussed. The chapter also made an attempt to validate the CE results based on some 'possible-to-obtain' revealed preference data and the conclusion that was arrived at is that the CE results are plausible. It revealed among other things, the producer preferences that could result in loss and conservation of diversity through trait values that reflect the benefit (and consequently reasons for maintaining the breeds) the producers derive from the traits.

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CHAPTER SEVEN

GENERAL DISCUSSION AND CONCLUSIONS

7.1. Aim of the Study

The potential of indigenous breeds in developing countries is often inadequately documented and utilised (Philipsson and Okeyo, 2006). Economic theory indicates that much as production systems are given and producers are rational in making their production and consumption decisions. However, producers' responses that would be reflected in productivity, loss and/or conservation of indigenous traits are not sufficiently known. This study, aimed at filling this knowledge gap by analysing the small ruminant breeds in the pastoral production system focusing on indigenous AnGR, provides detailed analysis of the small ruminant breed categories kept by pastoral households in Marsabit district of Kenya. The study was based on 4 research questions (i) do some small ruminant producers prefer or choose a particular indigenous breed category over other(s) and what influences the choice? (ii) are the production and marketed surplus of priority breed category(s) and alternative category(s) determined by household characteristics, farm characteristics and other external factors such as distance to the nearest livestock market and perceived market price? (iii) what are the values attached to specific non-marketed traits of small ruminant priority breed category(s) and alternative categories by producers? (iv) are the contribution of priority breed category(s) and alternative categories to livelihoods in terms of household income, nutrition, investment and other social functions significantly different? and (v) is the relationship between household vulnerability and livestock asset holding and management significant?

7.2. Study Methodology

The study, having used survey data from households in Marsabit, applied two criteria that derive farming systems, population density and market access, in selecting the survey sites and survey design. Alongside descriptive statistics on several aspects of the production system, for instance, levels of production and drought effects, logit and tobit models were performed to identify both producer preferences and determinants of production and marketed surplus. In addition, descriptive statistics in form of frequency and cross-tabulations were applied to show the contribution of small ruminants to livelihood. The analysis of the relationship between livestock asset holding and livelihood vulnerability drew from the asset function framework methodology. CE using both MNL and RPL were applied in deriving the values attached to small ruminant's non-market traits and the sources of heterogeneity in the values within the population surveyed.

7.3. General Discussion of the Results

The study identified the priority (dominant) small ruminant categories in pastoral households, based on the combination of two different traits of focus. The notion stipulated by Adu and Lakpini (1988) that pastoralist communities use the mixed species approach not only to ensure complementarity in forage use but also for direct benefits to the household in term of tangible and intangible requirements is also reflected here. The results here indicate that the pastoralists keep different species (for instance, cows, camels, sheep and goats) and even variants within the breeds of the species kept (for instance the categories of small ruminants). The different categories of sheep and goat are kept by households in that in one particular household; it is easy to find all the categories present. This is because different categories fulfil different household requirements at different times hence the households are most likely not to choose between the keeping of one category over another, albeit as approached in this study, the households will keep more of one category (here in referred to as the dominant/ priority category) than the other categories depending on the household's orientation towards the household requirements fulfilled by such categories.

Several household characteristics, farm characteristics and external characteristics were found to have influence on the keeping of the dominant categories i.e. the forces behind the differences in the households' orientation towards the household requirements fulfilled by the dominant categories. These were found to include ethnicity religion, household head education level, access to veterinary drugs, distance to the nearest livestock market, distance to the nearest urban centre, producer practices such as frequencies of watering the animals and perceived market values of the categories. Some of the characteristics identified here reflect the differences in the husbandry requirements of the small ruminant categories based on their different productive and adaptive attributes, and the households' ability to handle such requirements. For instance, watering requirements, susceptibility to diseases due to poor nutrition that characterises a drought condition and the households' animal management skills (ability to assess health requirements of the flocks and administering the drugs) coupled with the household's ability to access veterinary drugs.

Having determined the levels of production (including marketed surplus) in section 4.4.3, the study went further to identify household, farm and external characteristics that would influence the levels. The tobit model results identified the characteristics such as ethnicity, religion household head's education and age, distance to the nearest livestock market proximity to the nearest urban centre and perceived market values as among the characteristics that proved significant in influencing the levels of production and marketed surplus. It is interesting to note here that most of the factors seen to influence the levels of production and marketed surplus also influence the keeping of the priority/ dominant categories.

With information on what is kept in terms of the small ruminant breed categories, their levels and what influences their keeping and their levels of production. This study of small ruminants breed would not be complete without an indication of their contributions to the livelihoods of the pastoral communities. As indicated by Devendra (2005) that the economic contribution of small ruminants to poor farm households and livelihood systems is much higher than is imagined, the results in chapter 4 clearly highlights this enormous contributions. The study results also give an indication that the production system under study is highly subsistence-oriented.

Devendra (2005) indicate that considerations which underline the fact that both species (sheep and goats) currently make a most important contribution to nutritional and food security to rural communities not only in those countries where there are sizeable small ruminant populations, such as India, Pakistan and China, but also elsewhere. These considerations include the fact that small ruminants produce a variety of foods, which are both useful for both urban and rural markets; the meats from goats and sheep and also goat milk are very valuable for household nutrition and food security in rural areas. Small ruminant milk production, notwithstanding the relatively small overall impact, plays an essential part in certain difficult and marginal environments since often it represents an important source of high-quality protein (Boyazoglu, 1997). In the current study, it was revealed that goat milk contributes the most in poor households' nutrition through milk consumption particularly during the dry season.

Further, from the results presented, goats followed by sheep were considered as the most important livestock species in fulfilling most livestock livelihood functions. The revealed positive relationship between well-being status and asset holding imply that for poor pastoral livestock keepers, policy, research and development efforts should therefore put more emphasis on their small ruminant livestock holding if their livelihoods have to be improved. Such issues as proper utilization and continued conservation of their indigenous breeds therefore take the centre stage. Arguments for community-based management of the breeds would therefore follow suit if policies have to be successful in implementing programmes aimed at proper utilization of the breeds where incentives structure need to be based on community's involvements. In order to identify incentive structures and policies that need to be put in place to improve the livelihoods of poor livestock keepers, the producers preferences and economic values they attach to the different but pertinent small ruminant non-market traits need to be known not only as a possible route in which producer responses lead to either loss or conservation of the indigenous small ruminant traits but also as a way of providing the much needed economic valuation data which is very instrumental a basis for decision-making and could provide important inputs into priority setting and policy formulation (Ruto et al. 2008).

The question of the values that pastoral producers attached to the small ruminant non-market attributes saw to it, the application of CE technique. The results of the WTP from the MNL models derived the values attached to different small ruminant traits in the various segments of the pastoral production system. From the MNL results, for instance in buck, since the producers value disease resistance more than other productive traits, (say meatiness or body size in terms of standing height) an animal with less disease resistance and probably more of either meatiness (strength) or height traits will be less favoured by the producers. The same scenario can be presented in sheep where more disease resistance animals will be favoured at the expense of other traits embedded in rams such as rump conformation and fatness. This presents an avenue in which producer responses, based on the values they attach to non-market traits, could leads to either loss or conservation of the traits. For instance, as indicated above, fatness trait would be lost at the expense of conservation of disease resistance trait. But since the producers attach positive utilities (though of different magnitudes) to these traits, the extreme case of high possibility of loss of these traits seems unlikely. A flipside of this reveals what would happen in terms of sustainable utilisation of these livestock in that supposing negative values were attached to some of the traits, for instance fat deposits in sheep, this would indicate a possibility of loss in these traits, a preliminary step towards the loss of genetic resources embedded on these farm animals.

Differences stemming from producer practices within the production system were identified, from the RPL model, as the major sources of the differences in the values attached to traits such as kidding rate in does, strength/ meatiness in bucks and drought tolerance in rams. The revelation of the information on the values attached by the producers to non market traits and the heterogeneity in their preferences, goes a long way in providing not only the much needed information in policy formulation but also providing a set of information that will avert the detrimental aspect of undermining FAnGR. For instance, the knowledge that small ruminant attach as much as KShs.1163 in value toward goat milk production trait and up to KShs.3082 towards attaining a good health status trait, will give stakeholders and the general public a notion of how important the goats in question are, to the livestock keepers hence the AnGR will not be undermined in terms of its role in people's livelihoods.

With the recurrent drought in the study area, these valuation results forms a good foundation for sound conservation and restocking management. This implies that restocking, which normally comes about as a livelihood recovery strategy after natural calamities such as droughts, would be easier to undertake in a most efficient and most effective way by providing to the livestock keepers, animals that match their trait preferences. In terms of sound conservation, as derived from Smale and Bellon (1999), since AnGRs are characteristically public good, the information on private values (whether high or low) combined with public values (whether high or low), of the SRGRs would be used to determine conservation strategies that can be applied on these valuable genetic resources. Some of these conservation strategies would include public interventions for instance *ex-situ* conservation where the genetic resource is of high public value but low private value, least cost *in-situ* conservation where both high private and public values are exhibited and no intervention at all where both low private and public values are found.

7.4. Conclusions and Implications

From the evidence of the existence of diversity (based on the perspective of the producers) and great contribution to livelihoods, small ruminants constitutes an enormous genetic resource that can be exploited for the benefit of poverty reduction in livestock keeping households. They contribute greatly towards household income consumption and investments. Pastoral households are mainly subsistence-oriented. They rear small ruminants for both home consumption and income from sale of both live animals and livestock products such as milk. Due to the nature of the pastoral lands, characterised by harsh ecological conditions, rough terrains and poor infrastructure, indigenous small ruminants (generally described as 'hardy') have dominated the pastoral production system. There is need to promote and popularise the use of indigenous SRGR with unique and adaptive genetic attributes such as resistance or tolerance to biotic and abiotic stresses (Lebbie and Ramsay, 1999). This tantamount to adding values to SRGR, a process that would lead to improving the livelihood of the livestock keepers. Besides value addition, policy formulation should take into consideration the economic values attached to the SRGR in order to achieve positive impacts from the specific policies.

Though this study, having been carried out immediately after the adverse drought that took its toll on both human and livestock in East Africa, might be seen to reflect a post drought situation, droughts in the area are recurrent hence are not a new phenomenon that could drastically change the pastoralists' views. However, a follow-up study carried out under normal (non-drought) condition would go a long way in providing a complete picture of the small ruminant situation in the pastoral households. Small ruminants are not only kept in pastoral production systems but can also be found in other livestock systems. Since this study was carried out within the constraints of the pastoral system which limits its generalization to other production system, it would be interesting for a similar research to be extended to other production system in order to have a holistic overview of small ruminants in different production systems.

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APPENDICES

APPENDIX 1: Tables

Table A1: Mean Herd Sizes of Animal Categories in 2005 and 2006 by Wealth Groups

Animal Class and Period	Wealth Group	Statistics	Small Ruminant Categories 1	2	3	4
Does in May 2005	Well-off	Observations	90	91	90	89
		Mean	21 (17.7)	23 (35.2)	*24 (*21.8*)*	20 (31.5)
	Poor	Observations	82	77	82	71
		Mean	14 (13.2)	*18 (*14.2*)*	*18 (*15.9*)*	13 (9.7)
Does in May 2006	Well-off	Observations	90	91	90	89
		Mean	6 (8.9)	6 (7.0)	*7 (*10.8*)*	5 (5.7)
	Poor	Observations	82	77	82	71
		Mean	3 (3.7)	*4 (*4.8*)*	*4 (*5.9*)*	*4 (*3.7*)*
Bucks in May 2005	Well-off	Observations	91	91	79	89
		Mean	*14 (*18.3)	12 (13.0)	9 (7.9)	10 (10.8)
	Poor	Observations	88	80	73	77
		Mean	7 (7.4)	*8 (*6.3)	7 (7.4)	6 (5.9)
Bucks in May 2006	Well-off		91	91	79	89
		Mean	*5 (*12.4)	4 (6.9)	3 (5.1)	2 (3.5)
	Poor	Observations	88	80	73	77
		Mean	1 (2.3)	1 (2.1)	1 (1.7)	*2 (*3.1)
Sheep in May 2005	Well-off	Observations	88	87	79	78
		Mean	*27 (*22.1)	24 (31.4)	19 (17.6)	17 (17.5)
	Poor	Observations	80	84	69	79
		Mean	11 (10.1)	*16 (*14.3)	10 (10.6)	13 (11.6)
Sheep in May 2006	Well-off	Observations	88	87	79	78
		Mean	*8 (*7.5)	6 (7.5)	6 (7.8)	5 (7.7)
	Poor	Observations	80	84	69	80
		Mean	*3 (*3.1)	2 (3.2)	*3 (*2.9)	*3 (*4.7)

Table A2: Summary of Animal Categories Kept by Households

Small Ruminant Categories	Animal Classes/ Does (30 Households dropped): Households with category as dominant	Total[1]	Total[2]	Bucks (27 Households dropped): Households with category as dominant	Total[1]	Total[2]	Sheep (25 Households dropped): Households with category as dominant	Total[1]	Total[2]
1	45	3000	3081	55	1855	1954	72	3082	3171
2	46	3477	3546	55	1642	1724	57	3234	3365
3	51	3514	3590	24	1197	1270	21	2135	2209
4	31	2635	2717	42	1331	1429	28	2238	2364

<u>**Note**</u>: Total[1] is the total of both production and marketed surplus within a period of 1 year (animals slaughtered, sold, died of both drought and other causes and animals held at the time of data collection) for the households considered in the analysis

Total[2] is the total of both production and marketed surplus within a period of 1 year (animals slaughtered, sold, died of both drought and other causes and animals held at the time of data collection) for the all households surveyed

Table A3: Average Proportion of Contribution to Annual Income from Sale of Livestock

Livestock	All wealth groups-pooled (n = 191)	Poor (n = 97)	Well-off (n = 94)
Sheep and goats	0.72	0.79	0.65
Other livestock	0.28	0.21	0.35

Note: n = observation

Table A4: Average Proportion of Contribution to Annual Income from Sale of Livestock

Livestock	All wealth groups-pooled (n = 191)	Poor (n = 97)	Well-off (n = 94)
Does	0.20	0.19	0.20
Bucks	0.38	0.48	0.28
Sheep	0.14	0.12	0.17
Other livestock	0.28	0.21	0.35

Note: Other livestock include Cattle, camel and chicken
n = observation

Table A5: Mean Contribution to Household Daily Milk Production (%)

	Milk Seasons and Wealth Groups					
	Wet Season Milk			Dry Season Milk		
Animals	Poor (n=75)	Well-off (n=93)	All wealth groups - pooled (n=168)	Poor (n=84)	Well-off (n=91)	All wealth groups-pooled (n=175)
Goats	34.13	17.41	24.87	36.48	21.36	28.61
Sheep	15.13	9.42	11.97	16.74	12.09	14.32
Camels	38.48	11.97	52.99	34.83	59.29	47.54
Cow	12.27	16.74	10.17	11.96	7.26	9.52

Note: n = observation

Table A6: Mean Contribution to Household Income from Daily Milk Sales (%)

	Milk Seasons and Wealth Groups					
	Wet Season Milk			Dry Season Milk		
Animals	Poor (n=33)	Well-off (n=66)	All wealth groups - pooled (n=96)	Poor (n=35)	Well-off (n=60)	All wealth groups-pooled (n=95)
Goats	28.65	9.04	15.78	9	2	5
Sheep	0.00	3.52	2.31	3	1	1
Camels	54.78	79.73	71.15	72	92	84
Cow	16.57	7.72	10.76	17	6	10

Note: n = observation

Table A7: Mean Contribution to Household Daily Milk Consumption (from own farm) (%)

	Milk Seasons and Wealth Groups					
	Wet Season Milk			Dry Season Milk		
Animals	Poor (n=75)	Well-off (n=93)	All wealth groups - pooled (n=168)	Poor (n=84)	Well-off (n=91)	All wealth groups- pooled (n=175)
Goats	34.1	19.27	25.89	39.06	25.22	31.87
Sheep	16.83	10.65	13.41	18.28	13.9	16
Camels	36.87	61.37	50.44	31.3	52.52	42.33
Cow	12.19	8.71	10.26	11.36	7.92	9.57

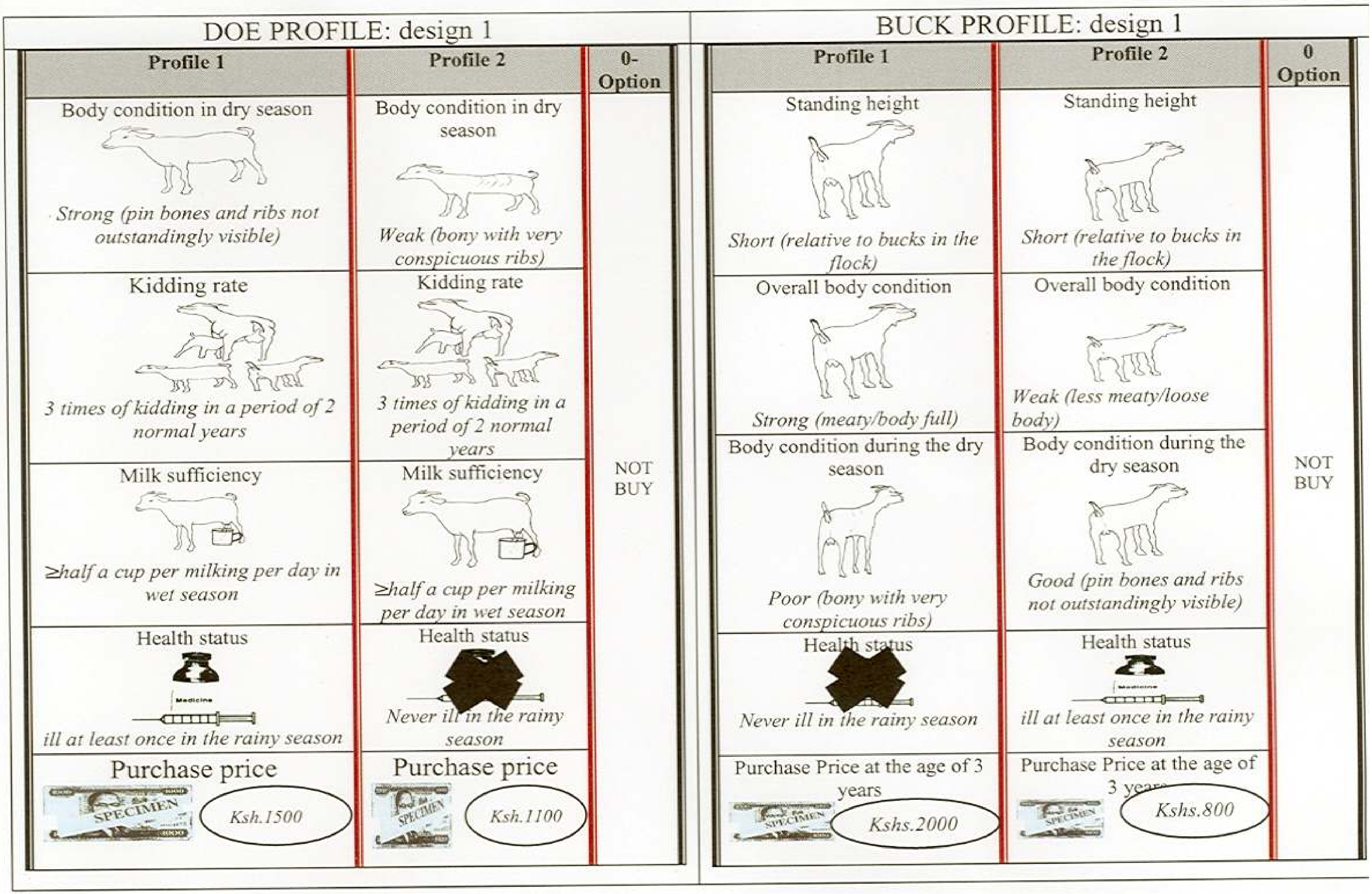
Note: n = observation

Table A8: Contribution to Meat Consumption (Numbers Slaughtered in one Year)

	Animals and Wealth Groups								
	Does			Bucks			Sheep		
Small ruminant categories	Poor (n=57)	Well-off (n=75)	All wealth groups - pooled (n=131)	Poor (n=55)	Well-off (n=77)	All wealth groups- pooled (n=132)	Poor (n=77)	Well-off (n=83)	All wealth groups- pooled (n=160)
1	1	2	2	1	2	1	2	4	3
2	2	2	2	1	1	1	2	2	2
3	1	2	2	1	1	1	2	1	2
4	1	2	2	1	2	1	2	2	2
All (Pooled)	5	8	7	4	5	4	7	10	8

Note: n = observation

APPENDIX 2: Sample of Profile Designs/ Choice Sets



DOE PROFILE: design 1

Profile 1	Profile 2	0-Option
Body condition in dry season *Strong (pin bones and ribs not outstandingly visible)*	Body condition in dry season *Weak (bony with very conspicuous ribs)*	NOT BUY
Kidding rate *3 times of kidding in a period of 2 normal years*	Kidding rate *3 times of kidding in a period of 2 normal years*	
Milk sufficiency *≥half a cup per milking per day in wet season*	Milk sufficiency *≥half a cup per milking per day in wet season*	
Health status Medicine *ill at least once in the rainy season*	Health status *Never ill in the rainy season*	
Purchase price SPECIMEN *Ksh.1500*	Purchase price SPECIMEN *Ksh.1100*	

BUCK PROFILE: design 1

Profile 1	Profile 2	0 Option
Standing height *Short (relative to bucks in the flock)*	Standing height *Short (relative to bucks in the flock)*	NOT BUY
Overall body condition *Strong (meaty/body full)*	Overall body condition *Weak (less meaty/loose body)*	
Body condition during the dry season *Poor (bony with very conspicuous ribs)*	Body condition during the dry season *Good (pin bones and ribs not outstandingly visible)*	
Health status *Never ill in the rainy season*	Health status Medicine *ill at least once in the rainy season*	
Purchase Price at the age of 3 years SPECIMEN *Kshs.2000*	Purchase Price at the age of 3 years SPECIMEN *Kshs.800*	

HHID ________

APPENDIX 3: QUESTIONNAIRE

Economic Analysis of Small Ruminant Breeds in Pastoral Production System: A case of Sheep and Goat in Marsabit, Kenya

Date of interview Date: ___ Month: ___ YEAR ___

Interviewed by: ________________________________

Date Checked Date: ___ Month: ___ YEAR _______

Division: ________________________________

Location: ________________________________

Sub-location: ________________________________

Village: ________________________________

Household Identity (HHID): ___________________

Household Name: ____

Main Respondent: ____

Gender **(1**=male, **2**=female**)** _________

Relation to Head: ______

Ethnicity: _______________ **(1**=Rendille, **2**=Gabra, **3**=other specify _______________**)**

Religion: ______________ (1 = Christian 2 = Muslim 3 = other specify ____________

Social responsibility held by the household head in the village (if any) _________________________________

GPS Coordinates: X________________________ Y ________________

Relation to head
1=Head **2**=spouse **3**=child **4**=other relative **5**=worker

HHID ________

SECTION 1

Section 1a: Family composition[1]

Ask about individuals who are part of the household in the last 12 months including those who were present for at least 2 months in the last 12 months **(May 2005 – May 2006). For Average income,** ask for other non-farm income including remittance from relatives, pensions etc.

Name of Household head and spouse(s)	Relation to head	Gender	Age	Education in years	Occupation	Average non-farm income (Especially if occupation is not = 1)
	1 Head					
	2 Spouse					
	2 Spouse					

Household members aged 16 and above

FEMALES				MALES			
Total Number	Highest (years) education level	Occupation	Average non-farm income (Especially if occupation is not = 1)	Total Number	Highest (years) education level	Occupation	Average non-farm income (Especially if occupation is not = 1)

Household members below age 16

FEMALES				MALES			
Total Number	Number below age 7	Number attending school	Highest (years) education level	Total Number	Number below age 7	Number attending school	Highest (years) education level

Gender	Occupation	Income per month
1 = Male **2 =** Female	**1** = Livestock keeper **2** = Livestock keeper cum trader **3 =** Salary earner e. g. teacher, police **4** = Casual wage earner/ labourer **5** = Trader/ businessman/ woman **6** = Artisan e. g Taylor, carpenter. **7**=Others (specify) **8** = N/ A – not applicable	**1** = < 2, 500 **2** = 2,500 - 5,000 **3** = 5,000 - 10,000 **4** = Above 10,000

[1] Section included in both whole study questionnaire and part CE questionnaire

HHID ________

Section 1b: Decision Making

Please list household members who are **Responsible** for the following livestock production

Type of decision made	Relation to head of the person responsible	Gender of the person responsible
Grazing and watering of Sheep and goats		
Grazing and watering of other livestock e.g. camel and cattle		
Purchases and sales of sheep and goats		
Other Livestock purchases and sales		
Sheep and goat, and their products' consumption and utilization		
Other livestock and livestock product consumption and utilization		
Choice/ selection of type of sheep and goats kept and breeding		
Types of other livestock kept and breeding		

Section 1c: Producer Practises[2]

Small Ruminant	Largest distance to pasture (foora) – in dry season		Frequency of watering in dry season				Frequency of watering in wet season		Access to vet services	Access to vet drugs	Distance to the nearest livestock market where you sell		Distance to the nearest livestock market 3 years ago	
	DISTANCE	UNIT	FREQUENCY	UNIT	DISTANCE	UNIT	FREQUENCY	UNIT			DISTANCE	UNIT	DISTANCE	UNIT
Sheep and Goats														

Section 1d: Livestock Inventory in the Last 12 Months (May 2005 – May 2006)

Q2: Does this household keep goats? (**1**= yes, **2**= no)[2] ______________

Q3: If **yes,** how many **Goats** in total did this household own in **May 2006**?[2] **Does__________ Bucks _______ Kids_____**

Relation to head	Gender	Watering Units	Watering Distance Units	Distance Units	Access
1=Head **2**=spouse **3**=child **4**=other relative **5**=worker	**1** = Male **2** = Female	**1** = Daily **2** = Weekly **3** = Fortnight **4** = Other (specify)	**1** = KM **2** = Day's walk **3** = Hour's walk 4 = other (specify)	**1** = KM **2** = Day's walk **3** = Hour's walk 4 = other (specify)	**1**= Always **2** = Occasionally **3**= None

[2] Section included in both whole study questionnaire and part CE questionnaire

HHID ________

Section 1e: ANIMAL TYPES BASED ON THE TRAIT LEVELS WITHIN THE BREED KEPT IN THE HOUSEHOLD

Q4: What are the different combinations of traits of the **DOES** (she-goats) you are currently (**May 2006)** keeping? *Fill in the table below*

TRAITS/ LEVELS	TYPE/ CHOICE 1	TYPE/ CHOICE 2	TYPE/ CHOICE 3	TYPE/ CHOICE 4	OTHER (Specify) 5
Milk production: 1= Sufficient for the kid and household **2= Sufficient for the kid only**	1	2	1	2	
Body condition during the dry season: 1=strong/ good **2=weak/ poor**	1	2	2	1	
How many animals from this "type" did you own last year **(May 2005)**?					
How many animals from this "type" did you own in **May 2006**?					
What is the average value (in KShs.) of such an animal					
How many of such an animal did you slaughter for home consumption in the last 12 months?					
How many died from drought related causes in the last 12 months?					
How many died from other causes e.g. disease?					
How many did you sell in the last 12 months?					
Total amount received from sales					
How were you paid (mode of payment)?					
Reason for sale					
To whom was the (or most of) animal sold					
How much milk does this animal produce in an average dry season					
How much milk does this animal produce in an average wet season					
On a scale of 1 to 5, rate this animal's general medical (drugs and veterinary) requirement					
For what purpose or reason do you keep this animal?					

To whom the animal was sold	Reason for sale	Purpose/ reasons for keeping	Mode of payment
1 = Livestock-keeper	**1**=to finance food needs	**1=**for household income	**1**= in cash
2 = Local trader (rural trader)	**2**=to pay school fees	**2=**for home consumption	**2**= credit
3 =Retailer (Peri-Urban)	**3**=to cover social obligations e.g. dowry	**3**=for cultural rights and for ceremonies e. g. dowry	**3**= in kind (paid with other goods or services)
4 = Wholesaler (Urban)	**4**=to finance medical care	**4**=for social security/ status	**4**= other (specify)
5 = other (specify	**5**=other (specify)	**5**= other (specify)	

HHID ________

Q5: What are the different combinations of traits of **BUCKS (he-goats)** you are currently (**May 2006)** keeping and how many **BUCKS** do you have from each type (combination). *Fill in the table below*

TRAITS/ LEVELS	**TYPE/ CHOICE 1**	**TYPE/ CHOICE 2**	**TYPE/ CHOICE 3**	**TYPE/ CHOICE 4**	**OTHER (Specify) 5**
Body size: 1= Tall/ big 2= Short/ small	1	2	1	2	
Body condition during the dry season: 1=strong/ good 2=weak/ poor	1	2	2	1	
How many animals from this "type" did you own last year **(May 2005)**?					
How many animals from this "type" did you own in **May 2006**?					
What is the average value (in KShs.) of such an animal					
How many of such an animal did you slaughter for home consumption in the last 12 months?					
How many died from drought related causes in the last 12 months?					
How many died from other causes e.g. disease?					
How many did you sell in the last 12 months?					
Total amount received from sales`					
How were you paid (mode of payment)?					
Reason for sale					
To whom was the (or most of) animal sold					
On a scale of 1 to 5, rate this animal's general medical (drugs and veterinary) requirement					
For what purpose or reason do you keep this animal?					

Q6: Does this household keep Sheep? *(***1**= yes, **2**= no)[3] ________

To whom the animal was sold	**Reason for sale**	**Purpose/ reasons for keeping**	**Mode of payment**
1 = Livestock-keeper	**1**=to finance food needs	**1**=for household income	**1**= in cash
2 = Local trader (rural trader)	**2**=to pay school fees	**2**=for home consumption	**2**= credit
3 =Retailer (Peri-Urban)	**3**=to cover social obligations e.g. dowry	**3**=for cultural rights and for ceremonies e. g. dowry	**3**= in kind (paid with other goods or services)
4 = Wholesaler (Urban)	**4**=to finance medical care	**4**=for social security/ status	**4**= other (specify)
5 = other (specify	**5**=other (specify)	**5**= other (specify)	

[3] Section included in both whole study questionnaire and part CE questionnaire

HHID ________

Q7: If yes, how many sheep did this household own in **May 2006**?[4] **EWES**______ **RAMS** ______ **LAMBS**______

Q8: What are the different combinations of traits of **SHEEP** you are currently keeping and how many do you have from each type (combination)?

TRAITS/ LEVELS	**TYPE/ CHOICE 1**	**TYPE/ CHOICE 2**	**TYPE/ CHOICE 3**	**TYPE/ CHOICE 4**	**OTHER (Specify) 5**
Fat deposition: 1=Body full of fat 2=Body not full of fat	1	2	2	1	
Body condition during the dry season: 1=strong/ good 2=weak/ poor	1	2	1	2	
How many animals from this "type" did you own last year **(May 2005)**?					
How many animals from this "type" did you own in **May 2006**?					
What is the average value (in KShs.) of such an animal					
How many of such an animal did you slaughter for home consumption in the last 12 months?					
How many died from drought related causes in the last 12 months?					
How many died from other causes e.g. disease?					
How many did you sell in the last 12 months?					
Total amount received from sales					
How were you paid (mode of payment)?					
Reason for sale					
To whom was the (or most of) animal sold					
How much milk does this animal produce in an average dry season					
How much milk does this animal produce in an average wet season					
On a scale of 1 to 5, rate this animal's general medical (drugs and veterinary) requirement					
For what purpose or reason do you keep this animal?					

To whom the animal was sold	**Reason for sale**	**Purpose/ reasons for keeping**	**Mode of payment**
1 = Livestock-keeper	**1**=to finance food needs	**1**=for household income	**1**= in cash
2 = Local trader (rural trader)	**2**=to pay school fees	**2**=for home consumption	**2**= credit
3 = Retailer (Peri-Urban)	**3**=to cover social obligations e.g. dowry	**3**=for cultural rights and for ceremonies e. g. dowry	**3**= in kind (paid with other goods or services)
4 = Wholesaler (Urban)	**4**=to finance medical care	**4**=for social security/ status	**4**= other (specify)
5 = other (specify	**5**=other (specify)	**5**= other (specify)	

[4] Section included in both whole study questionnaire and part CE questionnaire

OTHER LIVESTOCK[5]	No. Owned **May 2005**[5]	No. Owned **May 2006**[5]	**In the last 12 months (May 2005 – May 2006)**						Current value per Animal (Kshs.)
			No. sold	Total Amount Received (KShs.)	Sold to Whom	Reason for Sale	Number died of drought related causes	Number died of other causes e.g. disease	
Cows									
Bulls/ oxen									
Heifer									
Young bulls									
Calves									
Male Camel									
Female Camel									
Young Camel									
Chicken									

At this point introduce the choice task. Explain to the respondent what the choice task requires including the traits and their levels. Use the simple example given and record the respondent's choice from the example here[5]

_______ Profile example ______ Choice _______

Then move to the next page and administer the choice task

To whom the animal was sold	**Reason for sale**
1= Livestock-keeper	**1**=to finance food needs
2 = Local trader (rural trader)	**2**=to pay school fees
3 =Retailer (Peri-Urban)	**3**=to cover social obligations e.g. dowry
4 = Wholesaler (Urban)	**4**=to finance medical care
5 = other (specify	**5**=other (specify)

[5] Section included in both whole study questionnaire and part CE questionnaire

Section 2: Profile Choice[6]

Explain the choice task then present the profile cards to the respondent and let the respondent choose one profile card from each choice set and record the choice number. The Doe profiles should be presented to all respondents but for Buck and Ram profiles, Present the profiles for Bucks to every 1st respondent and Rams to every 2nd respondent (indicate the one presented in the space provided)

Doe Profile Choice

		Choice
Design (Choice set):		
		Choice
Design (Choice set):		
		Choice
Design (Choice set):		
		Choice
Design (Choice set):		
		Choice
Design (Choice set):		
		Choice
Design (Choice set):		

________Profile Choices

		Choice
Design (Choice set):		
		Choice
Design (Choice set):		
		Choice
Design (Choice set):		
		Choice
Design (Choice set):		
		Choice
Design (Choice set):		
		Choice
Design (Choice set):		

[6] Section included in both whole study questionnaire and part CE questionnaire

HHID ________

SECTION 3: LIVESTOCK PRODUCTS (over the past 12 months – May 2005 – May 2006)

3a: Fresh Milk Production in Dry Season. Indicate months last year _______ to _____; this year ______ to _____

Livestock Product	Produced? **1** = yes **2** = no	Production months	Average production per day in dry season		Average Amount consumed at home per day		Average Amount Given away per day		Sold? **1** = yes **2** = no	Number of sales months (dry season)	Average amount sold per day in sales month		Price per unit of sale (KShs.)	Where was most of the milk sold
			Amount	Unit	Amount	Unit	Amount	Unit			Amount	Unit		
Goat milk														
Sheep Milk														
Camel milk														
Cow milk														

UNITS :		**Where Milk was sold**
1 =250ml cup	**5** =litre	**1**= local market
2 =350ml bottle	**6** = Kgs	**2**= traded in the village
3 =500ml cup	**7** = Numbers	**3**= neighbours
4 = 750ml bottle	**8**= other (specify)	**4**= collected by traders
		5= other, specify

HHID ________

3b: Fresh Milk Production in Wet Season. **Indicate months last year _______ to _____; this year ______ to _____**

Livestock Product	Produced? 1= yes, 2= no	Production months	Average production per day in wet season		Average Amount consumed at home per day		Average Amount Given away per day		Sold? 1= yes, 2= no)	Number of sales months	Average amount sold per day in sales month		Price per unit of sale (KShs.)	Where was most of the milk sold
			Amount	Unit	Amount	Unit	Amount	Unit			Amount	Unit		
Goat milk														
Sheep Milk														
Camel milk														
Cow milk														

UNITS :		Where Milk was sold
1 =250ml cup	**5** =litre	**1**= local market
2 =350ml bottle	**6** = Kgs	**2**= traded in the village
3 =500ml cup	**7** = Numbers	**3**= neighbours
4 = 750ml bottle	**8**= other (specify)	**4**= collected by traders
		5= other, specify

3c: <u>Other Livestock Products</u> – (in the last <u>12 months</u> <u>May 2005 – May 2006)</u>

Livestock Product	Produced? (1= yes, 2= no)	Total production		Av. amount consumed in the last 12 months			Sold? **1**= yes **2**= no	Total amount sold in the past 12 months			Total Amount received	Where sold	Total average amount given away		Value **(if not sold)** KShs.
		Qty	Unit	Amt	Freq	Per		Qty	Unit	Price	KShs.		Amt	unit	
Beef															
Camel meat															
Goat hides & skins															
sheep hides & skins															
Other hides & skins															
Honey															
Ghee/ animal fats															
Other products (specify)															

Q9: Other than selling hides and skins, in the **past 12 months** has anyone in the household made products such as belts, ornaments etc from the hides and skins produced in this household? (**1**= yes, **2**= no) (If **no**, skip to next page) ________

Q10: If **yes,** were they sold (**1**= yes, **2**= no) (if **no**, skip to next page) ________

Q11: If Sold please give the total income from the sales (KShs.):

Sheep skin products KShs. ____________ Goat skin products KShs. ____________

Cattle skin products KShs. ____________ Camel skin products KShs. ____________

UNITS :	**PER (period)**	**Where sold**
1 =250ml cup **2** =350ml bottle **3** =500ml cup **4** = 750ml bottle **5** = Litre **6** = Kg **7** = Numbers **8** = other (specify)	**1** = Day **2** = Week **3** = Month **4** = Other (specify	**1**= local market **2**= traded in the village **3**= neighbours **4**= collected by traders **5**= other specify

HHID ________

Section 3d: Cost of Raising the Flock: Other Costs in the last 12 months (May 2005 – May 2006)

Cost activity	**Cost per purchase**	**Frequency of purchase**	Total amount spent in KShs.	Total animals attended	Proportion of the amount spent on **sheep**	Proportion of the amount spent on **goats**
Tick control						
Veterinary services						
Medicine and vaccine						
Other costs (specify)						

Q12: Do you hire labour for herding? (**1**= yes, **2** = no) __________

Q13: If YES, how much do you pay KShs. ___________/ **PER** __________

Q14: if NO, how much **wage would you pay** to a casual worker **per day** for herding? KShs.__________

PER (period)		
1 = Daily	**2** = Weekly	**3** = Month
4 = 6 months	**5** = year	**6 =** Other (specify)

HHID ________

Family Labour (include non paid labour by other non-family members) **on livestock**

Household Member	Number	Frequency of tending livestock		Hours per day on livestock	Proportion of time spent on sheep and goats in wet season	Proportion of time spent on sheep and goats in dry season
		Frequency	PER (period)			
Men (16 years & above)						
Women (16 years & above)						
Children (15 years & below)						

Section 1f: Importance of Livestock activities to the household income/ livelihoods

Please rank in order of importance in terms of contribution to income/ livelihood of the household, the following livestock activities.

Activity	**Importance of ACTIVITY to household income/ livelihood**
Sale of livestock	
Sale of livestock products	
Home consumption of livestock and livestock products	
Social cultural function of animals e. g ceremonies like sorio, dowry payments or social security/ status	

Current species by function

From the species kept in the household, ask the respondent to rank their importance in listed functions

Function	**Sheep**	**Goat**	**Cattle**	**Camel**	**Other (specify)__________**
Consumption *(e.g. for meat, milks and other animal livestock products etc)*					
Income *(e.g. for family needs like food, clothing etc)*					
Buffering *(e.g. for covering unexpected costs e.g. in children)*					
Insurance *(e.g. in case the family needs money fast)*					
Transport *(e.g. for movement of goods and household)*					
Social *(e.g. status: to have respect in the community)*					
Accumulation *(e.g. to increase income and production)*					

PER (period)	**Importance of livestock/ activity**
1 = Daily **2** = Weekly **3** = Month **4** = Other (specify)	**1 =** most important **2 =** second most important **3** = third most important **4 =** fourth most important **5 =** household did not engage in this/ no contribution

HHID ________

Q15: How would you rate your income from Sheep and Goats? ____________

Q16: why? (See codes below) ____

Q17: In the past 12 months how many times did you have problems financing basic expenditure e. g food, medicine? _______

Q18: How many times were sheep sold to cover such expenses? ____________

Q19: How many times were goats sold to cover such expenses? ____________

Q20: what is your ability to face a crisis demanding KShs.2000? ____________

Q21: If you had a crisis demanding a certain amount of cash, what kind of animals would you sell first? _________ **(***in the table below list the animals that would be sold, 1st, then second and 3rd … if any, in case of either or both sheep and goat, ask the animal type (refer to codes used in previous tables***))**

Animal	**Sex** (1= male, 2 = female)	**Age** (years)	**Type**

Q22: How would you rate your ability to meet social obligations which require livestock? _________

Q23: (Ask the respondent) Rate how you think the family's economic condition compares to most households in the area[7] __________

Q24: (Ask the respondent Rate how you think the family's economic condition compared to most households in the area, 12 months ago?[7] ______

Q25: (Instructions: Rate how you think the family's economic condition compares to most households in the area)[7]. __________

Q15	**Q16**	**Q20**	**Q21**	**Q22**	**Q23, 24 &25**
1 = very satisfactory **2** = satisfactory **3** = unsatisfactory **4** = very inadequate **5** = other (specify)	**1 =** Lack of good breeds 2 = lack of adequate knowledge on proper animal care **3 =** lack of market/ market information **4** = other (specify)	**1**= could pay without long-term livestock system damage **2**= could pay with long-term livestock system damage **3**= could not pay	**1**=Sheep **2**=Goat **3**=Cattle **4**=Camel **5**=Chicken **6**=other (specify)	**1**= Almost always **2** = usually **3** = occasionally **4** = hardly ever **5** = Other (specify)	**1**= well-off **2** = not so poor **3** = poor **4** = poorest

[7] Section included in both whole study questionnaire and part CE questionnaire

Section 4b: Household Agricultural Assets (Prompt for each item as listed)[8]

At present (**May, 2006**), how many/ much of the following does this household own that are usable/repairable? **Instructions:** For value per unit, ask for the resale price for the asset or the current market value of the asset as it is (Total value is only recorded for the quantity owned in May 06. But if asset was present in May 05 and absent in May 06, record the May 05 value)

Asset	Quantity		Total Value	Asset	Quantity		Total Value	Asset	Quantity		Total Value
	May 05	**May 06**			**May 05**	**May 06**			**May 05**	**May 06**	
Donkey				Solar panels				Radio			
Bicycle				Battery				TV			
Wheel barrow				Generator				Telephone/ mobile			
Spray pump				Houses				Automobile(__________)			
Cart				Grinder				Other (specify)			

RESTOCKING (*tick where appropriate*)

Is there any restocking activity either by government or NGO taking place in this area	Yes [____]	No [____]
If yes, By who?	GOVT [____]	NGO [____] give name
If yes, have you benefited from such an activity?	Yes [____]	No [____]

Instruction: Observe the main house of the household and record:

Roof type ________ **Wall type** ________ **Floor type** _______

ROOF TYPE	**WALL TYPE**	**FLOOR TYPE**
1 = Grass thatched **2** = Mud and twigs **3** = wooden **4** = Iron sheet **5** = other (specify) ____________	**1** = Grass and/ or twigs **2** = Mud **3** = wooden **4** = mud and cement **5** = Block/ brick & Cement **6** = other (specify) ____________	**1**= Mud **2**= Cement **3**= other (specify) ____________

[8] Section included in both whole study questionnaire and part CE questionnaire