Valuation of Genetically Determined Cattle Attributes Among Pastoralists of Kajiado District: Implications for Breed Conservation

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DECLARATION

This thesis is my original work and has not been submitted to any university for any degree.

Signed ____________________ **Date** 29/09/2008

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Abstract

Domestic animal diversity in developing countries is embedded in traditional farming and pastoral communities who manage their livestock according to their indigenous knowledge and in tune with local constraints. Especially in marginal environments, local livestock breeds are crucial for sustaining rural livelihoods by producing a wide range of products while requiring relatively low levels of input with regard to fodder, management and health care. Compared with other livestock species, cattle stand out across developing countries in terms of provision of non-market services, including draught power, manure, risk management through hedging, asset storage, community bonding, and ceremonial services, amongst others. Therefore the maintenance of the adapted cattle breeds is ecologically more sustainable and will ensure sustainable food and livelihood provision for communities. However, economic forces of globalization as well as political backing for crossbreeding with exotic breed, among other factors have already resulted in the extinction of a large number of breeds and many more are threatened.

Kajiado district in Kenya is inhabited mainly by the Maasai pastoralist community who are at the crossroad of socio-economic transition. It is widely recognized that the cattle they tend represent a unique genetic resource. This study identifies attributes of the cattle breed they keep as being specific for their purposes and unique to their production system. Consumer theory was used in the theoretical framework of the study. The study involved the use of conjoint analysis to identify the cattle attributes valued by the pastoral cattle producers and rank these attributes, all of which have not been valued through the conventional market system.

Results indicate that adaptability traits, feed requirements and drought tolerance are more valued by the pastoralist in the study area than productivity traits (milk and meat production).

That household characteristics condition the valuation of cattle attributes was evident. Presence of off-farm income, land size owned by the household, formal education of the household head and location of the household were critical determinants during the valuation. One implication is that, distinguishing differences in preference between groups of respondents in connection with specific socio-economic, agro-ecological zones and production system can be used to promote conservation-through-use of breeds at risk of extinction.

CHAPTER I
INTRODUCTION

1.1. Background

Of all the forms of biodiversity, the one that is most important to human kind is probably that upon which we rely for food. The most fundamental benefit we derive from the other species with whom we share the planet is in our food. Although a part of the nutritional needs of people in many of the world's poorest nations are still met from wild animal and plant populations, the vast majority of global human food is derived from domesticated species (Rege and Gibson, 2003). Livestock genetic resources underlie the productivity of local agricultural systems. The genes embedded in livestock species, particularly cattle, donkeys, and goats, make the various species and their breeds important sources of draft power for cultivation and transport and maintenance of the agro-ecological balance. Animal traction allows farmers to increase cultivated area, labour productivity and allocative efficiency. Livestock also play important roles in the processes of nutrient cycling and transfer, thus contributing to the sustainability of cropping systems that use little or no inorganic fertilizer (Tano et al, 2003). In addition to direct off-take, livestock are also valued for their roles in the farm economy because they are used for a wide range of functions such as store of wealth, insurance against risks and misfortunes, means of transport, manure and various social needs such as funerals, sacrifices and dowry. At the same time, livestock may be associated with environmental degradation, particularly when narrow productivity motivations lead to adoption of new systems of production that utilize exotic species and production methods not well adapted to local ecological conditions. Diversity in livestock species and breeds also provide a resource of genetic variation that can be exploited to provide continued improvements in adaptation and productivity (Rege and Gibson, 2003). However genetic erosion within livestock species and breeds seriously reduces the potential to alleviate poverty, improve food security and promote sustainable agriculture. The loss of locally adapted genes 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.

The conservation and correct assessment of existing biodiversity of plants and animals employed in agriculture is paramount for sustainable development. Extensive genetic diversity in these plants and animals allows the existence of plants and livestock breeds in all but the most extreme environments globally where they evolved, providing for human use, a range of products and functions. Conserving animal genetic resource (AnGR) which is expressed in breed diversity of species is central to rural development. If livestock keepers can make a reasonable living from their animals, they will not need to move to cities and abandon livestock keeping, which forms an important part of the resource base of AnGR. Conserving AnGR should therefore involve working with the farmers and pastoralists who keep and use the livestock. However there are other ways, albeit not appropriate currently, that AnGR in livestock, especially cattle, can be conserved. One could simply select cattle from around the world and try to conserve them in a single centre or location. The centralized facility could be a farm that simply harbours many breeds of cattle. Alternatively, the facility could be a laboratory that stores genetic traits in frozen embryos or DNA samples, a form of a gene bank (Mendelsohn, 2003). However this kind of conservation will not enable the genetically determined traits to co-evolve with the changing agro-ecological conditions locally. An alternative to a centralized facility and a more viable and less expensive way is to preserve cattle in the very systems they were adapted to survive in (*in-situ* conservation) (ibid). This would call for international intervention effort to be more of a program than a single laboratory. Farmers in locations around the world would be paid annually to sustain adequate populations of desired cattle breeds. This would protect the cattle from unintended interbreeding, disperse the beneficiaries of the program widely, and keep costs down since the animals are best suited for where they exist now anyway.

However if keeping of certain breeds of livestock is no longer profitable, farmers and pastoralists will give it up and their breeds will die out. It is noted that livestock form a component of the livelihoods of at least 70% of the world's rural poor including 194 million pastoralists, 686 million mixed farmers, and 107 million landless livestock keepers (Delgado et al., 1999), so conserving locally adapted breeds could be ensuring sustainable livelihoods for many farmers and pastoralists (Kohler-Rollefson, 2004).

Livestock breeds are crucial for sustaining rural livelihoods by producing a wide range of products while requiring relatively low levels of input with regard to fodder, management and health care (Rege and Gibson, 2003). The poor that live in low potential and unfavourable agricultural areas such as pastoralists depend directly upon genetic, species and ecosystem biodiversity for their livelihoods. In many regions AnGR are a vital component of this biodiversity (Anderson, 2003). The rural poor, living in complex, diverse and risk-prone livelihood systems in marginal areas, and the marginalized, living from scarce resources in more favourable areas, need AnGR capable of producing and performing the functions required of them in these livestock keeping systems, that are flexible, resistant and diverse (ibid).

The livelihood functions that livestock keeping fulfils include: cash income from sales of animals, their products and their services; as buffer stocks when other activities do not provide the returns required; as means of saving, accumulating assets, insurance and providing collateral for loans; as inputs and services for crop production; to capture benefits from common property rights e.g. nutrients transfer through foraging on common land and manure used on private crop land; for transport, fuel, food, fibre for the household; and to fulfil the social and cultural functions through which livestock ownership provides status and identity (Kohler-Rollefson, 2004; Anderson, 2003). All these functions of livestock imply that the conservation and correct assessment of existing biodiversity of livestock employed in agriculture is paramount for sustainable development.

Cattle as compared to other forms of livestock make a large contribution to many developing societies. Compared with other livestock species, cattle stand out across developing countries in terms of provision of non-market services, including draught power, manure, risk management, asset storage, community bonding, and ceremonial services, amongst others. For example Winrock International (1992) estimates that livestock contribute 25% of the total agricultural gross domestic product (GDP) in Sub-Saharan Africa. If the benefits of manure and draught power are included, this figure is estimated to increase to 35% of total agricultural output (Scarpa, Kristjanson, et al. 2003). The importance of cattle for sustainable livelihoods informed the choice of this species for the current study.

The management of the genetic resources embedded in cattle breeds requires a host of decisions, for instance, why and what genetically determined traits should be managed, how and where the traits should be managed. Many of these decisions would be much better informed if information on the economic value of cattle breeds, their traits and processes (e.g. alternative breeding and conservation programs) were available (Rege and Gibson, 2003). Decision makers in policy and research communities need economic values of cattle breeds and their traits as an input into the development of incentive schemes for conservation programs.

Past researchers e.g. Hall and Ruane (1993) suggest that globally 618 breeds of domestic animals have already become extinct and in Europe one third of the surviving 737 distinct breeds of livestock are in danger of extinction (Cunningham, 1992). A survey in sub-Saharan Africa revealed that out of 145 cattle breeds identified, 47 (32%) were considered to be at risk of extinction, and 22 (13%) previously recognized in the continent have already become extinct. In Kenya, the Kikuyu zebu is at the verge of extinction due to neglect and interbreeding (Rege and Tawah, 1999). There is therefore need for conservation efforts of the existing breeds.

Obviously, a population is extinct if its last individual has died. However it is more useful to define extinction as a threshold for the number of individuals in a population below which the population is not able to reproduce sustainably (Bennewitz and Meuwissen, 2005). According to Gandini et al. (2004), the lower bound of self-sustainability of a livestock breed is around 1000 females. Additionally, without any conservation effort, a breed size of below 100 females increases the extinction process rapidly, for example, due to low number of herds or low economic competitiveness of the breed. However if the long-run population growth rate for a breed or species is less or equal to zero, one can be certain that the population will become extinct at a future point in time, assuming no intervention is undertaken (Gandini et al., 2004).

Cattle breeds in developing countries are uniquely adapted to the harsh environments where they have evolved. It has also been noted that much development of livestock husbandry in recent decades has resulted in its being decoupled from local natural environmental conditions. As a consequence, processes of co-evolution have largely been circumvented. This brings with it new environmental dangers and social problems (Tisdell, 2000). Apart from concerns for animal welfare (and in some cases human health) raised by industrialized animal husbandry systems, the decoupling of animal husbandry from their adapted environments may constitute a time-bomb for the collapse of livestock production, an important component of the pastoralists livelihood. One cannot safely ignore the sustainability consequences of such methods of economic production (ibid). Threats to cattle genetic resources (including all AnGR) can be summarized as follows. Genetic dilution or eradication through use of exotic germplasm, changes in production systems leading to change in breed use or crossbreeding, famine, disease epidemics, civil strife or war and other catastrophes and political instability, changes in producer preference, usually in response to changes in socio-economic factors, and droughts, (Rege and Gibson, 2003). Because production is done in such dynamic socio-economic and agro-ecosystems, conservation of cattle traits that are genetically determined could best be conserved through use *in situ*.

Thus, nowhere is the need for efficient resource allocation for the task of biodiversity conservation more demanding than in developing countries. On one hand, so much of the livelihood of local communities is at stake, and on the other, so meagre is the resource base with which to achieve this objective. In pastoral societies, assessing the role of non-market values of cattle genetic resource (as expressed in the traits of cattle breeds) as decision aids is paramount, particularly because of the absence of efficient markets for many of the functions that cattle perform. Some of the non-market roles of cattle in pastoralist societies include risk management, asset storage, manure, community bonding and ceremonial services (Anderson, 2003).

The difference between the market value of a particular cattle genetic resource and its total economic value to humans is particularly large in developing countries. Little is known as to the magnitude of this divergence as few empirical studies have attempted to estimate it directly. To compound the problem, estimates of these values are likely to both have great variance and be of more complicated determination in developing countries. For example, intuitively pastoralists can put a very high value on genetically determined traits determining adaptive fitness in indigenous cattle genetic resources under extreme environmental conditions. However, conventional economic analysis may fail to account for such resilience and reach normative conclusions that favour the adoption of policies encouraging the introduction or promotion of high-input, high-output exotic breeds. Introduction of exotic germplasm, through crossbreeding and breed replacement, can result in extinction of the unique, well-adapted indigenous cattle genetic resources (Hammond and Leitch, 1999).

It is becoming more widely recognized, that the cattle tended by pastoralist represent a unique genetic resource (Rege, 1999). The traditional cattle herds kept by the pastoralist Maasai of East Africa belong to a broad sub-group of cattle referred to as 'Small East African shorthorn zebu' (a member of the broader *Bos indicus* group). Rege and Tawah (1999) have referred to this strain as the Maasai Zebu. These animals have been living in harsh, semi-arid conditions for thousands of years, and have a degree of tolerance to drought and endemic diseases not present in recently introduced zebu breeds, such as Sahiwal or the East African zebu breeds not native to the area, such as the Boran (Kristjanson et al., 2002). These latter breeds of cattle and their crosses are larger animals and therefore produce more meat and can also display higher productivity in milk when raised under a high level of management and nutrition. However, under the typical environmental and management conditions of these pastoral systems, and from the medium to long run perspective in production, they may not necessarily perform better than the Maasai Zebu. In fact, in severe drought conditions (an event that has occurred 4-5 times in the last 20 years in southern Kenya), the non-indigenous breeds are much more likely to perish. This was witnessed in the 1999 - 2000 drought, where pastoralists in southern Kenya incurred severe losses of their herds (Kristjanson et al., 2002).

The superior adaptive abilities make this breed (the small east African shorthorn zebu) valuable for further livestock development in Kenya and other harsh environments around the world. Achieving this goal of development will therefore require conservation and improvement strategies that avoid inappropriate breed dilution or replacement. There is therefore the need to have an economic valuation of the genetically determined traits carried in the breeds that are kept in given regions.

1.2. Statement of the Problem

Much of the indigenous cattle in the developing world, although extremely well adapted to local environments, are relatively unproductive if meat and milk are the only benefits valued. As a result, conventional economic analysis may tend to promote the introduction of exotic breeds. These exotic breeds often fail to deliver the expected long-term production improvements for a variety of reasons including their inferior resilience and adaptability. Yet, their introduction may dangerously displace or dilute indigenous animal genetic resources, eroding well-adapted indigenous traits that may be vital to maintaining world's food supplies and sustaining the livelihoods of the resource poor pastoralists (Scarpa, Kristjanson et al, 2003). The sustainability of the livelihoods of many resource poor pastoralists and their food supply will be affected adversely if only productive attributes such as milk and meat production, are considered in the development of cattle breads to be kept in pastoralists areas. As earlier noted, cattle provide other benefits to pastoralists such as risk management, asset storage, manure, community bonding and ceremonial services.

The main threat of extinction for indigenous zebu cattle breeds is interbreeding, especially with the recently introduced Sahiwal breed that produces more milk and meat (Kristjanson et al., 2002). It is possible that the crosses thereof may have superior quality, according to the current socioeconomic conditions. Consequently communities will choose to keep such exotic breeds that will eventually replace existing breeds; eroding the indigenous resources (pure breeds) that crossbreeding depends on (Karugia et al, 2001). Meanwhile, if there is a specialized local breed, it faces the danger of becoming extinct.

The keeping of crosses by such communities is a perfectly rational medium-term strategy on their part. But it would be short-sighted of national governments and indeed global interests to lose the genetic resource these extant (existing) adapted cattle represent because of a temporary pattern in prevailing economic conditions (Tisdell, 2003). It is argued that this loss of genetic resources will reduce economic flexibility in an uncertain world and options should rationally be kept open at the national level and global level by conserving a portion of this genetic resource found in the existing adapted cattle breeds.

Farmers and pastoralists are the custodians and users of the vital pool of genetically determined traits found in cattle breeds. The pastoralists' involvement in identifying and conserving genetically determined traits that befit them has been minimal. It is therefore vital to involve the users and custodians in identifying the trait in which these genetic resources are manifested and consequently involving pastoralist in conserving these breeds' traits before it is too late.

1.3. Objectives

The broad objective of this study is to determine producers' preference for genetically determined cattle attributes among pastoralist of Kajiado district with a view of making the case for breed conservation-in-use. Thus, the specific objectives of this case study are:

1. To identify cattle attributes valued in pastoral cattle production, for possible inclusion in conservation and improvement programs.

2. To rank the cattle attributes that pastoral cattle producers value for priority setting in conservation and improvement programs.

1.4. Hypothesis

1. Cattle producers do not have systematic preferences for cattle breeds for specific purposes.

2. Adaptability traits are not valued more than productivity traits by pastoral cattle producers.

1.5. Justification

Assessment of farmers' breed preferences and values communities attach to traits of cattle breeds can assist breed conservation and improvement efforts in several ways. First, farmers' knowledge about specific attributes of different cattle breeds under village conditions can help to focus scientific research on particular traits and identify needs for further farmer education through extension programs. The farmers' knowledge on cattle attributes can be used to design selection and breeding criteria for the preferred attributes. Second, it can help to determine the 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. Third, information about farmers' breeding practices and breed preferences can help to identify the likely market for existing or improved breeds, as market information reveals buyer preferences for different breeds and attributes. This information can be useful in the design or improvement of conservation of breeds and breed improvement schemes. However if executed indiscriminately, breed improvement programs, such as crossbreeding, are a great threat to cattle genetic diversity. It is ironic that crossbreeding, if successful, would erode the very resources (the breed traits) on which it is based (Karugia et al, 2001).

CHAPTER II
LITERATURE REVIEW

2.1 Pastoralism

The world's pastoralists live in harsh environments and livestock form a vital component of their livelihood. They graze their livestock on parched dry land, steep hills, mountains and roadsides – resources that would otherwise go to waste (Kohler-Rollefson, 2004). In Africa the pastoralist live in the Sahara, the Sahel and the horn of Africa, areas with harsh climatic environment. The Kenyan pastoralists live in the arid and semi-arid (ASAL) districts and are endowed with a vast experience of indigenous knowledge on livestock management. Kenyan pastoralists' production system is that of low input and low management strategy. Kajiado district in Kenya (the study area) is one such area inhabited mainly by the Maasai community. The economy of the area has historically been dominated by the Maasai pastoralists who are in the midst of ongoing significant socio-cultural and economic changes (Kristanjan et al., 2002).

There are several reasons for concern for the Maasai and their cattle. One is due to the historical existence of indigenous breeds of cattle, sheep and goats in ecosystems with the richest biodiversity of wildlife on the African continent (Reid et al., 1999). Indigenous livestock are more resistant to diseases carried by wildlife, for example wildebeest, zebra. Tourism revenues, largely based on wildlife, are extremely important for Kenya's overall economic performance. Therefore ecological conservation is important for the wildlife as much as it is important to improve and sustain the wellbeing of the Maasai community who keep livestock as part of their livelihood strategy.

A second reason is that pastoralists have become less food secure over the last 20 years, and improving the productivity of their livestock production-based systems is an important poverty alleviation goal (Government of Kenya, 2001). The 1999-2000 droughts vividly demonstrated the relative hardiness of the indigenous compared with exotic breeds (Kristjanson et al., 2001). Implicitly it also demonstrated the potentially huge costs associated with the loss of livelihood resulting from losses of domestic cattle breeds amongst pastoralists. Therefore a balance between improving productivity, in terms of milk and meat production, and maintaining adaptability to the environment in terms of hardiness to drought and diseases, should be targeted while addressing the issue of poverty alleviation through livestock production productivity improvements in the context of the prevailing socio-cultural and economic environment.

Pastoral systems in the world are dynamic, however pastoral production has been described as ecologically destructive due to the long-term impact of larger than optimal herd size on a given pasture resource (Doran, Low, and Kemp, 1979). Doran, Low, and Kemp (1979), McPeak (2005), and Kabubo-Mariaria (2005) recognize the cyclic nature of livestock populations, as a "boom and bust" pattern. Because of this cyclic nature of pastoral production, recommendations and policies have in the past been inclined towards the change of attitude, culture and production system of pastoralist (Kabubo-Mariaria, 2005). Nevertheless the pastoral production systems are a livelihood strategy. Livelihood includes "the capabilities, assets (including both social and material resources) and activities required for a means of living". Livelihood strategies should be sustainable, so as to cater for the present and future populations. Sustainability is achieved when a livelihood "can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base" (Carney, 1998:4 as quoted in Anderson 2003). Local cattle breeds and the natural environment form part of the resource base of the pastoralists hence they are required amongst others for their livelihoods. Therefore the need to understand the value of the genetically determined traits in cattle, as in the current study, is required.

McPeak (2003) argues that environmental problems in the pastoral areas are not one of larger than optimal aggregate herd size. Rather it is suboptimal spatial distribution of stocking pressure. This observation is in agreement with Fernández-Giménez (n.d) averment that pastoralist strategies focus on manipulating the temporal and spatial distribution of grazing, as well as the kind and class of animals used, rather than regulating stocking rates. Hence McPeak's (2005) findings that

> pastoralists' income is directly related to herd size, that as herds increase, household income increases; wealth held in the form of livestock offers a higher rate of return over time than does wealth held in formal savings even if periodic herd losses are included in the calculations; accumulation of cattle at the household level is preferred to restocking through deploying formal savings in local livestock markets, since evidence suggested that female animals were infrequently available in markets in the study area and herders indicated that these animals were of questionable quality when they were available and that herd size post-crisis is an increasing function of herd size pre-crisis, suggesting herd accumulation serves a self-insurance function.

Such findings suggest a way forward in pastoral development is to strengthen existing pastoral production systems. In the short to medium-term, herd accumulation in such environments should be facilitated, not hindered. Efforts that support mobility should be designed to reduce externalities (such as ecological degradation) resulting from suboptimal spatial distribution of accumulated animals. In the longer term, a combination of formal insurance, higher rates of return to formal savings, and the development of livestock markets that allow self-restocking could reduce the economic incentive to accumulate animals (McPeak, 2005). In addition, development of alternative income generation strategies, other than livestock rising, could offer households currently involved in pastoral production a greater possibility of smoothing income streams over time. These longer term efforts should build on the pastoral production system and attempt to strengthen it rather than displace it (ibid). Such arguments as those presented by McPeak (2005) strengthen the case for conservation of locally adapted cattle breeds *in situ* so that the preferred traits are coupled with the changing socio-economic conditions and existing agro-ecological conditions.

Livestock including cattle of different species and breeds within species fulfil different functions in the pastoral household economy (Mwacharo et al, 2005; Rege, and Gibson, 2003) and poor families often keep a diversity of species and breeds for this reason. The livestock provide milk, meat, are a symbol of social status and they act as a savings bank and a store of wealth among other uses (Kohler-Rollefson, 2004). Livestock are capable of performing these many functions because of the genetically determined traits they posses. Cattle are an important livestock to pastoralists.

The need for sustainable development for livelihoods support and conservation of these cattle genetic resources, found in local breed (a natural capital asset), demands for economic valuation of the genetic resources. Particularly so because in fragile ecosystems, such as where most pastoralists produce (as in the study area), yield stability is often more valuable than yield *per se*, and is a manifestation of complex traits, such as adaptive attributes for example feed requirements and drought tolerance (Scarpa, Kristjanson et al, 2003). In such a valuation, determining the actual economic importance of the cattle breed and its traits is an important part in decision making (Drucker et al., 2001), besides taking into consideration other limiting production factors as land and labour. Unlike market-oriented commercial farmers, pastoralists produce cattle amongst other livestock to meet their livelihood needs, and follow broad production objectives that are driven more by their immediate livelihood needs rather than demands of a market. While monetary returns are the driving force in a high-input and free-market economy, non-income (savings, insurance, collateral for loans, buffer stocks) and socio-cultural functions may define the essential values of a community that keeps cattle as part of a livelihood strategy (Anderson, 2003). As a result it is not justified to base the economic evaluation of pastoral cattle production on the conventionally recognized (marketable) yield attributes, because the non-conventional utilities of livelihood based cattle can be as important, depending on the value systems of communities. Therefore because the reasons for keeping cattle, are not only market determined economic values, but fulfil a variety of other functions, evaluation of the production process should consider as many of their uses, as portrayed by their attributes, as possible (Ayalew et al, 2003).

2.2 Economic Value of Traits of Cattle Associated With Non Market and Socio-Cultural Roles

Since the dawn of agriculture, humanity has domesticated about 40 species of animals. Livestock keepers have developed over 7000 breeds (Kohler-Rollefson, 2004). In the context of domesticated animals, the breed represents an aggregate of both genetic stock and management strategies in relation to a particular environment responsible for a recognizable set of physical traits or characteristics, which collectively differ from those of other breeds (Scarpa et al, 2003; Tisdell, 2003). The set of genes in the breed determines every thing from the animals colour to its milk-yield; from drought and disease resistance to the number of off springs it is likely to have (Kohler-Rollefson, 2004). Some of these are manifested in the cattle as physical traits. Each one of the breeds is specialized for a particular area and production system. The abundance of breeds is a vital part of agricultural biodiversity which is essential for the sustainability of agricultural production where cattle production is included.

Animal genetic resources, as embedded in breeds, are the building blocks for all livestock development. They form the raw material that livestock keepers depend on to adapt to changes in the natural environment and in production conditions, to cope with disease outbreaks and to respond to new market opportunities (Wollny, 2003). In general animal genetic resources, as expressed in breeds, form the raw materials that livestock keepers depend on to adapt to changing economic and social conditions. The breeds most important to agricultural biodiversity concerns are those that have co-evolved with a particular environment and farming system; cattle breeds are not an exception. These have taken a long time to evolve and have adaptive characteristics such as drought resistance that cannot be devolved or transferred to other environments without commensurate change in management (Tisdell, 2003). Keeping the desired cattle genetic resources in centralised station, in the form of farms or in gene banks will require commensurate change in management; it will have centralised benefits if any and will require more spending since evolution of the breeds will have been decoupled from the natural environment. If cattle become uniform, there will be no more potential for adjustment. For instance diseases can rapidly spread through populations that are genetically similar or drought can reduce an un-adapted herd to zero. Livelihood-oriented livestock farming systems are risk-averse and therefore the investment is spread through keeping smaller, but more numerous and diverse species, and adapted breeds (Wollny, 2003). Nevertheless locally adapted breeds form the basis of genetic diversity suited to the environment. The diversity expressed in locally developed and adapted breeds should be conserved by the communities *in situ* so as to maintain the adaptive traits that cannot be easily devolved.

In this section, some studies that have derived economic value of cattle traits associated with non-market and socio-cultural roles will be reviewed. Ouma (2007) in her study examines cattle keeping households' preference for phenotypic (physical) cattle traits focusing on trypanosomosis prevalent production systems in Kenya and Ethiopia. Cross-sectional choice experiment survey data of cattle keeping households was used. Further, the study investigates potentially sustainable pathways by which the cattle keeping households can access improved genetic materials based on there cattle traits of preference. Mixed logit model is used to investigate existence of preference diversity, while latent class model is used to investigate the existence of endogenous preference groupings for cattle traits among the cattle keeping households.

The results reveal significant preference diversity among cattle keeping households. Good traction potential, fertility, trypanotolerance and reproduction performance are found to be the most preferred cattle traits. Traits related to beef and milk production are ranked below these traits. The results of the latent class model indicate that the households' preferences are clustered around the production systems under which cattle production takes place.

Moll (2005) presents an appraisal of costs and benefits of livestock systems that aims to make policy analysis and resulting livestock policies more effective by focusing on the total complex of market and non-market relationships of the livestock system within the broader context of the institutional environment of livestock keepers. The approach is based on: a distinction between recurrent production and embodied production to deal separately with regular income streams and irregular income from the sale of animals; a distinction between marketed and non-marketed resources and production, which leads to a discussion of prices and values for individual livestock keepers; and recognition and estimation of the services livestock provide in insurance, financing, and status display. The approach is applicable to all types of animals, either individually or in herds.

Moll's (2005) method to analyze livestock systems describes and demonstrates a number of income indicators to be formulated that capture, quantify, and organize the various benefits of a livestock system. Some of the income indicators are based on current market prices and are largely valid for all livestock keepers. However, the indicators "income in kind" and the intangible benefits are related to household characteristics that may differ substantially, such as household composition and access to financial institutions. Moll argues that the overall appraisal of the livestock system, the summation of the various income indicators is related to the costs of the system in terms of the household's production factors employed, thereby taking into account opportunity costs. Again, livestock keepers usually differ in factor endowments and the appraisal can accommodate the various options open to different groups.

The results further indicate that relative importance of the indicators will differ with the livestock systems under analysis and the presence or absence of markets for resources, production, and services. The cattle production analyzed in Western Province of Zambia took place in a situation with almost absent markets for resources and services, a rudimentary market for milk, and with a functioning market for slaughter animals. The case reflects an extreme, but not uncommon, situation of restricted access to markets. Moll argues that in more market-oriented systems, such as dairy production near urban areas, the importance of the net recurrent cash income will be more prominent and more visible. However, the linkages with crop production (recurrent income in kind) and the benefits in financing and insurance may still contribute substantially to the total benefit of the system. Additionally, in more market oriented livestock systems the household's production factors—labour, land and possibly also capital—usually have alternative opportunities in agricultural and non-agricultural enterprises that generally have clearly identifiable types of income. The application of the comprehensive appraisal of costs and benefits of livestock systems is therefore justified in a wide range of circumstances.

The inclusion of the markets for resources, production, and services in the analysis of livestock systems enables researchers and policy makers to assess these systems more closely from the viewpoint of the livestock keepers. This is highly relevant for the development of effective livestock policies, because livestock keepers will assess all proposed changes in the production system in the context of their objectives, factor endowment, and institutional environment.

Ouma, Obareet al (2004) uses data from a survey of two hundred and fifty cattle keeping households in three cattle keeping systems; intensive, semi–intensive and extensive systems, to assess the contribution of non–market benefits of cattle to the competitiveness and survival of smallholder cattle systems in Kenya, from an agricultural development perspective. The context of their study is where livestock are closely linked to the social lives of farmers and livestock assume finance and insurance roles for households, since financial markets function poorly and opportunities for risk management through formal insurance are generally absent.

The data used comes from a cross-sectional household level survey conducted on a sample of two hundred and fifty smallholder cattle keeping households in Kisii and Rachuonyo districts, in Kenya. Extensive, semi-intensive and intensive systems of cattle keeping are practiced in the study sites of Kisii and Rachuonyo districts. Semi –intensive and intensive system of cattle keeping is common in Kisii extensive keeping is common in Rachuonyo district.

The distinction between extensive and intensive agriculture refers to the amount and type of productive factors used in a given agro-climate. In the extensive systems, more land and less labour are used per unit of output. Livestock mainly rely on grazing on natural pasture in common grazing grounds and are predominantly local zebus characterised with low milk production. There is little use of purchased inputs and land sizes are also relatively large. An important feature in this system includes the use of cattle for draught power. In the intensive cattle production system, crops and livestock are closely integrated, with some crop residues being fed to cattle and manure from livestock being used to fertilise agricultural plots. This system is mainly found in the Kenya highlands where high population growth has resulted in reduction in land–holding sizes. Cattle are confined in one place where they are stall – fed with fodder and crop residues. Manufactured feeds are widely used especially at milking. The semi–intensive system is characterised by a lower human population density compared to the intensive systems, the dairy animals rely mainly on grazing which is usually supplemented with cultivated fodder in a cut and carry system of feeding. The breeds are the same as those in the intensive systems though with a higher local zebu content.

A complete budget analysis of the cattle enterprise is undertaken to estimate the contribution of non-market benefits to the competitiveness of the smallholder cattle production systems. The results indicate that up to 50-70 percent of the benefits realized from the smallholder cattle systems are non-cash. Further analyses indicate that smallholder cattle production systems are relatively competitive and efficient in utilization of household production factors, when non-market benefits are taken into consideration. This is especially so for extensive systems which are non-market oriented. The paper concludes by emphasizing the importance of non-market roles of cattle in evaluations of smallholder cattle production systems since this will have a bearing on any policy related interventions whose target is households that are wholly or partially dependent on the livestock economy.

In their study, Tano et al (2003), estimate the preferences of farmers for cattle traits in southern Burkina Faso using conjoint analysis. Here the technique is used in the context of a West African country where literacy is low, where cattle perform multiple functions. Low-input management is the norm, and cattle are exposed to a number of tropical diseases and other environmental stresses. The current study characterizes the preferences over cattle attributes, while focusing on drought tolerance in relation to other attributes, of a group of pastoral producers operating within Kajiado district in Kenya.

The results from Tano et al (2003) reflect the production practices of the region, suggesting that important traits in developing breed improvement programs should include disease resistance, fitness for traction and reproductive performance. Beef and milk production are less important traits. The study shows the potential usefulness of conjoint analysis for quantifying preferences in less developed countries for livestock and for the wide variety of other multiple-attribute goods. One implication is that conjoint analysis provides a quantitative methodology that helps make diverse livelihood strategies more operational. Distinguishing differences in preferences between groups of respondents in connection with specific agro-ecological zones and production systems can be used to promote conservation-through-use of breeds at risk of extinction.

2.3 Management of Breed at Community Level

Kohler-Rollefson (2000), avers that the livestock genetic diversity encountered in developing countries is a product of local environment combined with the breeding strategies of traditional communities. Intra-species biodiversity (the differentiation of livestock species into different breeds) is the outcome of many different communities managing livestock in many different habitats and ecological niches, and manipulating its genetic composition according to the specific requirements of their environment, their production system and their own preferences or breeding goals. The Maasai zebu is one such breed of cattle that has been developed by the Maasai community in Kajiado and other parts of Maasai land. The Maasai zebu form the reference to the cattle breed traits considered in the current study.

The production and breeding goals of pastoralists are far more multifaceted than in intensive production systems in developed countries (Kohler-Rollefson, 2000; Mwacharo et al, 2005). One aspect of overriding importance is to avoid risk – the ability of cattle to survive natural calamities (drought, climatic extremes), such as the *Neri* cattle breed kept by the Rebari in India (Sansthan, 2002), is necessarily more important than high productivity. In an unchanged production environment the increased probability of losing an animal which is more productive, yet more susceptible to drought, disease and other environmental stress, is often not considered when planning conventional improvement programs involving crossbreeding, as unrestricted feed supply and sufficient health care management are usually assumed. Risk aversion could be addressed through selection for adaptive fitness as an important aim in a breeding plan. Adaptive fitness is characterized by survival, health and reproductive related traits. The problem is that selection for low heritable and difficult to measure traits and the underlying antagonistic biological relationship between productive performance and fitness will result in low selection responses for fitness-related traits (Wollny, 2003). The appropriate strategy for any breeding program would therefore be to set suitable selection goals, which match the production system rather than ambitious performance objectives, which cannot be reached under prevailing environmental conditions. If selection is based only on one output oriented trait, e.g. milk yield or body weight gain, the assumed antagonistic relationship with other important traits such as health or reproduction related traits may negatively affect the overall biological and economic efficiency of any breeding program (Wollny, 2003).

Traditional livestock breeders have developed a large variety of institutions and mechanisms for optimizing the genetic quality of their cattle within the constraints of their environment. Restriction, even taboos on selling female breeding stock outside the community, exchange of animals between members of the same community in the form of stock loans and alliances is encouraged, careful selection of breeding males and offspring testing are some of the institutions and mechanisms developed (Kohler-Rollefson, 2000; Wollny, 2003). These institutions and their indigenous knowledge should be respected and where possible the knowledge taped. Many of the pastoral communities regard their breeds as a product of their communities and indigenous knowledge and therefore remain in their public domain as public good (Kohler-Rollefson, 2004). Therefore research on traditional cattle breeding systems and practices involving the farmer in a participatory way is required to enable the integration of indigenous knowledge into a scientifically based conservation strategy. It is in this regard that identifying the cattle attributes and ranking the value attached to such attributes by local communities as in the current study, is important to shade light into the traits of cattle to be selected for and conserved in the cattle breeds.

Economic theory draws a line between the allocative performances of competitive markets for public versus private goods. Further, economic theory on public goods suggests that truthful value revelation for public goods is much more problematic than for non-market private goods (Carson et al., 2001). It is therefore desirable to know if the African cattle and its genetic resources are private or public non-market goods. Strictly speaking, genetic material is not commonly available to users separately from the phenotype (physical characteristic). If one considers the genetic endowment of a single head of cattle, this appears to fit the private good definition, as it is clearly excludable and rival in consumption.

However, animal genetic resources can also be classified as quasi-public goods, since the genetic base determining a physical trait typical of a breed is shared across all the individuals of the population of the breed. Access to several fertile individuals may be very inexpensive, implying low excludability, and consumption of AnGRs is not well defined as it is not the main purpose of herd management. In fact, AnGRs are employed to generate new individuals, and are not used up in any sense, unless the phenotypes carrying them are destroyed. They are a renewable resource so long as they are managed appropriately. This argument suggests the existence of a weak form of non-rivalry in consumption (Scarpa, Kristjanson et al, 2003).

From this perspective, AnGRs may be considered quasi-public goods in an economic sense. The public good argument becomes more relevant when the issue of AnGRs management is observed from a different scale, the pool of genes shared among all individuals belonging to a particular breed. Benefits from the existence of such a gene pool are shared across many beneficiaries. This is especially the case when the pool is capable of producing phenotypes that are well-adapted to local environmental circumstances. From this viewpoint, then, AnGRs can be considered as pure public goods as both the non-rivalry and non-excludability criteria are met.

Regarding AnGR as pure public good, competitive markets will therefore fail to preserve valuable genetic stock in locally adapted cattle breeds considered unprofitable by pastoralists due to market signals since as agricultural and economic techniques advance, they bring change in product and technology preferences (M endelsohn, 2003). Fo r instance modern agricultural technologies tend to decouple agriculture from the surrounding natural environment. This they do by the creation of man-made environments for cattle such as the provision of artificial housing, regulated water and food supplies, veterinary care and improved pastures among others (Tisdell, 2003). For instance, there may be a heavy reliance on imported grains and food additives moving away from dependence on natural pasture.

This form of animal husbandry favours breeds that are highly productive under such conditions. Therefore, a breed with very little environmental tolerance, say Breed I (see figure 1), is likely to be favoured in comparison to a breed with a high degree of environmental tolerance, say Breed II. For example, curve ABC may represent production from breed I in relation to a range of environmental conditions and the corresponding curve for Breed II might be as indicated by curve DEF. If it is economic by human manipulation to hold environmental conditions at or in the neighbourhood of X_1, Breed I will be favoured and Breed II may disappear. Thus, a high-yielding risky situation is chosen. Nevertheless, if for some reason, farmers cannot sustain ideal or near ideal environmental conditions for Breed I, production from it collapses. In contrast, Breed II is more tolerant and robust in the local environment (ibid)

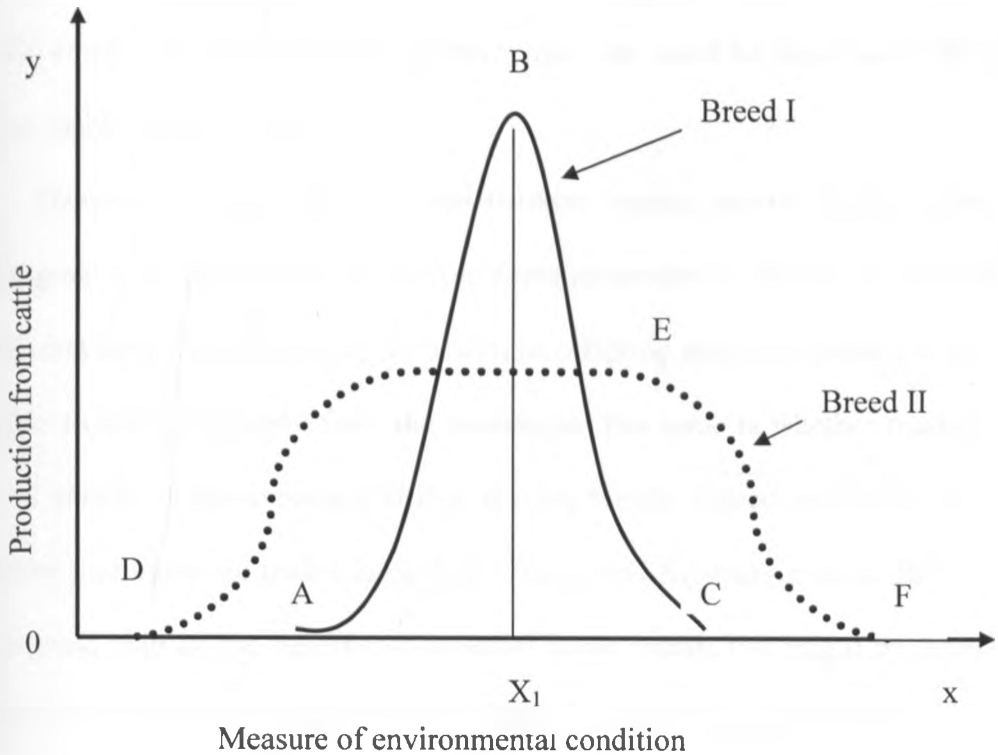

Figure 1: Modern Cattle husbandry may favour breeds that are highly productive but show a low degree of environmental tolerance (adapted: Tisdell, 2003)

From a long-term point of view, it is possible that concentration on high-yielding environmentally sensitive breeds will create a serious problem for the sustainability of livestock production. In addition, it is possible that farmers will lose their ability at some time to manipulate natural environmental conditions. If all environmentally tolerant breeds are lost in the interim, the level of cattle production could collapse. These arguments continue to reinforce the case for conservation of locally adapted breeds in the environments they evolved.

Breeds can be important elements of the genetic stock because they might contain special qualities that will be useful for future breeds. The animals themselves might not be economically viable in the prevailing economic conditions because their productivity is low. However, if they are capable of surviving in conditions brought about by local environmental and climatic stressful conditions, they may have genetic traits that could be combined with other animals to produce viable future breeds.

Therefore the question is would markets protect genetic stocks in breeds? From the private good perspective markets provide some protection as owners of particularly productive animals can earn a great deal say for semen or offspring since the genetic stock in breeds is not available to users separately from the phenotype. The issue is whether markets capture all the value of genetic stocks especially if they involve breeds. Indeed not all of, say, cattle attributes valued by pastoralist are traded in markets (Scarpa and Kristjanson et al, 2003). If the owners of breeds could reap all the benefits of potential future breeds that might be developed from their stock, there would be an incentive for markets to protect genetic stock. However, valuable genetic traits can be captured by purchasing only a few animals. If there are multiple owners of a particular breed, a potential buyer could buy a sample from any one of the owners. Because the genetic material is effectively co-owned, there is an incentive for all the owners to underbid each other trying to get the sale. As a result, the generic genetic resource in the breed will tend to be undervalued. No single owner can obtain the value of the resource as long as the other owners exist. Competitive markets will therefore fail to give incentives for the continued use of economically uncompetitive breeds to preserve valuable genetic stock (Mendelsohn, 2003).

Some studies have been done that have derived economic value of genetically determined traits associated with non-market and socio-cultural roles of livestock focusing on different traits such as disease resistance and traction power in different production systems and communities. Preferences for genetically determined traits are different according to spatial differences, the production system, communities involved and the prevailing socio-economic circumstances. No study has been done, in the knowledge of the author, to determine producers' preference for genetically determined cattle attribute among pastoralists with the aim of making the case for breed conservation in use. This study builds up on the discussion of conservation in use of cattle breeds by Tano et al (2003) and expands the range of adaptability traits to include drought tolerance.

CHAPTER III
METHODOLOGY

3.1 Stated Preference Methods and Conjoint Analysis

3.1.1Stated Preference Methods

Methods for valuing non-market, public goods are categorized as revealed preference (RP) that is indirect methods and stated preference (SP) that is direct methods. Revealed preference methods use actual choices made by consumers in related or surrogate markets, in which the non-market good is implicitly traded, to estimate the value of the non-market good for example tolerance to drought trait in cattle. Stated preference methods have been developed to solve the problem of valuing those non-market goods that have no related or surrogate markets. In these approaches, consumer preferences are elicited directly based on hypothetical, rather than actual, scenarios (Birol, Kontoleon and Smale, 2006).

Stated preference methods have been used by many authors; Tano et al, 2003; Scarpa, Kristjanson et al, 2003; Scarpa, Drucker et al., 2003; Ouma Abdulai et al, 2004 and Ouma et al, 2007, because they are able to capture the value of attributes that are important, but not captured by the revealed preference (RP) methods. The SP methods are more relevant in livestock attribute valuation in the developing countries because livestock is kept for both market and non-market reasons (Adamowicz et al, 1994; Scarpa, Kristjanson et al, 2003) and non-market values are difficult to determine using RP methods. In addition preferences for livestock attributes across regions, countries, communities, households and production systems are different (Scarpa, Kristjanson et al, 2003) thus valuation across such household specific factors is needed. In the current study the interaction effects of household characteristics were included in the analysis to capture their impact on cattle attribute valuation.

Stated preference methods ask the individuals to state their preferences from hypothetical choices hence the name, unlike RP methods which are based on actual choices observed in the market. The SP methods are appropriate in judging how individuals value certain products and services. They are used to place value to each of the attributes embedded in a good or service. The SP methods can be used to cover a wider range of attribute levels because they are hypothetical whereas RP methods do not encompass the range of proposed quality or quantity changes in the attributes of a good (Adamowicz et al, 1994: Birol, Kontoleon and Smale, 2006).

3.1.2 Conjoint Analysis

The contingent valuation method (CVM) and conjoint methods (CJ) are some of the SP methods used in attribute valuation. The CVM is most widely used for the estimating non-use values (Scarpa, Kristjanson, et al 2003) and it involves directly asking people how much they would be willing to pay (WTP) for specific services or the amount of compensation they would be willing to accept to give up specific services. The CVM is called contingent valuation because people are asked to state the WTP or WTA, contingent (dependent) on a specific hypothetical scenario. The method is however inadequate in the valuation of single attributes in a multi-attribute good (Scarpa, Kristjanson et al., 2003).

Conjoint analysis is a decompositional method that estimates attribute values of a product or service. It means estimating marginal values of a set of individual evaluation of alternatives that are pre-specified in terms of levels of different attributes (Green and Srinivasan, 1990) also called profiles. Although profiles give hypothetical options of a good's attributes, they should be realistic for the respondent's conceptualization, and not too many to cause confusion. About twenty profiles are considered too many for respondents with low education (Makokha, 2006). It is therefore critical to have a carefully thought out list of attributes in CJ analysis because too many attributes increase the burden on the respondents, yet too few reduce the predictive capability of a model (Green and Srinivasan, 1990; Hensher, 1994). Therefore there is need to limit attributes to only those that pastoralists are familiar with. The attribute levels chosen should include those levels in the current experience and if new levels have to be included they have to be within the believable bounds of the respondent. Attributes that have low medium and high levels can trigger behavioural response if the levels are clearly described and are well within the range of current experience and believability. The relevant attributes can be obtained from literature, key informants, past formal surveys or focused groups' discussions (Makokha, 2006). Information of the attributes for the current study was achieved by using the ranking done by Mwacharo and Drucker (2005) as basis for focused group discussions which then came up with the desired attributes that were used in the chosen conjoint analysis.

To preclude co-linearity between attributes, independent profiles, called orthogonal designs, are derived using an orthogonal design computer program (Kuhfeld, Tobias and Grant, 1994). In an orthogonal design, the parameter estimates are uncorrelated, which means each parameter estimate is independent of the other terms in the model. More importantly, orthogonality implies that the coefficients will have minimum variance, thus enhancing model efficiency (ibid). All possible combinations of the attribute levels give a full factorial design which considers all the main interactions, two level interactions and higher order interactions. The problem, however, with a full factorial design is that it is too costly and tedious to have respondents rate all possible combinations. For example, with five factors, two at two levels and three at three levels (denoted $2^2 3^3$), will have 108 possible profiles. To replace these exhaustive, but unmanageable designs, computer generated search algorithms are used to give a small number of non-exhaustive designs called information efficient or optimal orthogonal designs

(Kuhfeld, Tobias and Grant, 1994). Algorithms are defined, finite computer sets or operations or procedures that will produce a particular outcome. The algorithms use some efficiency criterion to get the efficiency designs, by selecting points or profiles from the full factorial design that increase efficiency to add to the experimental design, while deleting those that reduce efficiency. The orthogonal design so selected with the highest efficiency is the best amongst the others (ibid).

Orthogonal designs recognize main effects only and assume non-significance of the interaction effects among the levels. A main effect is an outcome that has consistent difference between levels of a factor. An interaction effect exists when differences on one factor depend on the level of another. The main effect designs assume that individuals process information in a strictly additive way, such that there are no significant interactions between attributes (Hensher, 1994). The SPSS computer program, which was used in the current study, uses the algorithm method to generate orthogonal main effects profiles. The attribute levels are fed directly in the orthogonal design generator to design the matrix for processing. The analysis in SPSS allows for specification for the minimum number of cases for the design. If the minimum number is not specified, the program allows for generation of the minimum number of combinations necessary for the orthogonal design. A full factorial design of three attributes each at three levels, as in the current study, gives $3^3 = 27$ profiles with all the interactions gives the following attribute effects:

Main effects: 1 2 3

Two-way effects: 12 13 23

Three-way effects: 123

The design has three main effects and four interaction effects. In general a full factorial design with three attribute levels can be written as 3^k, where k is the number of attributes. A fractional design is therefore $3^{(k-p)}$, where 3^{-p} is the fraction of the full factorial design (Makokha, 2006). For example a $3^{(3-1)}$ design is a 3^{-1} fraction (one third) of the full factorial design. The minimum orthogonal design for a 3^3 design gives 9 profiles (written as$3^{(3-1)}$). Blocking the profiles takes care of interaction effects (as the main effects stand on there own) and large orthogonal design. Particular profiles from the many profiles in the design are grouped together to make several distinct groups called blocks. Blocking reduces the number of profiles per card since there is a probability that respondents give inconsistent ratings as the number of profiles increases due to information overload (Green and Srinivasan; 1990Hensher, 1994). Information overload occurs when respondents are faced with large numbers of attributes and levels within attributes to make choices from. When faced with such tasks respondents tend to simplify the evaluation process by ignoring less important characteristics or by ignoring the levels themselves (Green and Srinivasan, 1990). However survey-based approach need to present respondents with enough choices that their preferences are sufficiently investigated, but must not overload them with many choices or give them too much information about each choice.

A complete block design (where each profile occur exactly the same number of times in each block) is not possible in CJ analysis. A balanced incomplete block design is achievable and is frequently used. The following are the requirements of a balanced incomplete block design (Green, 1974):

a) Each attribute level should appear once in each block,

b) Each attribute level should appear the same number of times in the experimental design, and

c) Every set of treatment (attributes) should occur together in the same number of blocks.

Table 3.0 shows an example of a balanced incomplete block design. In these designs, all treatment comparisons are of the same accuracy. A balanced incomplete design however is only possible where all attributes have the same number of attribute levels that is a symmetric orthogonal array (Makokha, 2006). All attributes used in the current study have the same number of attribute levels (3), thus the use of the balanced incomplete block design.

Table 3.0 Balanced Incomplete Block Design for Cow Attribute Valuation

Block	Card ID	Attributes and attribute levels		
		Milk yield	Drought tolerance	Purchase price
I	1	5 litres/cow/day	moderately tolerant	Ksh. 5,000
I	3	1 litres/cow/day	susceptible	Ksh. 25,000
I	4	10 litres/cow/day	tolerant	Ksh. 12,000
II	2	10 litres/cow/day	moderately tolerant	Ksh. 25,000
II	6	1 litres/cow/day	tolerant	Ksh. 5,000
II	7	5 litres/cow/day	susceptible	Ksh. 12,000
III	5	1 litres/cow/day	moderately tolerant	Ksh. 12,000
III	8	5 litres/cow/day	tolerant	Ksh. 25,000
III	9	10 litres/cow/day	susceptible	Ksh. 5,000

Conjoint analysis method is an extension of CVM, where large numbers of attributes can be included in the analysis without overwhelming the respondents, and where a respondent values attributes without offering money valuations (price tags) of the profiles (Gan and Luzar, 1993). The strength of CJ analysis lies in the information gained from measuring respondent's tradeoffs among multi-attribute products and services that can be used to establish utility of various products and services. The conjoint analysis method can be used to value livestock attributes in the face of different household characteristics, for example drought tolerance and feed requirements, that are not priced or transactions do not occur through organized markets, but desirable for breeding or conservation programs (Tano et al 2003: Scarpa, Drucker et al., 2003). This method is very relevant to Kenya and the current study situation because diversity in household's socio-economic characteristics causes differences in attribute valuation. This information can be of use in targeted interventions by government and researchers that counter the present trend towards marginalization of indigenous breeds.

According to Steenkamp et al (1987) the CJ analysis provides a more realistic situation to the respondent than the CVM, because attributes are evaluated as combinations. Products or goods possess attributes such as price, drought tolerance, milk yield and feed requirements for cows for example. Consumers typically do not have the option of having the product that is best in every attribute, particularly when one of those attributes is price. Consumers are forced to make trade-offs as they decide which products to keep (Kuhfeld, n.d). Consider a decision to purchase a cow for instance. High milk yield generally means increased high feed requirements and frequent watering. The trade off is an increase in purchase price and environmental impact and a decrease in milk yield and environmental adaptability. Conjoint analysis is used to study these trade-offs.

The CJ methods also provide consistency of answers from the respondents, which improves reliability of the results (Mackenzie, 1994). The CVM is close-ended with fewer alternatives, thus denying the respondents the chance to express a better strength of conviction (Casey, 2000). CJ methods have the ability of decomposing attribute profiles into marginal values. The inclusion of price as an attribute can be used to estimate the marginal utility of money, which is then used to get the marginal values and WTP for attributes (Mackenzie, 1992; Gan and Luzar, 1993).

3.1.3 Ratings, Rankings and Choices

The CJ method involves the respondent stating their preference either by choice, ranking or through rating. The choice design involves a respondent choosing from a set of alternatives, and its advantage is that it mimics the real environment best. However choice experiments are more difficult to design than the ranking and rating methods, because they require two choice sets, one to create choice alternatives (two or three alternative choices) and the other to create choice sets (the profile of each choice alternative) (Casey, 2000). Multinomial Probit or Multinomial Logit is the most appropriate choice models for analyzing choice designs. The multinomial Logit has been used by Scarpa, Kristjanson et al. (2003) in valuing indigenous cattle breeds in Kenya and by Karugia (1997) in his study of valuation of beef quality attributes in Kenya. Both studies by Scarpa, Kristjanson et al (2003) and Karugia (1997) compared the SP method with the traditional hedonic (RP) method. Scarpa, Kristjanson et al (2003) found that the choice method was precise in estimating the value for cattle traits relevant in market transactions for Maasai traders. After comparison of the two methods, RP and SP, they concluded that pastoralist engaging in cattle trading would not display a different set of economic preferences when answering hypothetical questions about cattle purchases, than when actually buying an animal. Their study validated SP method as revealing similar underlying preferences as in the RP method. Karugia (1997) also showed similarity in underlying preference structure of the two methods. The random utility theory is used in both the RP and SP models. In the current study the SP method was used to obtain and rank the cattle attributes valued by pastoralists in the face of their socio-economic and environmental conditions. Ouma, Abdulai et al, (2004) used multinomial and conditional logit models together with choice experiments in assessment of farmer preference for cattle traits in smallholder cattle production systems in Kenya and Ethiopia. Mixed logit model has also been used in choice experiments (Ouma, Abdulai and Drucker, 2007).There focus of the two studies was farmer preference for trypanotolerance, relative to other traits. In the present study the appeal is to the respondent's utility enjoyed from the cattle attributes. The study used the rating method unlike the choice experiments used by the above studies. The objective in the current study, as earlier stated, is to characterize the preferences over cattle attributes, while focusing on drought tolerance in relation to other attributes, of a group of pastoral producers operating within Kajiado district in Kenya.

Ranking is popular with analysts who subscribe to the view that individuals are more capable of ordering alternatives than choosing or rating (Hensher, 1994). It involves rank-ordering profiles from the most preferred to the least preferred. This method allows respondents to evaluate trade-offs among multiple attributes and facilitates consistency checks on response patterns (Casey, 2000). Baidu-Forson et al. (1997) used CJ ranking to incorporate non-monetary traits in some groundnut varieties. Therefore ranking can be used effectively in evaluating non-monetary traits in goods. However while the simultaneity of rankings reveals preference ordering efficiently, the respondent burden grows exponentially as the set of rankings increases thus increasing the likelihood of inconsistent ranking (Mackenzie, 1994).

Ratings are the richest response metric, giving both order and degree of preference (Hensher, 1994). Analysts select a 5 or a 10-point scale to represent an underlying continuous distribution of interval scaled rates. Casey (2000) used CJ rating method to incorporate some overlooked values from farmers' different agro-forestry practices in Brazil. Tano et al. (2003) used CJ ratings to estimate farmers' preference for cattle traits in Burkina Faso, West Africa. Both of these studies demonstrate use of ratings as a good method of evaluating traits that are not traded in the market as in the current study. Even though the method is the most demanding on the respondent (Hensher, 1994), it gives order of preference (just as rankings do) and additionally, degree of preference. The current study therefore adopted the CJ rating method.

The Ordered Probit or Logit are the most appropriate models for analyzing CJ rating or ranking data because the dependent variable takes increasing or decreasing intensity discrete values. The choice between ordered logit and probit models is normally due to convenience of understanding and the availability of the relevant software to use (Long, 1997 p.120) The Ordered probit model (OPM) was used and it has the same assumptions of cumulative normal distribution of the error term as binary probit, except that information is recorded with increasing preference intensities.

The ordinary least squares (OLS) has been the most commonly used model in CJ analysis, but the OPM was chosen over OLS because the OPM, a discrete choice model, solves heterscedasticity that occurs when OLS is used to analyse discrete dependent variables. In addition the maximum likelihood estimates are consistent and asymptotically normal (Sy et al., 1997). Heteroscedasticity occurs when the error term is not identically distributed because its variance is not constant, thus inflating the standard errors. Ratings data are preferably analyzed by treating the observed data as a non-linear rating scale in an ordered responses model which defines points on the observed rating scale as thresholds. Empirical rating scales are best viewed as discrete realizations of unmeasured continuous variables. The OPM allows one to include ordinal dependent variables into the preference model in a way that explicitly recognizes the ordinality and avoids arbitrary assumptions of cardinality and the consequent assumptions of equal utility distances between profiles. Unlike the OLS, the ordered probit (and logit) models take into account the floor and ceiling restrictions on models for example the attributes of an indigenous cattle breed and those of an exotic breed (Hensher, 1994). The OLS relates independent variables directly to ratings but the OPM first relates the independent variable to utility, then to their ratings through the threshold variables (Sy et al, 1997), a sequence that is consistent with the Lancaster consumer theory, the underpinning theory in the method used in the current study.

3.2 Theoretical framework

Analysis of cattle traits can be considered from the new consumer theory, developed by Lancaster (1966), which assumes that goods are not the direct object of utility, but it is from their attributes that the consumer derives utility (Sy et al, 1997: Tano et al 2003). That is utility or preference orderings are assumed to rank collections of attributes and only rank collections of goods indirectly through the attributes they posses (Lancaster, 1966). The assumption is that utility is related to the product attributes (Sy et al, 1997), and this utility can be decomposed into separate utilities (Tano et al 2003). This gives unbiased estimates of main effects of the attributes on utility, and marginal estimation of each level of each attribute can be obtained, without interaction effects of the attributes (Mackenzie, 1993).

The different physical traits or attributes expressed in livestock (cattle included) are genetically determined in the breeds (Simianer, 2005). 'Breed' is the most easily, commonly recognized and clearly demarcated unit of a stable genetic resource. In the context of cattle, the breed represents an aggregate of genes responsible for a recognizable set of physical attributes, which collectively differ from those of other breeds (Scarpa et al, 2003). For cattle such attributes or traits include milk yield, tolerance to drought, disease resistance, size of animal, ease of handling, ability to graze diverse species of grasses and ability to move long distances (Jabbar et al, 2003).

In terms of the utility function, this translates into using the attributes of goods as the arguments of the function. For cattle, this permits the analysis of pastoralists' preferences in terms of the benefits that they perceive to result from various genetically determined traits of cattle. The overall good in the current study is the cattle breed, a composite of various genetically determined traits in adaptation to the environment.

Conjoint analysis is one empirical application of the Lancaster consumer theory; hedonic price analysis (a traditional RP method) is another (Tano et al, 2003). A hedonic market is one for a heterogeneous good that is characterized by a series of attributes, for example a cow or a house or a car. The price of the good (e.g. the cow) depends on the bundle of attributes chosen: $P_{cow} = f$ *(udder size, milk per day, age of cow, size of cow, calving interval).* (Rosen, S., 1974) The hedonic price function, which relates each attribute to the price of the bundle, can be used to compute the marginal cost of each attribute: *Marginal cost of cow size* $= \partial$ *(price)/* ∂ *(cow size)* In selecting a cow the buyer equates the marginal cost of each attribute to his marginal WTP for each attribute. Estimating the hedonic price function and computing its derivatives thus yields estimates of the marginal WTP for each attribute (Rosen, S., 1974). However, using hedonic price analysis to estimate cattle owners' preferences in rural Africa can be very difficult. First, as noted by Tano et al (2003), 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. Second, 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 (Kohler-Rollefson, 2000). Third, breeding cattle and young animals are thinly traded in African markets (Tano, 2003). Fouth, hedonic price analysis has inherent identification problem in modeling (Karugia, 1997). In such circumstances, the collection of price data is likely to be incomplete and can suffer from substantial measurement errors. Therefore the consideration to use a stated preference method, in this case conjoint analysis, due to the advantages earlier mentioned.

In CJ data are generated through a survey in which respondents are asked to rate products with alternative levels of important attributes. Tradeoffs between attributes can be studied, including wider variation in relevant variables than might be observed in actual field data. Thus, researchers can design conservation strategies and guide new breed improvement programs by presenting traits of hypothetical cattle. Those data can provide information about the marginal values of the specified levels of traits. The marginal values can be used to generate preferences of producers of existing or hypothetical breeds that are described in terms of the levels of traits. The overall preference of a specific profile is obtained by adding up the estimated coefficients of the levels of traits that make up the profiles. This is particularly relevant for assessing the potential and overall utility of 'genetic resource' embedded in cattle breeds. The results of a conjoint analysis study can be used to distinguish differences in preferences between groups of respondents (Sy et al., 1997). Assessing these differences in connection with locations and production systems can lead to better targeting of conservation programs of breeds at risk of extinction.

Following Sy et al (1997), a producer's theoretical utility associated with the j^{th} breed choice can be written can be written as:

$U_j = f(S_{1j}, S_{2j}, ..., S_{gj}; Z_1, Z_2, ..., Z_i; \mu_1, \mu_2, ..., \mu_g | T_g) + \varepsilon$, where;

S and Z are the main effect variables representing the attributes good and household characteristics, respectively,

$j = 1, 2, ..., m$ stands for combinations of attributes,

$g = 1, 2, ..., n$ stands for attribute levels

$i, = 1, 2, ..., n$ stands for different household characteristics of the respondents performing the evaluation

$\mu_g = S_{gj} * Z_i$ denotes the interaction between the attributes of the good and household characteristics,

ε_{ij} is the stochastic error term that models the unobservable components of the function including measurement and random errors, T_g represents the parameter estimates.

Taking the first order conditions of the above equation with respect to the good's attributes gives the marginal utility that producer assigns to that particular attribute level.

$$\frac{\partial U(S^*)}{\partial S_g} = \frac{\partial f(.)}{\partial S_g} + (\frac{\partial f(.)}{\mu_g} X \frac{\mu_g}{\partial S_g}),$$ where;

$\frac{\partial U(S^*)}{\partial S_g}$ is the marginal utility of the g^{th} level of a good to a given individual,

$\frac{\partial f(.)}{\partial S_g}$ or V_g is the marginal value of the g^{th} good attribute level, measures change in utility when only product attributes levels vary,

$\frac{\partial f(.)}{\mu_g}$ or b_g is the , measures the variation in utility associated with changes in the interaction term, it is a direct measure of community segments. People with the same interaction term have similar preference, and hence can be grouped into one segment, $\frac{\mu_g}{\partial S_g}$ or Z_i is the individuals social-economic background. In terms of derivatives from the first order conditions, Z_i is not varying, and is therefore the constraint. In general the marginal utility of a product attribute to an individual can be presented by: $\frac{\partial U(S^*)}{\partial S_g} = V_g + Z_i\ b_g$ These marginal utilities arise from a change in utility following a change in the level of an attribute, other attribute levels remaining constant. At constant utility level, the marginal rate of substitution (MRS) for two attributes levels can be measured if all others are held constant except the two. This is the rate at which a consumer is willing to substitute one attribute for another in order to remain at the same indifference curve (Varian, 2003). Consider the utility function:

$U = b_1X_1 + b_2X_2 + \ldots$ where X_1 and X_2 are two attribute levels, b_1 and b_2 and are marginal utilities then constant utility means that:

$\partial U = b_1 \partial X_1 + b_2 \partial X_2 + ... = 0$. Rearranging the equation gives: $\frac{\partial X_1}{\partial X_2} = \frac{-b_2}{b_1}$

Thus the negative of the two coefficients will measure the MRS. The MRS measures the slope of the indifference curves assuming that monotonicity of preferences prevails. Moving along the indifference curves means giving up one good for another, thus dictating the negative slope (Varian, 2003). If the coefficient, b_1 , is the cost of the product then the marginal willingness to pay (WTP) is measured. When say b_1 is the cost of a given attribute, the consumer is willing to substitute (pay) some money to obtain X_2. Positive ratios show WTP for attributes that increase utility, while negative ratios show willingness to accept (WTA) payment in order to give up a product. This theory relates easily to cattle attribute valuation. Total utility to an individual arising from say a cow (which has different attributes) is a combination of changes in utility arising from change in each of the attribute and changes in utility when individual characteristics change.

3.3 Conceptual framework

The conceptual framework for analysis of cattle traits can be considered from the consumer theory developed by Lancaster (1966) which assumes that utility is derived from the attributes of goods rather than the good *per se* as noted earlier. The framework aims at identifying the underlying influences on an individual or group rating behaviour for cattle traits. A rating decision can be viewed as a decision making process linked to a complex web of factors both external and internal to the decision maker as presented in figure 2. The terms in ovals represent latent variables while those in boxes are observable by the analyst. Cattle can be viewed as discrete goods with a composite of various genetically determined traits with potentials of meeting several objectives. The decision makers problem is to rate highest a cattle profile that maximizes his utility from a set of alternative profiles with different levels of traits. These profiles can be perceived to represent different cattle breeds with varying trait levels. The universal set of alternative cattle breeds is determined by the decision maker's environment as it influences the options available to him. This may include factors such as properly functioning markets and level of development of national conservation and breeding programs. The personal constraints faced by the decision maker n, such as household income and access to information then determine the feasible profile set (C_{n}), which is a sub-set of the universal set of alternatives (C), represented as $C_n \in C$.

Following the new consumer theory, utility derived from alternative cattle profiles within the alternative set of the decision maker is perceived to be determined by the attributes of the alternatives. These are the sources of utility based on the new consumer theory. The decision maker is assumed to form a utility function for the alternatives and assign a utility value for each alternative by valuing and trading off the attributes that are important in his rating decision. A utility maximizing behaviour is assumed to be exhibited, resulting in preference and rating highest an alternative with the highest positive utility value.

Though the sources of utility are strictly linked to the attributes of the alternatives the contextual and socio-economic characteristics of the decision-maker are included since they influence preference and rating behaviour. These descriptors are not sources of utility per se, but can condition the role of unobserved attributes and be considered as influences on the parameter estimates of observed attributes. The inclusion of socio-economic characteristic of decision makers is one way of explicitly accounting for observed preference diversity as explained by specific observable characteristics.

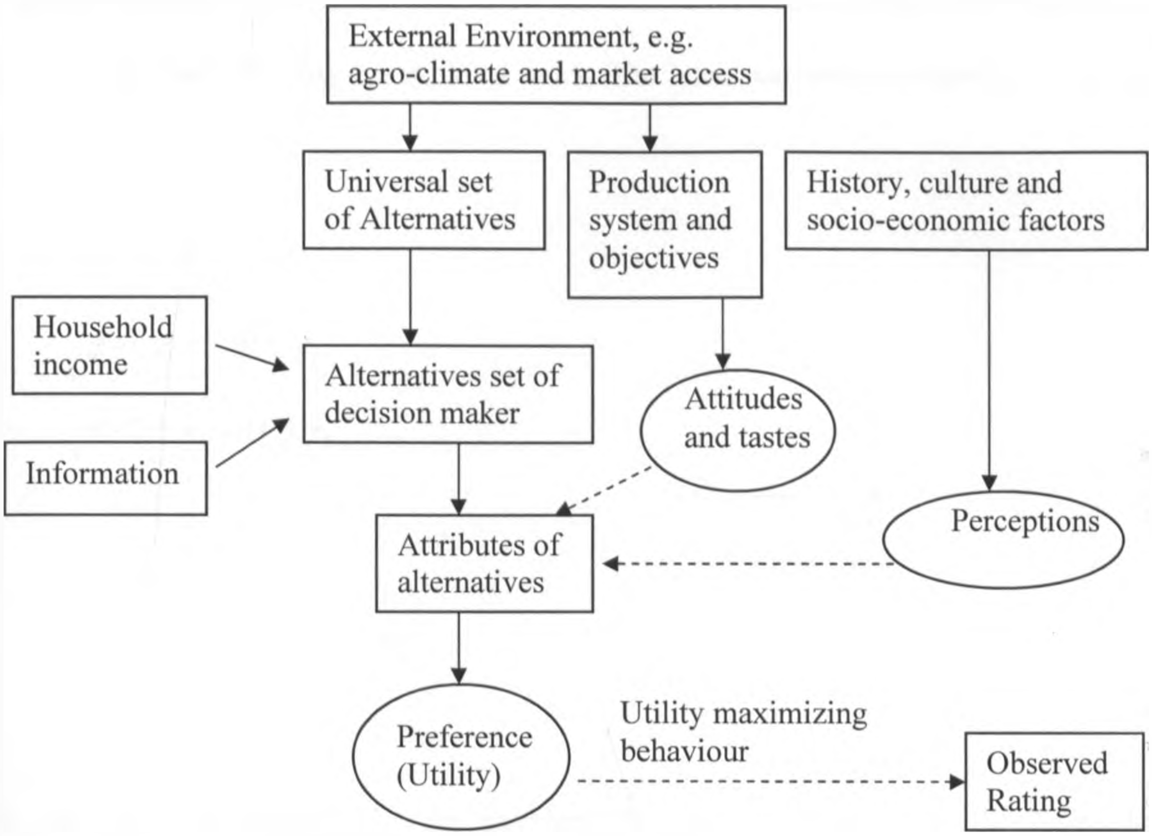

Figure 2: Rating model framework for cattle traits

A decision maker's attitudes and perception of the attributes and attribute levels are unobservable to the analyst and influences rating behaviour. Attitudes reflect the decision make's needs, values and tastes and are influenced by external factors as well as socio-economic characteristics. Perception of attribute levels is influenced by the decision maker's past experience, culture and other socio-economic factors such as age and level of education.

3.4 Empirical framework

The utility an individual will derive from keeping a given cattle breed is a function of the characteristics of the cattle breeds, the individuals' socio-economic background, the interaction between the individuals' background and the characteristics of the breed (Sy et al.,1997). Since utility is not directly observable, a latent (underlying) variable representing ratings or rankings of animals is used in place of utility in empirical work. The latent variable is related to utility as follows:

$$R=0 \text{ if } U \leq 0$$

$$R=1 \text{ if } 0 < U \leq \gamma_1$$

$$R=2 \text{ if } \gamma_1 < U \leq \gamma_2$$

.

.

.

$$R=\omega \text{ if } \gamma_{\omega-1} \leq U$$

Where R's are preference ratings, U is the unobservable utility level and γ's are the threshold variables that link the respondents' actual preferences and the ratings (Sy et al., 1997). Using the latent variable, the general empirical model is written as:

$$R = \alpha + X\beta + Y\lambda + e$$

where R is a vector of preference ratings (0, 1, 2,....n), X is a vector of non-stochastic variables capturing the levels of traits, Y is a vector of non- stochastic variables capturing the interaction between the levels of traits and farmers' background, β 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 individuals' characteristics and *e* is an error term. The marginal values β and λ are estimated from observations on R, X and Y. When the dependent variable is discrete, for example ratings or preferred choice, a discrete choice estimator is appropriate (Scarpa, Kristjanson et al., 2003).

The λ vector measures the variability in preferences due to the interaction between farmers' characteristics and the levels of traits. Farmers with the same estimated λ have similar preferences, and would make up one group of the producers. Preferences regarding physical attributes of livestock differ across regions, countries, communities and production systems. In developing countries, especially in low-input smallholder production systems, the most valuable livestock attributes are often those that successfully guarantee many functions, flexibility and resilience in order to deal with variable environmental conditions (ibid.). In contrast, in developed countries, livestock attributes maximizing output of specific products are more valuable. Livestock genetic diversity encountered in developing countries is a product of local environment combined with the breeding strategies of traditional communities. As stated earlier intra-species biodiversity (the differentiation of livestock species into different breeds) is the outcome of many different communities managing livestock in many different habitats and ecological niches, and manipulating its genetic composition (that, together with other environmental factors, which is responsible for the physically expressed trait) according to the specific requirements of their environment, their production system and their own preferences or breeding goals (Kohler-Rollefson , 2000).

Multi-purpose, rather than specialized breeds are more suitable to low-output/low-input production systems. For example, Davis (1993) reports results from a Northern Australia case study in which tropical and temperate breeds were compared, and shows marked evidence of the superior ability of tropical breeds to grow and reproduce in conditions of high ambient temperatures, poor feed quality and high parasite and disease incidence. Moyo (1996) has shown that, under the semi-arid conditions of southern Zimbabwe and for pasture-based beef production, the indigenous breeds, *Mashona* and *Nguni*, were more productive in terms of weaned calf produced per kg of body weight of cow per year than the exotic breeds and their crosses. Thus, estimates of λ can be used to assess preferences across production systems and different household characteristics in general to determine if a groupings approach to *in situ* breed conservation and improvement is warranted.

3.5: Data needs, Sources and Sampling methodology

To achieve its objectives the current study required data on household characteristics and how different households rate different combinations of cattle attributes. The data was collected through focused group discussions and cross-sectional household level survey conducted on a sample of 180 cattle keeping households in Kajiado district in Kenya.

A survey was undertaken where respondents were required to make ratings of their preferences on cattle traits. The development of a survey instrument involved a number of steps. First, available literature was reviewed to develop a list of important cattle attributes and producer characteristics for potential inclusion in the questionnaire. Second, focused group discussions were held with extension workers in the division and farmer groups from different locations of the study area in order to evaluate question formats, contents, identify important cattle attributes preferred by farmers and elicit general advice. The last stage was the development of the survey instrument, initial pre-testing, modification and preparation of the final version that was used at the household level survey.

The sampled households were randomly selected from six locations of Central division, Kajiado district. Each household respondent was asked to rate four sets of cow and bull attributes. Each set had five profiles. From each of the six locations selected, six villages were randomly selected and then at each village five households (boma) randomly selected. Major landmarks such as shopping centres, schools and churches, nearest the village headman's boma were identified. From the land mark point 5 households to the east-west transect were interviewed. Mwacharo, et al. (2003) used a similar transect line to get the sample in their study.

3.6: Identification of Attributes

Mwacharo et al (2003) listed 16 traits that pastoralist in Kajiado district consider important in specific cattle breeds. The list formed a working basis that was used to identify the four most important traits each for the cows and the bulls. The identification processes was conducted through focus group discussions. Five focus group discussions were held; the Sajironi, Seuri and Olgos group discussions were held in Sajironi cattle Market while the Delalekutuk and Silale groups meet at the District Livestock office in Kajiado.

The focus group discussion members listed eight important cattle traits for cows and bulls separately. From the list constructed they were asked to rank the four they considered most important. The rankings are as listed in table 3.1. Leg length, drought tolerance, history for milk in the dam and feed requirements were the four most highly ranked traits for the bulls, while milk yield, drought tolerance, udder size and feed requirements were the most highly ranked traits for cows. These four attributes (for bulls and cows) were respectfully selected for CJ analysis.

Purchase of animals, especially cows was listed as one way of building up or restocking of a cattle herd and buying of bulls was mentioned as a way of introducing new genetic vigour thus improving the herd. Money is used in transactions, hence the inclusion of price as one of the attributes. Price is a function of various attributes and characteristics, meaning that the marginal value of attributes and other characteristics contribute to price. However market prices do not specifically provide signals on the marginal value of specific characteristics that are important to producers (Sy et al, 1997). Nonetheless price enables one to put value on attributes and additionally most of the respondents participate in the market once in a while and therefore engage in evaluation of trade-offs between price and other attributes. Therefore price can be used to compute marginal utility for money and WTP (Gan and Luzar, 1993).

Table 3.1 Rankings of important cattle traits by discussion groups

Group	Sajironi		Seuri		Olgos		Dalalekutuk		Silale	
Traits	***Cows rank***	***Bulls rank***	***Cows rank***	***Bulls rank***	***Cows rank***	***Bulls rank***	***Cows***	***Bulls rank***	***Cows rank***	***Bulls rank***
Leg length		1		1		4		1		1
History for milk		3		3		3		3		4
Tentacles shape		6		7		6		6		7
Drought tolerant	2	2	2	2	3	1	2	2	2	2
Feed requirement	4	4	3	4	4	2	4	4	4	5
Tail length	6	5	5	6	5	5	5	5	5	6
Water requirement	7	8	8	8	8	8	7	8	7	3
Body condition	5	7	6	5	7	7	6	7	6	8
Milk yield	1		1		1		1		1	
Udder size	3		4		2		3		3	
Disease tolerant	8		7		6		8		8	

Source: Author workings

The attributes considered for analysis, therefore were leg length, drought tolerance, price, history of milk in the bull's dam and feed requirements for the bulls, whereas milk yield, drought tolerance, price, udder size and feed requirements were considered for cows. The improved bull has long strong legs, is susceptible to drought, is high priced, dam has history of high milk yield, and bull needs purchased feed supplements and or planted fodder. While the improved cow has high milk yield, is susceptible to drought, high priced, medium & firm udder and needs purchased feed supplements and or planted fodder. Therefore the improved cattle can be said to need high quality feed and high level management. The zebu bull has short legs, is drought tolerant, is low priced, dam has history of low milk yield, and the bull does not need purchased feed supplements and planted fodder. While the zebu cow has low milk yield, is tolerant to drought, is low priced and small udder and does not need purchased feed supplements or planted fodder. Therefore the indigenous zebu is low input cattle that have low output. Table 3.2 gives traits and traits levels used to generate the orthogonal designs that were used in the profiles.

Table 3.2 Attributes used in the cattle breed stated preference experiment

Bulls		**Cows**	
Attribute	***Levels***	***Attribute***	***Levels***
Leg length	1= short 2= long weak 3= long strong	Milk yield	1= 10 litres/cow/day 2= 5 litres/cow/day 3= 1 litres/cow/day
Drought tolerance	1=tolerant 2= moderately tolerant 3=susceptible	Drought tolerance	1=tolerant 2= moderately tolerant 3=susceptible
Price per animal	1= Ksh. 8,000 2= Ksh. 19,000 3=Ksh. 65,000	Price per animal	1= Ksh. 5,000 2= Ksh. 12,000 3= Ksh. 25,000
Milk history of dam	1= 1 litres/cow/day 2= 5 litres/cow/day 3= 10 litres/cow/day	Udder size	1=small udder 2= medium udder (firm) 3= large udder (sagging)
Feed requirement	1=need supplements 2=occasional supplements 3=No supplements	Feed requirement	1=need supplements 2=occasional supplements 3=No supplements

3.7 The Experimental Designs

Two survey designs were developed for both cows and bulls. The two designs were adopted to avoid giving a lot of information at one go (information overload) to the respondents. Also on ranking the attributes the focused group discussions gauge different attributes for the bulls and the cows. If one design were to be used with the five traits that had three levels each, then too many choices and too much information about each choice would be available for decision making. This crowding of information is what we call information overload. When there is information overload, survey respondents tend to simplify the evaluation process by ignoring less important characteristics or by ignoring the levels themselves, especially when they have to evaluate profiles with a large number of levels_(Green and Srinivasan, 1990). One design for each comprised of the two traits which were ranked as most important and price, while the second design (one for each of cows and bulls) included the remaining two traits. In the second design the most important adaptability trait, "drought tolerance", was included to make three traits and also to bridge the two cards used to present the profiles (Green and Srinivasan, 1990). Table 3.3 gives one of the experimental orthogonal designs and blocks for the study; the other designs are in appendices A3.2, A3.3, A3.4, and A3.5. For each of the designs the three attributes and their levels were used to get profiles for the experiment. Given that each trait had three levels, the number of profiles can be too high to have a meaningful rating of preference. The full factorial design of three attributes each with three levels gives 3^3 =27 possible profiles in one run, which will make data collection quite impractical. The profiles are many and will lead to information overload on the respondent thus may cause rating inconsistence (Green and Srinivasan, 1990). Each profile was presented in the form of a card representing a hypothetical breed that was described in terms of levels of traits included in the experimental design. Blocking the 9 combinations resulted in 3 different balanced incomplete block designs, each with 3 profile combinations. Adding two profile combinations to each block, one with all attribute levels for a typical improved exotic cattle and the other with attribute levels typical to a zebu gave five profiles for each block. The two extremes acted as the floor and ceiling of the profiles in each block, thus giving a comparison and reference points with the other levels in between (Adamowicz, 1994)

3.3 Orthogonal design 1 used for cow attributes valuation

Block	Card ID	Milk yield	Drought tolerance	Purchase price
I	1	5 litres/cow/day	moderately tolerant	Ksh. 5,000
I	3	1 litres/cow/day	susceptible	Ksh. 25,000
I	4	10 litres/cow/day	tolerant	Ksh. 12,000
I	10	1 litres/cow/day	tolerant	Ksh. 5,000
I	11	10 litres/cow/day	susceptible	Ksh. 25,000
II	2	10 litres/cow/day	moderately tolerant	Ksh. 25,000
II	6	1 litres/cow/day	tolerant	Ksh. 5,000
II	7	5 litres/cow/day	susceptible	Ksh. 12,000
II	10	1 litres/cow/day	tolerant	Ksh. 5,000
II	11	10 litres/cow/day	susceptible	Ksh. 25,000
III	5	1 litres/cow/day	moderately tolerant	Ksh. 12,000
III	8	5 litres/cow/day	tolerant	Ksh. 25,000
III	9	10 litres/cow/day	susceptible	Ksh. 5,000
III	10	1 litres/cow/day	tolerant	Ksh. 5,000
III	11	10 litres/cow/day	susceptible	Ksh. 25,000

3.8 Empirical Model

Four models, that is two models for bulls and two models for cows, were estimated. The analysis was conducted with the iterative maximum likelihood procedure for Ordered Probit Model (OPM) in Limdep (Greene, 2002), with ratings as the dependent variable on one hand and attribute levels and household characteristics being the independent variables. Since all the traits considered in this study have three levels, one level (the base level) was left out during the estimation to avoid the dummy variable trap. The medium level was the base level in this case. The interpretation of the parameter estimates of the variable that has been left out is the negative of the sum of the estimates of the levels that were included in the regression (Tano et al., 2003). All the attributes were effect-coded, thus making coefficients marginal values. The effect-coding dictates that all coefficients should add up to 0 (ibid.) and they enable direct measurement of marginal changes in the dependent variable as a result of a unit change in the independent variable. The base level is assigned -1 for all columns representing the remaining levels. Each column contains 1 for the level represented by the column a -1 for the base and a 0 for otherwise.

The convention in stated preference models is to use "effect codes" rather than 1,0 dummies. Effect codes are common in applied statistics in the analysis of designed experiments because (a) 1,0 dummies confound the alternative-specific constant with the effects of interest; whereas, effects codes orthogonalize the attribute effects to the constant, (b) effects codes simply contrast the parameter estimates with one of the levels; whereas 1,0 dummies contrast the estimates with the constant, and (c) interactions defined from effects coded columns are orthogonal to their respective main effects and other estimable interaction effects; whereas 1,0 coded dummies are not (Adamowicz et al, 1994). Thus effects codes have more desirable estimation properties.

The following empirical models were fitted to the data:

$$Y^* = \alpha + \beta_i X_i + \gamma X_i Zg + e$$

Where Y^* were the ratings of the profiles that were rated from 1 to 5. X_i stands for

MILKYIELD, DROTOLRT, DROTSUSP, PRICE, (see table 4.0 for a description of the acronyms of the variables) attribute levels in model 1 for cows evaluation, DROTOLRT, DROTSUSP, TEUDLARG, TEUDSMAL, NOSUPP, NEEDSUPP attribute levels in model 2 for cows evaluation, LSTRGLEG, SHTLEG, DROTOLRT, DROTSUSP, PRICE attribute levels in model 1 for bulls evaluation, and DROTOLRT, DROTSUSP, MILKHLOW, MILKHHIGH, NOSUPP, NEEDSUPP attribute levels in model 2 for bulls evaluation.

X_i Z_g is the interaction terms between attribute levels X_i and household characteristics Z_g. Letter g stands for all household characteristics considered, while *e* is the error term. Table 4.0 describes the variable names used for attributes and the household characteristics thought to influence the valuation of the attributes.

3.9 Profile Presentation

Alternatives that are specified in terms of levels of different traits (attributes) are called profiles in this study. These profiles were presented to respondents for rating. Stimuli to elicit response on the profiles from respondents can be presented to respondents in one of the following three ways: verbal descriptions, paragraph descriptions, and pictorial representations (Sy, et al., 1997; Tano, et al., 2003). Verbal descriptions use cards in which each level of traits is described in a brief line item fashion, while paragraph descriptions give a more detailed description of each level. Pictorial representations use some graphical images to present the levels of traits.

Table 4.0 Attributes and the household characteristics descriptions

Attributes	Level name	Description
Milk yield[m]	MILKMOD	Moderate milk yield 5 litres (= -1) verses
	MILKLOW[c]	Low Milk Yield 1 litres (= 1)
	MILKHIGH[c]	High Milk Yield over 10 litres (= 1)
Purchase price[m]	MODPRICE[bc]	Moderate price Ksh.12000(cow), Ksh.19000(bull), (= -1) Vs
	LOWPRICE[bc]	Low purchase price Ksh.5000(cow), Ksh.8000(bull), (= 1)
	HIPRICE[bc]	High purchase priceKsh.2000(cow),Ksh65000(bull), (= 1)
Drought tolerance[m]	DROTMOD[bc]	Moderate drought tolerant (= -1) Verses
	DROTOLRT[bc]	Drought tolerant (= 1)
	DROTSUSP[bc]	Drought susceptible (= 1)
Udder size[m]	TEUDMOD[c]	Medium firm udder (= -1) Verses
	TEUDLARG[c]	Large udder (= 1)
	TEUDSMAL[c]	Small udder (= 1)
Feed requirements[m]	MODSUPP[bc]	Occasional supplements (= -1) verses
	NOSUPP[bc]	No purchased supplement (= 1)
	NEEDSUPP[bc]	Need purchased supplements (= 1)
Leg length[m]	LWKRGLEG[b]	Week legs (= -1) verses
	LSTRGLEG[b]	Long strong legs (= 1)
	SHTLEG[b]	Short legs (= 1)
Milk yield history of dam[m]	MILKHMOD[b]	Moderate milk yield history 5 litres (= -1) verses
	MILKHLOW[b]	Low milk yield history of dam 1 litre (= 1)
	MILKHHIGH[b]	High milk yield history of dam 10 litres (= 1)
Household characteristics		
Off-farm income[m]	INC	None (= -1) verse Has (= 1)
Land size	LAND	Land size of the household in acres
Education of hh head	EDUC	Formal Education of household head in year
Number of goats	GOAT	Number Other non-grazing livestock (goats)
Location[m]	WET	Dry (= -1) verses wetter (= 1)
	α	Conventional intercept and threshold interval dummy
	β	Parameter estimates in main effects
	γ	Parameter estimates in interactions

[c,b,bc]The referenced attributes levels were used respectively for cows, bulls and both bulls and cows evaluation. The household characteristics were used for both bulls and cows evaluation.

[m]Attributes with multiple levels are coded using effects codes. The base level is assigned -1 for all columns representing the remaining levels. Each column contains a 1 for the level represented by the column and a -1 for the base and 0 for otherwise.

Tano, et al. (2003) and Irungu (2006) used verbal card description and some pictures in their studies. Sy, at al (1997) used verbal card description in their study. A combination of verbal card description and pictorial presentation is expensive, needs more time to conduct a field interview and the respondent could be fatigued more quickly as compared to card presentation only, which is convenient, straight forward and inexpensive (Tano, et al., 2003). In the current study verbal description on cards was preferred in presentations of the differences in the levels of cattle traits to survey respondents. The profiles describing attribute characteristics were written to cards.

During personal interviews, household respondents were asked to consider five profiles each, of bulls design 1 and design 2 and of cows design 1 and design 2, and give a rating to each profile using a five-point (1-5) preference scale, where 5 means the most desirable animal profile for the respondent's cattle operations, 1 the least desirable animal profile and ratings 2 to 4 to represent desirability between the two extremes. Beans were used to represent the rating scale, with 5 beans used for the highest preference (5) and 1 bean for the least desirable profile (1). After considering all the five profiles in each card deck the respondent evaluated each profile by assigning a number of beans corresponding to the rating he or she preferred. Ratings of profiles were recorded using a prepared questionnaire. Each questionnaire had four block designs, one each for the first and second experimental design for bulls and the first and second experimental designs for cows. All block one experimental designs were placed in one set of questionnaires and likewise for bock two and block three experimental designs. The block designs were divided equally among the total number of questionnaires (180) that were to be administered.

3.10 The Study Area

The study area was the Central division of Kajiado district in Kenya. Central division of Kajiado district has predominantly the Maasai community who are mainly pastoralist. However, immigrant communities (Kikuyu and Kamba) have come in and introduced crop faming for subsistence (Kristjanson et al 2002), and cattle of different breeds which has also been adopted up by some of the indigenous Maasai. This introduces a cosmopolitan community who are more likely to have information about the advantages and disadvantages of different breeds and also can have option of adopting different breeds into their herds. The Central division of Kajiado district is also the division in which the district headquarters lay, therefore technologies on cattle improvements through extension efforts and spill-over from people staying in the Kajiado town is more intense here. In addition movement to most parts of the vast division was easier and less expensive having the district headquarter as the base for the current study.

The division has ten administrative locations, which are Ildamat, Loodokilani, Sajiloni, Enkorika, Oloibelbel and Nkoile, in which the study was done, and Enkaroni, Township, Torosei and Olootuluguni. Figure 3 shows the map of the study area. The land tenure system was formally group ranches were land was owned by a group and grazing was communal. However subdivision of the group ranches was done and members were given allotments of parcels of land. The allotments were of different size in acres for different groups. Individual owners of land respect the boundaries while razing. The main economic activity in the study area is livestock keeping.

The area is semi arid and at an altitude of less than 1000 m above sea level with poor soils, having low potential for biomass production. Temperatures range from a minimum of 18.C to a maximum of 32.C. The rainfall pattern is bimodal, erratic and poorly distributed with peaks occurring during the long (March to May) and short (October to December) rainy seasons. The annual precipitation is between 300mm and 800 mm with a rainfall reliability index of 40% (Jaetzold and Schmidt, 1983), with the area towards the north and north-eastern part of the division (including Ildamat, Loodokilan and Sajilon locations) being wetter and greener (for it receives more precipitation) than that towards the south and south-eastern (including Enkorika, Oloibelbel, Enkorika and Nkoile locations). Thus, the natural conditions favour livestock or game ranching.

Figure 3: Map of Kenya with Kajiado District inset and a pullout of Central Division in Kajiado District

When the residents have to sell their animals they walk them for long distances to the market places. Some of the livestock markets that the keeper use includes Sajiloni and Township in the division and Kiserian in neighbouring Ngong division.

CHAPTER IV
RESULTS AND DISCUSSION

One hundred and eighty questionnaires were administered to 180 households. Seven of the questionnaires did not have complete data and could not be used in the analysis. Therefore 173 questionnaires were available for analysis. All the 173 households that took part in the survey grazed their cattle on free range pasture. Table 4.1a gives summary statistics some of the household characteristic. Only 57 (about 33%) of these households had a source of off-farm income. The average land holding for grazing for each *boma* was 184 acres while the least acreage held was 10 and the maximum was 1900 acres. Of the surveyed households (*boma)*, the household heads had an average education of 5 years of formal education. There were household heads that had no formal education at all and the highest formal education attained was of up to college level of 15 years. The mean age of the household heads was 48 years. The youngest head of household was 22 years while the oldest was 80 years. Ninety eight percent (169) of the household heads were men. The average size of the household was 8 members. The number of cattle kept was from 1 to 251 with the average household keeping 27 cattle.

Table 4.1a Summary Statistics of Household Characteristics

Variable description	Mean	SE	Minimum	Maximum	n
Land size of the household in acres	183.6	15.71	10	1900	173
Number of goats owned by household	36	3.49	0	400	173
Total cattle kept by household	27	2.79	1	251	173
Household size	8	0.26	2	17	173
Age of household head	48	0.98	22	80	173
Education of household head in years	5.4	0.42	0	15	173

Of the 173 households nine of them keep at least one of the breeds recorded. Eighty percent of the households kept cross breed of the cattle. Table 4.1b shows cattle breeds kept by household with different characteristics. Most of the crosses were of the Zebu and Sahiwal line. Ten percent of the families kept Sahiwal, 7.14% of the households kept Zebu, 1.65% kept Boran and less than 1% kept Exotic breeds. All the households that kept Zebu and Boran breeds and 79% of the households that kept Sahiwal breed while 47% of those that kept crosses had less than eight household members.

Sixty nine percent of the households that kept Zebu, all those who kept Boran, 79% of the Sahiwal keepers and 63% of the households that kept crosses had each a herd of less than twenty seven.

Table 4.1b Cattle Breeds Kept by Household with different Characteristics

		Zebu	Boran	Sahiwal	Crosses	Exotic
Number of hh keeping breed		13	3	19	146	1
Households with size (Members)	< 8	13	3	15	68	1
	8(mean)	-	-	3	9	
	> 8	-	-	1	69	
Households with Total cattle	< 27	9	3	15	92	1
	27(mean)	-	-	-	1	-
	> 27	4	-	4	53	-
Households with head education up(yrs)	0-7(Primary)	4	2	7	78	1
	8-12(Secondary)	5	1	7	53	-
	13-15(College)	4	-	5	15	-
Mean age of h/hold head		57	44	51	47	35
Households with Land size	< 184	7	2	15	87	-
	184(mean)	-	-	-	-	-
	> 184	6	1	4	59	1
Households with off-farm income members		5	1	9	47	0

The educational attainment of the household heads was respectfully;

a) 31% of zebu keepers, 67% of boran keepers, 37% of sahiwal keepers and 53% of crosses keepers, up to primary,

b) 38% of zebu keepers, 33% of boran keepers, 37% of sahiwal keepers and 36% of crosses keepers, up to secondary,

c) 31% of zebu keepers, 26% of sahiwal keepers and 11% of crosses keepers, up to college level. The percentage of those who have attained higher education and were keeping zebus was higher. Those with higher education are likely to get off-farm employment, thus they kept zebus which require less of there man hours in management so as to employ the time in other economic employment activities.

The mean ages of the household heads are 57, 51, 47, 44 and 35 respectfully, for the households that kept Zebu, Sahiwal, crosses, Boran and exotic breeds. On average household heads of those who kept Zebus were older and household heads of those who kept crosses and exotic breeds were younger and that most households kept crosses. This may be explained by the fact that younger generation was taking up the technology of crossbreeding more seriously than the older generation. Most of the households (61%) had land holding that was less than average (184 acres). Those households which kept crossbreeds have the least percentage (32%) of its members who have off-farm income, followed by those who keep Boran breed (33%). Those who keep Sahiwal have the highest percentage of household members with off-farm income (47%) while those who keep zebu have 38% of its members with off-farm income. The Sahiwal breed is relatively expensive and thus needs off-farm income to purchase, while the high percentage of members earning off-farm income for the zebu keepers would be explained by the relative management easy that the breed requires thus releasing the labour for off-farm employment.

In the conjoint analysis for cattle attributes analysis, four models were estimated using the iterative maximum likelihood procedure for Ordered Probit in LIMDEP (Green, 2002) with the ratings as the dependent variable and the attribute levels and the household characteristics as the independent variables.

4.1 Main Effects

Separate models were estimated for cows and bulls using ordered probit. Model 1 for cows was fit to data collected with the first design (2 highest ranked traits and price) and is used to estimate the marginal values of milk yield and part worth values for drought tolerant, drought susceptible and purchase price. One attribute, drought tolerance had three effect-coded levels, but the medium level was not included in the OPM to avoid the dummy variable trap. Each attribute level had its column, and code 1 was for the level present in the ranked combination, 0 for the other level absent in the combination and -1 for the omitted attribute level. The other attributes, milk yield and purchase price retained their real values. Model 2 for cows was fit to data collected for second design (drought tolerance and 2 lowest ranked traits) and used to estimate part worth values for drought tolerant, drought susceptible, large udder, small udder, need for purchased supplements and no need for purchased supplements. All explanatory variables were non-continuous and were entered as effect-coded variable, taking the values 1, 0, or -1. Model 1 of bulls was fit to data collected with the first design (2 highest raked traits and price) and used to estimate marginal values and part worth values for long strong legs, short legs, drought tolerant, drought susceptible and purchase price. Effect-codes of the form 1, 0, and -1 were used for the attribute levels, with -1 being for the omitted attribute level in the OPM. The use of effect coding (1,-1) instead of dummy coding (0, 1) leads to marginal effect coefficients being equal to partworths (Sy et al., 1997) Model 2 for bulls was fit to data collected with the second design (drought tolerance and 2 lowest raked traits) and used to estimate partworth values for drought tolerant, drought susceptible, history of low milk yield for dam, history of high milk yield for dam, need for purchased supplements and no need for purchased supplements.

The estimated results for cows are presented in Table 4.2 and the results for bulls are presented in Table 4.3. The appropriateness of the specified models was tested from the magnitude of threshold variables,γ's which link profile ratings and utility. The threshold coefficients should vary in the following manner: $\gamma_1 \leq \gamma_2 \leq \ldots \leq \gamma_{w-1}$ and they must be positive (Sy et al., 1997). Failure to exhibit any of these conditions would imply specification error of the model. In this study, all the threshold coefficients were positive, followed the above rule and were statistically significant at 99% confidence level ($p<0.01$), implying that there was no misspecification error.

The overall significance of the models is assessed using the likelihood ratio statistic, which is distributed as a chi square. The null hypothesis tested here is that all coefficients of the regressors do not affect ratings of the cattle attributes.

That is H_0: $\beta_1 = \beta_2 = \ldots = \beta_i = 0$ (Long, 1997). In the study the critical values are of 9.488, 11.070 and 15.033 for respectively 4, 5 and 6 degrees of freedom at the 5% level of significance. The likelihood ratios for all the models are 328.04 and 260.19 for models 1 and 2 for cows and 129.19 and 376.81 for models 1 and 2 for bulls. The likelihood ratios are much larger than the critical values, indicating the rejection of the null hypothesis, $\beta_1 = \beta_2 = \ldots = \beta_i = 0$, at 95% confidence level. This means that the attributes are relevant variables in explaining the variations in preferences.

The significance of the individual parameters was assessed using the p-value. Results of the main effects of levels of traits of cows on ratings, shown on Table 4.2 indicate that all coefficients were found to be statistically significant at 10% significance level, apart from two attribute levels, one each from model-1 equation and model-2 equation.

Table 4.2: Coefficients of the Main Effects of Levels of Traits of Cows on Ratings

Variable	Model 1 coefficient	WTP/WTA (KSh.)	Model 2 coefficient
Constant	0.394(0.0817)***		0.596(0.0450)***
Milk Yield	0.072(0.0123)***	1,800	
Purchase price	-0.00004($5.3x10^{-5}$)		
Drought tolerant	0.746(0.0629)***	18,650	0.333(0.0600)***
Drought susceptible	-1.075(0.0644)***	-26,875	-0.423(0.0602)***
Moderate drought tolerant[b]	-0.329		-0.09
Large udder			-0.086(0.0656)*
Small udder			0.021(0.0604)
Medium firm udder[b]			-0.065
No purchased supplements			0.535(0.0606)***
Need purchased supplements			-0.357(0.0606)***
Occasional supplements[b]			0.178
Coefficients of threshold variables			
γ_1	0.377(0.033)***		0.316(0.0301)***
γ_2	0.834(0.041)***		0.706(0.0387)***
γ_3	1.566(0.055)***		1.354(0.0511)***
Log likelihood (Lω)	-1172.619		-1187.764
Restricted log-likelihood(Lυ)	-1336.639		-1317.859
Likelihood ratio (LR)	328.04		260.19
Degrees of freedom	4		6

***, **, * denote significance at 1, 5 & 10% levels respectively, n = 865

[b] The coefficient estimate of the reference level is equal to the negative of the sum of reported levels

Values in brackets are standard errors

The likelihood ratio is computed as: LR = -2 (Lυ - Lω)

The coefficients for purchase price in model-1 and that for small udder in model-2 were not significant. Most coefficients in the two models were significant at the 1% significance level. Significance of the coefficients means that the attribute levels are different from the typical category, which was the medium level of each attribute studied. The non-significance of a coefficient does not mean that the attribute or the level of attribute is not important to producers. Rather, it implies that producers are indifferent to the proposed range of variation in levels of attribute. The coefficient on each attribute level represents the marginal value (measuring the underlying marginal utility) that the typical producer (the respondent), irrespective of background, assigns to each attribute level of preference. Marginal utility is the change in utility obtained from a bundle of goods when the level of one of the goods varies slightly as the levels of the other goods in the bundle remain constant (Varian, 2003). In the current study the bundle of good is referred to as the profile of attributes and the marginal utility is that of the attributes that make up the bundle. Each profile describes a breed or hypothetical breed of cattle in terms of pre-specified attribute levels. To illustrate the marginal values, the marginal value that an average producer places on a cow with high milk yield is 0.072 while a marginal value of -1.075 is attached by the same average producer to a cow that is drought susceptible in model-1. Negative marginal values mean that producers' preference (utility) would decrease when attribute levels are varied positively and positive marginal values mean that producers' preference would increase, relative the base level, when attribute levels are varied positively. Marginal values measure the underlying utility, and since utility or preferences are ordinal measures, the relative importance of the coefficients is more important than the absolute magnitude. Therefore large marginal values associated with an attribute level indicate high preference for that particular level. The positive and significant coefficient of the milk yield attribute means positive marginal utility, implying that households gave higher ratings to profiles with higher milk yield than to profiles with lower milk yield. The coefficient on purchase price is not significant, implying that the producers were indifferent to the range of values that were proposed for price. The attribute drought tolerance has relatively large and significant coefficients in both models for cows. This indicates that producers place high value in drought tolerant cows than in drought susceptible cows (the coefficients on drought susceptible are negative). Similarly cows that depend entirely on natural pasture are preferred to cows that will need supplementation on natural pasture for their feed requirements. The negative and significant coefficient to the attribute level, large udder, implies that producers are averse to cows with large udders and that large udders reduce the marginal utility the producer derives from such a cow.

The negative ratio of marginal utilities gave the Marginal Rate of Substitution (MRS). If the denominator in the ratio of the MRS was the marginal utility arising from a change in the purchase price then the marginal WTP or WTA was obtained. The marginal WTP for an attribute is obtained if the sign on the ratio is positive while the marginal WTA compensation to keep an attribute if the sign on the ratio is negative. For example in model 1, KSh. 1,800, $(-[\frac{0.072}{-0.00004}])$ is the value a typical household is willing to pay (WTP) to have a cow with high milk yield. The marginal WTP for drought tolerance is KSh. 18,650. The typical household is willing to pay more for a cow that is drought tolerant than for a cow with higher milk yield. This ranks drought tolerance higher than milk yield. The marginal WTP for drought tolerance was Ksh. 18,650 while the marginal WTA compensation to have a drought susceptible cow was Ksh. 26,875. This is because households are not sure of the weather conditions that bring about drought and the subsequent survival of their cattle, therefore they would want to be compensated KSh. 26,875 for the lower utility. The measure of WTP and WTA can only be equal in a predictable perfectly competitive environment (Makokha, 2005). In the current study, lack of drought predictability due to unpredictable rainfall and climatic patterns causes much higher WTA. If the predictability of drought was more reliable, then the WTA value would be closer to the WTP value.

It is important to look at how households trade-off feed requirements with other attributes because it is the most important attribute in model 2. The reference point for feed requirement is the medium-level attribute, occasional supplementation. With reference to this base level attribute the marginal rate of substitution (MRS) of feed requirement for drought tolerance is;

$$\frac{-(-0.423)}{0.178} = 2.376 \text{ units of supplementation.}$$

This means that, other attributes remaining constant, a typical household trades off 2.376 units of occasional supplements for higher drought tolerance in a cow. A typical household trades off;

$\frac{-(-0.086)}{0.178} = 0.483$ units of occasional supplements for a cow with a small udder. The trade-offs show that the occasional feed supplements that households give up to rear cows that are drought tolerant (an adaptability trait) is more than that they give up to keep a cow that has a small udder (productive trait). This leads to the conclusion that the adaptive trait is preferred to the productive trait.

The coefficients of the main effects of levels of traits of bulls on ratings are reported in Table 4.3. The results indicate that all the coefficients were statistically significant at 90% confidence level, except for two attribute levels in model-1 equation. The coefficients for long strong leg and for purchase price were not significant. Non significance of coefficients means that preferences of the respondent for the specified levels were not significantly different from the typical categories,. As stated earlier the respondents were indifferent to the proposed range of variation in levels of attribute. Most of the coefficients in the two models for bulls are significant at 99% level.

Table 4.3: Coefficients of the Main Effects of Levels of Traits of Bulls on Ratings

Variable	Model 1	WTP/WTA (KSh.)	Model 2
Constant	0.674(0.0664)***		0.546(0.0527)***
Long strong legs	0.067(0.0554)	3,350	
Short legs	0.074(0.0520)*	3,700	
Week legs[b]	-0.141		
Purchase price	-0.00002(1.51×10^{-5})		
Drought tolerant	0.158(0.0580)***	7,900	0.600(0.0649)***
Drought susceptible	-0.250(0.0623)***	-12,500	-0.542(0.0674)***
Moderate drought tolerant[b]	0.092		-0.058
Low milk yield history dam			-0.407(0.0699)***
High milk yield history dam			0.178 (0.0681)***
Moderate milk yield history[b]			-0.229
No purchased supplements			0.537(0.0721)***
Need purchased supplements			-0.710(0.0838)***
Occasional supplements[b]			0.173
Coefficients of threshold variables			
γ_1	0.261(0.0254)***		0.350(0.0326)***
γ_2	0.625(0.0344)***		0.807(0.0419)***
γ_3	1.199(0.0473)***		1.536(0.0555)***
Log likelihood (Lω)	-1263.682		-1127.529
Restricted log-likelihood(Lυ)	-1328.276		-1315.936
Likelihood ratio (LR)	129.188		376.814
Degrees of freedom	5		6

***, **, * denote significance at 1, 5 & 10% levels respectively, n = 865

[b] The coefficient estimate of the reference level is equal to the negative of the sum of reported levels

Values in brackets are standard errors

The likelihood ratio is computed as: LR = -2 (Lυ - Lω)

The positive and relatively large coefficient of short legs, which means a positive and relatively large marginal utility, implies that producers gave higher rating to bulls with shorter legs than to ones with longer legs. Just like in cows, drought tolerant has positive and relatively large coefficients in both models 1 and 2, meaning that bulls that are drought tolerant are preferred to drought susceptible bulls and that drought tolerance increases utility for such a bulls. Drought susceptibility reduces the chances of a bull surviving a drought occurrence, causing a small herd in herd post-drought period, a situation unfavourable to the producers because of reduced asset base reducing their ability to meet planned and emergency financial requirements.

It is therefore expected that bulls that are more susceptible to drought are not preferred by producers. The coefficient of drought susceptible is negative, therefore being consistent with expectation that drought susceptibility reduces utility the producer enjoys from bulls.

The bull is partly responsible of transmitting the milk yield trait to its daughters. The milk yield trait is also partly acquired from the dam. Therefore milk yield history of the bull's dam is important since it is expected that the bull will eventually transmit this trait to its daughters. High milk yield is preferred to low milk yield in cows. The sign on the coefficient of "low milk yield history of dam" is negative; implying that "low milk yield history on the bull's dam" reduces utility derived by the producers from the bulls. Bulls that do not require supplementation above natural pasture are preferred to bulls that require supplementation, which is why the coefficient on "no purchased supplements" is relatively large and positive. However the negative and significant coefficient of "need purchased supplements" implies that feed supplementation above natural pastures reduces preference in bulls.

The marginal WTP for a bull with short legs (KSh. 3,700) is higher than the marginal WTP for a bull with long legs (KSh. 3,350). Leg length can be considered as a proxy of bull size, in the sense that larger bulls (with long legs) produce more meat but they need more feed to maintain their bodies. In addition, leg length as a proxy to bull size can be considered as an adaptive trait in the sense that smaller bulls (short legs) require less natural pasture to maintain their small bodies. Although producers derive utility from keeping bulls that can produce meat, they prefer those that can depend entirely on natural pasture throughout drought seasons. They will therefore require to make trade-offs between these two traits. Thus a bull with short legs is preferred to a bull with long legs, meaning that on making trade-offs between the two, farmers prefer the adaptability trait to the productivity trait. The marginal willingness to pay for a drought tolerant bull ($-[\frac{0.158}{-0.00002}] = \text{KSh. } 7900$) is much higher than that of 'leg length' (Ksh. 3,700), emphasizing the preference of adaptability traits to production traits. Drought susceptibility in bull gives a disutility to the producers; hence the producers are willing to accept compensation, WTA, of KSh. 12,500 ($-[\frac{-0.250}{-0.00002}]$) to keep a drought susceptible bull. Bulls that are drought susceptible are likely to die quickly on the on set of drought than bulls that are drought tolerant. This loss will reduce the asset base of the producers thus reducing the capability to cope will the stresses of fluctuating and unpredicted weather conditions. Drought tolerant bulls are less likely to die on the onset of drought and will survive the drought. Cattle as a strategic livelihood asset are used as a store of wealth. When sold they meet planned and unplanned expenses of the household, therefore in the pastoral communities as in the study area it is logical for producers to prefer drought tolerant bulls. When selling cattle for planned or unplanned expenses the bulls (not cows) are sold first.

Each coefficient in the two models give the marginal utility that arise from a change in utility following a change in an attribute level, given constant levels of other attributes. At constant utility level, the marginal rate of substitution (MRS) for two attribute levels can be measured if all other attributes are held constant. This is the rate at which a consumer is willing to substitute one attribute for another in order to remain on the same indifference curve, that is derive same utility (Varian, 2003). With reference to feed requirement (occasional supplements) as the base, the marginal rate of substitution, MRS, of feed requirement for drought tolerance is $-[\frac{-0.542}{0.178}] = 3.045$ units of supplements, compared to $-[\frac{-0.407}{0.178}] = 2.287$, the MRS of feed requirement for high milk yield history of the bull's dam. Feed requirement substitution for drought tolerance is higher than feed requirement substitution for high milk yield history of the dam. Therefore drought tolerance in bulls is valued higher by the producers than high milk yield history of the dam. Drought tolerance is an adaptability trait and milk yield history is a productive trait. Consequently just like in the trait preference for cows, those for bulls lead to the same conclusion that adaptability traits are valued more than the productivity traits. Therefore the hypothesis that adaptability traits are not valued more than productivity traits by pastoral cattle producers is rejected.

4.2 Interaction Effects

A second set of ordered probit models was run with cattle attributes and household characteristics as the independent variables while preference ratings were the dependent variable. Table 4.4 shows the impact of interaction between levels of traits and household characteristics on ratings of bulls and cows. The significance of the interaction effects imply that household characteristics substantially influence attributes valuation, and that households can be segmented along their characteristics. Only the coefficients of the interactions that were statistically significant were used. Non significance means that different groups do not value the attribute any differently from the typical (average) household.

Table 4.4 Impact of Interaction between Levels of Traits and Household Characteristics on Ratings of Bulls and Cows

Levels of traits	Presence of off-farm income	Land owned in acres	Formal Education of household head in year	Keeping of other non-grazing livestock (goats)	Location (wetter)	Average household
Traits of Cows						
Milk Yield	-0.007 (0.006)	-0.234 (0.00002)	-0.0001(0.001)	0.0001 (0.0001)	0.004 (0.006)	0.072
Drought susceptible	-0.046 (0.056)	-1.347	-0.008 (0.009)	0.00006(0.001)	0.024 (0.05)	-1.075
Large udder	0.005 (0.054)	0.0001 (0.0002)	0.021 (0.009)**	0.0004 (0.001)	-0.017 (0.055)	-0.086
No purchased supplements	0.051 (0.051)	-0.001(0.0001)*	-0.011 (0.009)	0.0004 (0.001)	0.072 (0.052)	0.535
Traits of Bulls						
Short legs	0.011 (0.0514)	-0.0001 (0.0001)	-0.001 (0.008)	0.0008 (0.001)	-0.017(0.048)	0.074
Drought tolerant	-0.034 (0.059)	-0.00005(0.0001)	0.005 (0.0102)	-0.001 (0.001)	-0.108 (0.0565)*	0.600
Low milk yield history dam	0.038 (0.056)	-0.00004(0.0001)	-0.025 (0.0094)***	0.002 (0.001)	0.017 (0.0699)	-0.407
Need purchased supplements	-0.027(0.054)	-0.0001(0.0001)	0.021 (0.009)**	0.001 (0.001)	-0.091 (0.0546)*	-0.710

***, **, * denote significance at 1, 5 & 10% levels respective

Values in brackets are standard errors

Table 4.5 Part worth Values of Cattle Attributes to Household with Different Characteristics

Levels of traits	Presence of off-farm income	Land owned in acres	Formal Education of household head in year	Keeping of other non-grazing livestock (goats)	Location (wetter)	Average household
Traits of Cows						
Milk Yield	0.072	0.072	0.072	0.072	0.072	0.072
Drought susceptible	-1.075	-1.075	-1.075	-1.075	-1.075	-1.075
Large udder	-0.086	-0.086	-0.151	-0.086	-0.086	-0.086
No purchased supplements	0.535	0.534	0.535	0.535	0.535	0.535
Traits of Bulls						
Short legs	0.074	0.074	0.074	0.074	0.074	0.074
Drought tolerant	0.600	0.600	0.600	0.600	0.492	0.600
Low milk yield history dam	-0.407	-0.407	-0.432	-0.407	-0.407	-0.407
Need purchased supplements	-0.710	-0.710	-0.689	-0.710	-0.801	-0.710

Note: Part worth measures the overall preference for attributes by combining the coefficient for a typical producer with interaction effects.

A high part worth indicates a high level of preference.

The coefficients represent the incremental values of preferences for cattle attributed to household profiles. Interactions are specifically selected in order to keep data analysis to a manageable level but still demonstrate differences between producer characteristics. Since the coefficients are deviations from the average, the average part worth, they can be positive or negative. For instance a typical household would value a cow's 'feed requirements' attribute of requiring no supplementation at 0.535; a household with more land than average would discount-0.001 from the average part worth value. In the end, owning larger land sizes by households reduces part worth value attached to the attribute 'no feed supplements' to 0.354. Households whose heads have attained formal education of more than 6 years have an incremental value of 0.021 added to the part worth value of -0.086 attached to a large udder of a cow by an average household. The incremental coefficients on milk yield and drought susceptibility are not significant for any of the household characteristics. Therefore households with different characteristics do not perceive them differently from the way a typical households does.

For bulls the part worth value that a typical household attaches to drought tolerant trait level is 0.6, but a household in wetter location will discount this value by -0.108 leading to a part worth value of 0.492. An average producer would value the need purchased supplements attribute of bulls at -0.170; formal education of the household head of more than six years would add 0.021 to that value and households in wetter locations would discount-0.091from the average part worth value. Ultimately, the part worth values for need purchased supplements attribute of bulls would be -0.191 for a household whose head has more than six years of formal education and -0.261 for households in wetter locations.

4.3 Household Preferences

Although information on average part worth of cattle attributes is useful, it falls short of providing preferences of specific households based on their characteristics. Segmentation or grouping of the households was done on the basis of formal education of the household head, land size regularly used by the household for grazing, location of the household whether in the wetter (receive more precipitation) or drier (receive less precipitation) place of the study area, presence of off-farm income in the household and number of goats kept by the household (a proxy of the type vegetation cover in the area). The households are the cattle producers. These profiles of producers were interacted with cattle attributes to capture the impact of producer characteristics on preference for cattle attributes.

Table 4.5 contains the part worth values for each of the household characteristics chosen. The part worth values of each household characteristic are computed by adding the partworths of an average producer (household) to the incremental part worth value due to household characteristic (shown in table 4.4). Only coefficients that were statistically different from zero were included in the part worth values of household characteristics. A statistically insignificant coefficient of the interaction variables would mean that the household's preference for that particular attribute was not different from the preference of the typical household. A large part worth value associated with an attribute indicates high preference for that particular attribute.

All households have high preference for adaptive traits as compared to productive traits. Adaptive traits are those that make the animal get adapted to the local environment while productive traits bring about increase in products such as milk and meat. For instance, households that use more than average land size for grazing, place a high part worth on the trait of no need of feed supplements in cows (0.534) than the trait of milk yield (0.072). For the same household characteristic, drought tolerant trait (0.600) is valued higher than short legs trait (0.074) in bulls. Leg length is a measure of bull size, consequently approximating the amount of meat a bull can yield on slaughter. Thus the productive trait, leg length, is less valued than the adaptive trait drought tolerant by households with more than average land size.

Households with more than average education for the household head are more averse to cows with large udder than the average household. This may be explained by the knowledge that large udders are prone to more injury in the environment that is characterized by a vegetation of thorny bushes. The injuries increase production cost by increasing treatment costs as well as reduce production of milk as injured cows may mot be milked well. A slightly higher preference for cows that do not require supplementation is noticed for households with average of land size (184 acres) used for grazing as compared to households that have more than average land size. Households with larger than average land sizes, have not yet experienced reduced pasture availability (pressure). This would be implying an emerging land pressure leading to inadequate availability of pasture for the traditional free-ranging grazing system practiced in the study area.

Location is an important determinant of the demand for and supply of agricultural technologies (Staal *et al.*, 2002) as it shapes the farmers' production context. This context, in turn determines the level of resource endowment, constraints and institutions underpinning farmers' tastes and preferences for agricultural technologies. In this study, two areas were compared; households located in the wetter locations where pasture was green and available most part of the year, and the average household located in areas that are dry much of the year. Drought tolerance is of high preference in drier areas than it is in wetter areas as evidenced by the lower coefficient of drought tolerant trait of bulls by households in wetter areas as compared to the households with the rest of the characteristics being average.

Education is one of the socio-economic variables that transform consumer tastes and preferences (Evenson, 1967). Consumer preference send signal to producers on what to produce. Education also improves the capacity of the producer to interpret signals sent by consumers. Livelihood cattle producers are both consumers and producers of the products and functions from the cattle they keep. Higher education of the household head impacted negatively on bulls whose dams had a low milk yield history. With education the producer is able to understand better that bulls can transmit traits of high milk production from their dams to their daughters. Milk yield is a genetic trait that is partly transmitted from the dam to the bull and in tern transmitted to the bull's daughters through the bull. Education influences the preference for milk yield history in bulls. With more education households become more averse to bulls that can transmit less milk yield to their daughter. Purchased supplements increase the costs of production, so higher education comes in handy to make vivid this relationship to the cattle producer. Households generally dislike keeping bulls that require supplementation; however households in wetter areas are the most reluctant followed by households whose head has higher education than average (6 formal years).

4.4 Relative Importance of Traits

Since the part worth values for the traits are measured on a relative basis, the traits used in the two models can be compared. In conjoint studies, this comparison is achieved by computing the relative importance score for traits. This is the ratio of the part worth range for the particular trait and the sum of all the part worth ranges. The coefficients of the part worth values were used to calculate the relative importance of different attributes by taking the difference between the highest and the lowest part worth value of an attribute over the sum of the ranges for all attributes (Sy et al., 1997). The relative importance allows for attribute-to-attribute comparison as well as comparison of traits used in the two models. This ratio provides an indication of the traits the survey respondents valued most highly thus answering the second objective of the study; to rank the cattle attributes that pastoral cattle producers value. Tables 4.6 and 4.7, show the relative importance of the main traits of Cows and bulls respectively.

Table 4.6: Relative Importance of the main Traits of Cows

Traits	*Ranges*	Model 1	*Ranges*	Model 2	*O/Ranges*	Overall
Milk Yield	*0.072*	0.038(2)			*0.072*	0.031(4)
Drought tolerance	*1.821*	0.962(1)	*0.756*	0.431 (2)	*1.289*	0.546(1)
Udder size			*0.107*	0.061 (3)	*0.107*	0.045(3)
Feed requirement			*0.892*	0.508(1)	*0.892*	0.378(2)
Total	***1.893***	**1.0**	***1.755***	**1.0**	***2.360***	**1.0**

Source: Computed from estimates data of Tables 4.2

The overall importance of the traits is obtained by combining estimates of both designs as if they were coming from a single design using then following formula: $\psi_a = \dfrac{[\max(V_{ga}) - \min(V_{ga})]}{\sum \omega_a}$ (Tano et al, 2003)

Where v_{ga} is the marginal value of the g[th] level of the a[th] trait; ψ_a represents the relative importance for the a[th] trait; $\Sigma\omega_a$ is the sum of the ranges, [max (v_{ga}) - min (v_{ga})], across all traits.

A high relative importance ratio indicates that the trait is more preferred and is ranked high. The ratios are entered in the columns marked model 1, model 2 for the respective models and the column marked overall, for the combined ratios of the two models. The figures in bracket are the respective ranks of the traits.

In model 1 for cow, drought tolerance (0.962) is ranked higher than milk yield (0.038). Therefore drought tolerance is ranked one then milk yield ranked two. In model 2 for cows, preference was in the order, feed requirement ranked as one, drought tolerance ranked as two and udder size ranked as three. Drought tolerance an adaptive trait has a direct link to herd size after drought, a precaution that the producers have to take such that they have cattle after a drought, in case of one. Cattle form part of the resource base for the livelihood pastoralist producers. Feed requirement is another important adaptability trait. Cows that require higher purchased supplements than occasional supplementation are less preferred than those that do not require supplementation and entirely depend on natural pasture for feed. Pasture becomes limiting seasonally with the most limiting season being in the dry seasons of January to March and July to September.

Given that both models had one trait in common, and all conjoint part worth values are relative measures (Sy et al., 1997), it is possible to combine all part worth values of levels of traits included in each model and compute a unique index that shores the relative importance of each trait reflecting a preference ordering based on the entire set of traits. Combining the part worth values from the two models and considering them as one model we compute the overall relative importance ratio. On the basis of the overall index, the relative importance of the traits for cows can be established as follows: drought tolerance (0.546), feed requirement (0.378), udder size (0.045) and milk yield (0.031). The pastoralist producers have a high preference for adaptability traits as compared to production traits. The adaptability traits drought tolerance and feed requirement are ranked higher than the production traits udder size and milk yield. Udder size which can be considered also as partly an adaptive trait is ranked higher than the purely production trait of milk yield. Udder size is considered as a production trait in that it is a proxy of milk yield, a cow with a large udder is expected to produce more milk than a cow with a small udder. Conversely, udder size is an adaptability trait in that a small udder is less prone to injuries, in the pasture terrain that is characterized by thorny bushes, than a large udder. Injury to a large udder increases production costs thus the preference of a small udder size.

In model 1 for bulls, drought tolerance was the most important trait followed by leg length. In model 2, feed requirement, drought tolerance and milk yield history of the dam were the order of preference.

Table 4.7: Relative Importance of the main Traits of Bulls

Traits	*Ranges*	Model 1	*Ranges*	Model 2	*O/Ranges*	Overall
Leg length	*0.215*	0.345(2)			*0.215*	0.076(4)
Drought tolerance	*0.408*	0.655(1)	*1.142*	0.384(2)	*0.775*	0.275(2)
Milk yield history of dam			*0.585*	0.197(3)	*0.585*	0.207(3)
Feed requirement			*1.247*	0.419(1)	*1.247*	0.442(1)
Total	***0.623***	**1.0**	***2.974***	**1.0**	***2.822***	**1.0**

Source: Computed from estimates data of Tables 4.3

The overall importance of the traits is obtained by combining estimates of both designs as if they were coming from a single design using then following formula:

$$\psi_a = \frac{[\max(V_{ga}) - \min(V_{ga})]}{\sum \omega_a} \text{ (Tano et al, 2003)}$$

Where v_{ga} is the marginal value of the g^{th} level of the a^{th} trait; ψ_a represents the relative importance for the a^{th} trait; $\Sigma\omega_a$ is the sum of the ranges, $[\max(v_{ga}) - \min(v_{ga})]$, across all traits.

Given that both designs of bulls had one trait in common, and all conjoint part worth values are relative measures (Sy et al., 1997), it is possible to combine all part worth values of the levels of traits included in each case and compute a unique index that shows the relative importance of each trait. This provides a way to overcome the limitations created by the need to limit choices in the survey to three traits, each at three levels. As noted earlier, drought tolerance in both models of bulls was quite close, which gives support to the construction of a common index reflecting a preference ordering based on the entire set of traits. In constructing the overall index, the average of the two estimates of coefficients in each case was used. The results about the overall index of relative importance of the traits of bulls are shown in the last column of Table 4.7 (bulls).

On the basis of the overall index, the relative importance of the traits for bulls can be established as follows in order of preference: feed requirement, drought tolerance, milk yield history of dam and leg length. It was noted that feed requirement and drought tolerance, adaptive traits, were rated higher than productive traits such as milk yield history of dam and leg length.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

Livestock genetic resources underlie the productivity of local agricultural systems. They 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 is of particular concern because of its implications for the sustainability of community livelihoods, the locally adapted agricultural practices and the consequent impact on food supply and security to these communities. Cattle as compared to other forms of livestock make a large contribution to many communities in developing countries. Therefore the value of, and the cattle attributes of the breed the pastoralist keep need to be the identified and included in improvement endeavours. I*n situ* conservation of the locally adapted genetically determined cattle traits call for special consideration.

Since cattle attributes valued most by pastoralist cattle producers are not always traded in the conventional markets, conjoint analysis, a stated preference method was used to estimate economic value of the cattle attributes. The new consumer theory guided the Conjoint Analysis. The Ordered Probit Model was used to get the MRS, WTP and WTA which were subsequently used to measure valuation of cattle attributes by different households.

The objective of the study was to determine producers' preference for genetically determined cattle attributes among pastoralist cattle production with a view to making the case for breed conservation-in use *(in situ)*. Profiles of cattle breed attributes were used to elicit response from the respondents. A household survey was done to collect data on cattle attribute preference. One hundred and seventy three household respondents from Kajiado Central Division were interviewed to get the data set. Results from the conjoint analysis showed that adaptive traits, drought tolerance and feed requirement are more valued than productive traits, milk yield in cows and history of milk yield in bull's dam. Differences in the household characteristics influence cattle attribute valuation. Off-farm income, acreage of land owned and normally used for grazing, education and location were determinants in cattle attribute valuation.

The method of conjoint analysis was used to estimate preference of cattle attributes in Central Division of Kajiado district for five important traits of cows and bulls respectively. The estimated models indicate that all of the traits were statistically significant with the expected signs. Drought tolerance as a cattle attribute was ranked first to milk yield in the first model of cows. Feed requirement attribute was ranked first and drought tolerance attribute the second followed by udder size attribute in the second model of cow preferences. Again drought tolerance attribute was ranked first to leg length in first models for bulls' evaluation design. In the second model for bulls' evaluation design, feed requirement attribute was ranked first while drought tolerance attribute was ranked second and milk yield history took third rank.

The technique used to combine the two sets of results for both cows and bulls confirmed these results. The overall rating of the attributes of cows was as follows; drought tolerance attribute was ranked one, feed requirement attribute ranked two, udder size attribute ranked three and finally milk yield attribute was ranked fourth. For bulls' attributes, the odder of preference from the most preferred to the least; feed requirements, drought tolerance, milk yield history of the dam and leg length.

5.2 Conclusions

Drought tolerance and feed requirement have been revealed by livestock owners, in the study, through conjoint analysis as key traits to be considered in efforts for genetic improvement and conservation. Productive traits such as udder size and milk yield in cows and milk yield history of the dam and leg length in bulls were consistently ranked lower than adaptive traits, such as drought tolerance and feed requirement. Ouma et al. (2007) and Ouma, Abdulai, et al. (2004) while focusing there studies on trypanotolerance, came to a similar conclusions, that adaptation traits such as traction, fertility and resistance to trypanosomosis were ranked higher than traits related to milk and meat. The results of the current study suggest that farmers in this harsh semi arid environment, with low potential for biomass production, do not focus on productive traits per se, but in combination with adaptive traits. Therefore breeding for improvement of productive traits, such as more milk and more beef should not be at the expense of reduced drought tolerance and increasing feed requirements by the cattle.

The null hypothesis that cattle producers do not have systematic preferences for cattle breeds for specific purposes is not accepted. Several significant differences in preferences among cattle producers for the levels of traits were found: (a) There was differential preference of large udder size in cows, low milk yield history in bulls and bulls that need purchased supplements in households with more than average education for the household head. Households with more than average education for the household head are more averse to cows with large udder than the average household. Low milk yield history of the bull's dam generally brings about disutility to all households, however the disutility is greater felt by households, whose heads, have more than average education than households which have heads with average education (six formal years). (b) On average households prefer cows that do not require purchased supplements. However households with more than average land size have not experienced the impact of reduced pasture availability due to reduced grazing land, hence they are less concerned about cows that do not require purchased feed supplements. Consequently there preference for such cows was less than that of the average households. (c) An average household has a higher preference for a drought tolerant bull than a household located in a wetter location. Thus bulls are preferred for herd improvement to be used on the indigenous cows. The fact that there were no detectable differences among cattle producers based on drought tolerance for cows, (cows form the base for herd building or restocking after drought), confirms the importance of drought tolerance to all cattle owners in the study area.

Often, meat and milk is used as the basis for development of a selection index for breed improvement. In the case of cattle keepers in Kajiado, Kenya (and likely elsewhere in semi arid Kenya) reliance on milk and beef production for breed selection is not advised. Traits related to milk meat production were consistently ranked below other factors such as drought tolerance and feed requirement reflecting the use of cattle breed as an important input in pastoralism.

These results indicate that all cattle keepers in Kajiado value the adaptation traits, especially drought tolerance and feed requirements, of the indigenous cattle breeds. To be consistent with those preferences, breed improvement and conservation programs should ensure that improved genotypes maintain drought resistance at the same time as they improve reproductive performance such high milk yield and more meat.

Finally, the differences in preferences between households as distinguished by conjoint and descriptive analysis in the study can be used to suggest *in situ* conservation of any desired cattle traits that are genetically determined such drought tolerance and ability to utilize poor quality fodder. Households whose heads are on average more than 51 years old and have secondary or higher education with a household size of less than eight are more likely to keep the zebu breed. The best way to conservation is through-use, since this will be in recognition that the genetic resources in cattle breeds are natural-capital assets of pastoralist communities and that in a participatory manner the resources can be managed sustainably and be conserved. Since communities raise cattle in environments that they understand best, there is merit in seriously considering their preference in selection of the traits of cattle they breed for.

5.3 Recommendations

Quality and productivity of resources on which livelihoods depend should be addressed and built on opportunities available in the context of the circumstances under which decisions are made. Interventions to conserve and improve cattle breeds kept by pastoralist need to be, in the longer term, built on the pastoral production system and attempt to strengthen it rather than displace it. The specific recommendations are;

a) Pastoralists who raise cattle have vast knowledge on their environment and the cattle they keep. Therefore any conservation and improvement effort which taps on this knowledge to capture their values for traits in cattle is more likely to succeed. Breeding programs need not only target the characteristics that local farmers want, they should be available to local farmers. Wollny (2003) argues that community based breeding programs may be ideal for developing countries because local farmers can have an input into what the breeders are seeking. Further, farmers are more likely to trust new breeds from local programs that they are familiar with. Breed conservation programs must also try to be efficient. As discussed in Simianer et al. (2003), the program should prioritize conserving species that best protect the genetic stock. The motivation of a genetic program is the broadest possible genetic resource. Traits in breeds that are more unique would consequently have a higher priority than those that are close substitutes for one another. The Maasai pastoralists in the study area tend cattle with a unique genetic resource; the animals have a degree of tolerance to drought and can survive on natural pasture better than the recently introduced zebu breeds such as the Sahiwal or Boran and exotic breeds (Rege, 1999; Rege and Tawah, 1999). The Maasai community should be involved in conservation and improvement of the genetic stock in their zebu cattle by giving them incentives that promote the keeping of cattle with traits that they ineffably prefer.

b) The government need to take the lead in providing information to pastoralists on the need for conserving breeds that are adapted to the local environment. Education influenced preference of the attributes and the adaptability traits were more preferred than the productivity traits. Pastoralists can be given incentives for conserving genetically determined cattle traits by creation of derived demand of products from these cattle. Extension worker and researchers may create awareness among consumers of the distinctiveness of products such as meat and milk from the locally adapted cattle breeds, which may increase preference and demand for the products and thus demand for the local breeds. The government needs to ensure branding and traceability of cattle products thus making fair flow of market information. This will inform consumers and make producers accountable of the cattle they produce. Further the producers will be able to rip the benefits of conserving the genetically determined cattle traits they keep.

c) Directing conservation efforts should consider household characteristics. The household characteristics were shown to influence attribute valuation. The household characteristics are in tern influenced by culture, socio-economic factors and external environment such as market access. All these factors contribute to the preference by pastoralist of cattle traits that are not traded in the markets.

Public institutions such as governments consequently have a role to play in preserving uneconomic breeds but with valuable genetic resources for future genetic research. As mentioned earlier the Maasai Zebu found in the current study area have unique genetic resources. Because the genetic value of the stock is a public good, any genetic storage or conservation program is not likely to pay for itself. Revenues will probably be less than costs. However, the social benefits of future breeds developed from the genetic resources of the present adapted but uneconomic breeds could easily outweigh the costs if the programs are efficiently designed. The facility or organization that conserves the breed might not be able to reap these benefits, but society at large would enjoy them. There is consequently a good economic argument for establishing publicly supported program to protect threatened genetically determined traits in cattle breeds. Because the beneficiaries of this program are likely to be spread throughout the world, there is every reason to argue that this should be an international responsibility. Public and international organisations should be organized to develop conservation programs for the protection of threatened animal genetic resources.

5.4 Area for Further Research

Preferences and values change with time and space. The current study was carried out only in Central division of Kajiado. Further research can be carried out with the passage of time and at different places to determine the changes in preference for the genetically determined traits.

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APENDICES

Appendix A1: Survey Questionnaire

"Valuing cattle Genetic Resources among Pastoralists: Case of Kajiado District"

Enumerator name...................................... Date of interview (dd/mm/yy/__/__/07
Division name.................................... Community/area name........................

Questionnaire No.......

Introduction
The objective of this study is to make an economic evaluation of breed as a factor in cattle production. A student studying at the University of Nairobi is carrying out this study. Information from the study may be useful to cattle keepers, researchers and extension workers. It may help them to make decisions about what trait to breed for and produce in the breed of choice, focus scientific research on particular traits and identify needs for further farmer education through extension.

We would like to ask you to help us obtain data to facilitate the study. Your selection was random and we would like to assure you that the information you provide us would be treated with confidence. I have a questionnaire that will guide us through this interview.

5.3.2 Household data

1. Name of respondent (optional).............................. [Male () or female () tick one].
2. Respondent's position in household (Tick)
   - 1= Husband
   - 2= Wife
   - 3= Co-wife
   - 4= Son
   - 5= Daughter
   - 6= Hired manager
   - 7= House help/farm labourer
   - 8= other (specify)..............................

3. Details of household head

Who is the household head? (tick)	Sex (tick)	Age in Years	Education level (tick)	
1=Husband 2=Wife	1=Male	....	1=No formal education	6= Form 5 or 6
3=Widow 4=Widower	2=Female		2= Std 1 trough 4	7=College(dip. or Cert)
5=Son			3= Std 5 trough 8	8=Adult literacy educ..
6=Other (specify)			4=Form 1 or 2	9=University
			5= Form 1 or 2	Other (specify)...........

4. Who is the farm manager? (Tick)

1= Husband 2= Wife 3= Co-wife 4= Son
5= Daughter 6=Hired manager 7= House help/farm labourer
8= other (specify)...............................

5, Give details about household members (including head) living permanently with the household and their primary occupation (for and outside the household). Include all children and infants.

Name	Age (yrs)	Sex 1=M 2=F	Primary activities AND/OR occupation(codes)	Name	Age (yrs)	Sex 1=M 2=F	Primary activities AND/OR occupation(codes)
1	[ ]	[ ]	[ ] [ ]	12	[ ]	[ ]	[ ] [ ]
2	[ ]	[ ]	[ ] [ ]	13	[ ]	[ ]	[ ] [ ]
3	[ ]	[ ]	[ ] [ ]	14	[ ]	[ ]	[ ] [ ]
4	[ ]	[ ]	[ ] [ ]	15	[ ]	[ ]	[ ] [ ]
5	[ ]	[ ]	[ ] [ ]	16	[ ]	[ ]	[ ] [ ]
6	[ ]	[ ]	[ ] [ ]	17	[ ]	[ ]	[ ] [ ]
7	[ ]	[ ]	[ ] [ ]	18	[ ]	[ ]	[ ] [ ]
8	[ ]	[ ]	[ ] [ ]	19	[ ]	[ ]	[ ] [ ]
9	[ ]	[ ]	[ ] [ ]	20	[ ]	[ ]	[ ] [ ]
10	[ ]	[ ]	[ ] [ ]	21	[ ]	[ ]	[ ] [ ]
11	[ ]	[ ]	[ ] [ ]	22	[ ]	[ ]	[ ] [ ]

* A person is a permanent resident in the household when in the household a majority of the nights per week

Activities and occupations codes

1=farm management/farmer
2=civil servant
3=employee private sector
4=business
5=labour on farm
6=labour off farm
7=housewife
8a=retired with pension
8b= retired without pension
9=religious leader
10=in school/college
11=pre-school age
12=other (specify)..........

6. Indicate who in the household is <u>primarily</u> responsible for carrying out the following tasks

Task	Main people doing the work are (see codes bellow)
Grazing animals/cattle	[ ] [ ]….
Watering cattle	[ ] [ ]….
Buying cattle	[ ] [ ]….
Selling cattle	[ ] [ ]….
Milking	[ ] [ ]….
Milk marketing	[ ] [ ]….
Spraying/dipping animals	[ ] [ ]….
Cleaning animal shed/boma	[ ] [ ]….
Obtaining /giving vet. Services	[ ] [ ]….
Activities related to other livestock	[ ] [ ]….
Preparing fields for crops	[ ] [ ]….
Planting crops	[ ] [ ]….
Weeding	[ ] [ ]….
Harvesting crops	[ ] [ ]….

Primarily responsible for carrying out the tasks
1=household head
2=household male (other than household head)
3=household female (other than household head)
4=children
5=long term labours
6=casuals

7. What is your present land size in acres? [……….] acres
8. Of the land you graze or farm but do not own
How much do you rent from others in acres for grazing […..], farming […..] Why and why…..
How much communal/public land do you use in acres for grazing […..], farming […..] why and when….

9. Indicate the number of different animals kept by the household:

	Number of Livestock owned by household	No. kept but not Owned by H/hold	Livestock kind	Number of Livestock owned by household	No. kept but not Owned by H/hold
1=Maasai zebu			5=Pure exotic		
cows			cows		
Bulls			Bulls		
Heifers			Heifers		
calves			calves		
2=Boran			6=Sheep		
cows			Red-Maasai		
Bulls			Blach-head persian		
Heifers			Dorpa		
calves			DorpaXRed-Maasai/ Blach-head persian		
3=Sahiwal			7=Goats		
cows			Local		
Bulls			Dairy		
Heifers			8=Poultry		
calves			Local		
4=Zebu X Exotic crosses			Exotic		
cows			9=Donkeys		
Bulls					
Heifers					
calves					

10. What are the main objectives of keeping cattle? (Rank)

Objective	Rank
Income	
Food	
A savings	
Social prestige	
Manure for crops	
Cow dung for cementing houses	
Other (specify)	

11. What is the system for keeping cattle?

1=only grazing

2=mainly grazing with some stall feeding

3=mainly stall feeding with some grazing

4=only stall feeding

12.1 Please rate the following attributes of bulls. Consider all the attributes associated with each and considering your environmental conditions and management style. In each evaluate on a scale of 1-5 according to your preferences, the animal you will keep. *Note: 5 means the most desirable animal for your cattle operations, 1 the least desirable cattle and 2 to 4 represent desirability between the two extremes.* **(Use the cards given)**

Survey design 1 for bulls attributes valuation-BLOCK I

Rate	Card ID	Leg length	Drought tolerance	Purchase price
	1	long strong	tolerant	Ksh. 19,000
	2	short	susceptible	Ksh. 65,000
	7	long week	moderately tolerant	Ksh. 8,000
	10	Short	Tolerant	Ksh. 8,000
	11	Long strong	Susceptible	Ksh. 65,000

Survey design 2 for bulls attributes valuation-BLOCK I

Rate	Card ID	Drought tolerance	History of milk dam	Need for purchased supplements
	1	tolerant	10 litres/cow/day	NEED supplements
	5	moderately tolerant	5 litres/cow/day	NO supplements
	9	susceptible	1 litres/cow/day	OCATIONAL supplements
	10	TOLERANT	1 LITRES/COW/DAY	NO SUPPLEMENTS
	11	SUSCEPTIBLE	10 LITRES/COW/DAY	NEED SUPPLEMENTS

12.2 Please rate the following attributes of cows. Consider all the attributes associated with each and considering your environmental conditions and management style. In each evaluate on a scale of 1-5 according to your preferences, the animal you will keep. *Note: 5 means the most desirable animal for your cattle operations, 1 the least desirable cattle and 2 to 4 represent desirability between the two extremes.* **(Use the cards given)**

Survey design 1 for cows attributes valuation-BLOCK I

Rate	Card ID	Milk yield	Drought tolerance	Purchase price
	1	5 litres/cow/day	moderately tolerant	Ksh. 5,000
	3	1 litres/cow/day	susceptible	Ksh. 25,000
	4	10 litres/cow/day	tolerant	Ksh. 12,000
	10	1 litres/cow/day	tolerant	Ksh. 5,000
	11	10 litres/cow/day	susceptible	Ksh. 25,000

Survey design 2 for cows attributes valuation-BLOCK I

Rate	Card ID	Drought tolerance	Udder size/condition	Need for purchased feed supplements
	1	moderately tolerant	medium udder (firm)	OCATIONAL supplements
	2	tolerant	small udder	NO supplements
	3	susceptible	large udder (sagging)	NEED supplements
	10	tolerant	small udder	NO supplements
	11	susceptible	medium udder (firm)	NEED supplements

At the end of the discussions: *Thank you for your contributions. You have been very helpful.*

Appendix A 3.1

Orthogonal design 1 used for Bulls Attributes Evaluation

Block	Card ID	Leg length	Drought tolerance	Purchase price
I	1	long strong	tolerant	Ksh. 19,000
I	2	short	susceptible	Ksh. 65,000
I	7	long week	moderately tolerant	Ksh. 8,000
I	10	Short	Tolerant	Ksh. 8,000
I	11	Long strong	Susceptible	Ksh. 65,000
II	3	short	moderately tolerant	Ksh. 19,000
II	6	long strong	susceptible	Ksh. 8,000
II	9	long week	tolerant	Ksh. 65,000
II	10	Short	Tolerant	Ksh. 8,000
II	11	Long strong	Susceptible	Ksh. 65,000
III	4	long week	susceptible	Ksh. 19,000
III	5	short	tolerant	Ksh. 8,000
III	8	long strong	moderately tolerant	Ksh. 65,000
III	10	Short	Tolerant	Ksh. 8,000
III	11	Long strong	Susceptible	Ksh. 65,000

Appendix A 3.2

Orthogonal design 2 used for Bull Attributes Evaluation

Block	Card ID	Drought tolerance	History of milk of dam	Need for purchased supplements
I	1	tolerant	10 litres/cow/day	NEED supplements
I	5	moderately tolerant	5 litres/cow/day	NO supplements
I	9	susceptible	1 litres/cow/day	OCATIONAL supplements
I	10	TOLERANT	1 LITRES/COW/DAY	NO SUPPLEMENTS
I	11	SUSCEPTIBLE	10 LITRES/COW/DAY	NEED SUPPLEMENTS
II	2	susceptible	5 litres/cow/day	NEED supplements
II	3	tolerant	1 litres/cow/day	NO supplements
II	7	moderately tolerant	10 litres/cow/day	OCATIONAL supplements
II	10	TOLERANT	1 LITRES/COW/DAY	NO SUPPLEMENTS
II	11	SUSCEPTIBLE	10LITRES/COW/DAY	NEED SUPPLEMENTS
III	4	moderately tolerant	1 litres/cow/day	NEED supplements
III	6	tolerant	5 litres/cow/day	OCATIONAL supplements
III	8	susceptible	10 litres/cow/day	NO supplements
III	10	TOLERANT	1 LITRES/COW/DAY	NO SUPPLEMENTS
III	11	SUSCEPTIBLE	10LITRES/COW/DAY	NEED SUPPLEMENTS

Appendix A 3.3

Orthogonal design 2 used for Cow Attributes Evaluation

Block	Card ID	Drought tolerance	Udder size/condition	Need for purchased feed supplements
I	1	moderately tolerant	medium udder (firm)	OCATIONAL supplements
I	2	tolerant	small udder	NO supplements
I	3	susceptible	large udder (sagging)	NEED supplements
I	10	tolerant	small udder	NO supplements
I	11	susceptible	medium udder (firm)	NEED supplements
II	4	tolerant	medium udder (firm)	NEED supplements
II	6	moderately tolerant	large udder (sagging)	NO supplements
II	8	susceptible	small udder	OCATIONAL supplements
II	10	tolerant	small udder	NO supplements
II	11	susceptible	medium udder (firm)	NEED supplements
III	5	tolerant	large udder (sagging)	OCATIONAL supplements
III	7	moderately tolerant	small udder	NEED supplements
III	9	susceptible	medium udder (firm)	NO supplements
III	10	tolerant	small udder	NO supplements
III	11	susceptible	medium udder (firm)	NEED supplements