INTEGRATION OF INDIGENOUS KNOWLEDGE WITH THE FARMERS' PREFERRED PHENOTYPES AND BREEDING PRACTICES ON *Capra hircus* POPULATIONS IN KAJIADO AND MAKUENI COUNTIES

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BY

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DECLARATION

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DEDICATION

I dedicate this work to my father, Martin Okello Otieno and my wife, Mary Adhiambo who have always been there for me. They inspired and motivated me to this very end. I give them special thanks for their devoted prayers and dedication, love and support that have made me reach where I am today and become who I am today.

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LIST OF ABBREVIATIONS/ ACRONYMS

AnGR: Animal Genetic Resource.

ANOVA: Analysis of Variance.

ANP: Applied Nutrition Project.

ASAL: Arid and Semi-Arid Land.

ASK: Agricultural Society of Kenya.

CGRA: Centre for Genetic Resource

CGRFA: Commission on Genetic Resource for Food and Agriculture.

Cm: Centimeter.

CV: Coefficient of Variation.

DF: Degrees of freedom.

Dr. Doctor.

DRMPA: Drought Risk Management Peer Assistance Project.

ESGPIP: Ethiopian Sheep and Goat Productivity Improvement Programme

F: F-Statistics.

FAO: Food for Agricultural Organisations of the United Nations.

Fig.: Figure.

GIS: Geographical Information System.

GoK: Government of Kenya

GPS: Global Positioning System.

Hrs: Hours

HWC Human Wildlife Conflict.

IGAD Intergovernmental Authority on Development.

KARI: Kenya Agricultural Research Institute.

KBS: Kenya Stud Book.

Kg: Kilogram.

Km^2 Square kilometers.

KNBS: Kenya National Bureau of Statistics.

K Sh. Kenya shillings.

LPI: Livestock Policy Initiative

NAFIS: National Farmers Information Service.

N: Population size.

NGOs: Non-Government Organisations.

Obs. Observation

Prof. Professor.

SADC: South African Development Community

SD/std: Standard Deviation.

SEA: Small East African.

SAS: Statistical Package for Analysis.

UNESCO: United Nations Educational Scientific and Cultural Organization.

ABSTRACT

A survey was conducted to study the integration of indigenous knowledge with the farmers' preferred phenotypic trait and breeding practices on indigenous goats in Kajiado and Makueni Counties as the first step towards designing of best conservation and management measures. A structured questionnaire **(appendix I**) was used for recording observations between 1st September, 2013 and 2nd December, 2013. This study covered key characteristics of goat production and areas of goat breeding such as: general farm details, number of goats, main activities of the farmers, farming types, breeds, flock structure, quantitative traits, qualitative traits, feeding, housing, catastrophes, selection, mating systems, breeding systems, average age at parturition, breeding problems, and the importance of goats. A total of 360 goats were randomly sampled from the two Counties and the data were analysed using SAS software version 9. Results showed that the average number of goats in Kajiado was 100.65 ± std 49.88 while in Makueni it was 12.28 ± std 6.46. The main activity of the people interviewed was farming as 58 people (96.67%) in Kajiado and 42 people (61.60%) chose farming as their main activity because this was their main source of livelihood. Flocks were dominated by breeding females at a mean of 39.06 ± std 16.75 in Kajiado and a mean of 5.62 ± std 3.50 in Makueni because females were kept to reproduce to increase the size of the flock and the males were kept majorly for cash and only one or two was left to reproduce with the females. Weight, height, heart girth length and back length were highly correlated at $p<0.001$ which means that by measuring one of the four traits, one is able to get information concerning the other three. Breed and sex had high significant effect on weight. The Galla goats weighed more than the Small East African goats as least square mean for the Galla goats was 46.33 ± s.e 0.36 kg while the Small East African goat had 32.41 ± s.e 0.41 kg. The males were superior in weight than the females as the males had a least square mean of 45.75 ± s.e 0.43kg while the females had a least square mean of 32.99 ± s.e 0.30 kg. Drought was

the major catastrophe as it killed an average number of goats of effects 1.87 ± std 1.64. Pneumonia and diarrhea were the major diseases according to 28 farmers (46.66%) in Kajiado and 31 farmers (51.66%) in Makueni. Ticks and fleas were the major parasites according to 42 farmers (70%) in Kajiado and 4 farmers (63.34%) in Makueni. Treatment was mostly done by the farmers individually as 54 farmers (90%) in Kajiado and 46 farmers (76.67%) in Makueni treat the animals by themselves. This was so because it was either not easy to get a veterinarian or it was expensive for them to hire veterinarian doctors. Some farmers used traditional medicine like mavuavui; (*Steganotaenia araliacea),* was used to treat pneumonia. Farmers also devised feeding methods during drought as 48 farmers (80.00%) in Kajiado and 23 farmers (38.33%) in Makueni cut leaves from up trees to feed the goats. When doing selection of breed, 58 farmers (96.67%) and 57 farmers (95%) considered large body size and drought resistance respectively in Kajiado. The farmers in Makueni considered age and drought resistance at equal chances of 59 farmers (98.33%). The main mating system was natural uncontrolled as 113 farmers (95.17%) of the overall 120 farmers interviewed in Kajiado and Makueni chose this as the main mating method. The major breeding system was pure breeding at 85 farmers (70.83%). The average age at parturition of the goats was 1.435 ± 0.125 years in Kajiado and 1.44 ± 0.121 years in Makueni. Abortion was the major breeding problem because it was caused by environmental stressors like drought and diseases as 54 farmers (93.92%) in Kajiado and 55 farmers (95.66%) claimed it was a problem. Goats were majorly kept for cash 9100%) and meat (100%) in Kajiado and for cash (100%) and dowry (100%) in Makueni. In conclusion, the study showed that there that were neither pure Galla goats nor pure Small East African goats in Kajiado and Makueni because of crossbreeding encouraged by: mating that occurred at the markets; water points, free ranging feeding method, pastoralism due to drought, selection methods and translocation of female goats from Makueni County to be mated with the males in Kajiado County. Environmental problems like

drought and diseases caused several deaths and reduced the level of existing gene pool of the goats.

CHAPTER 1.0 GENERAL INTRODUCTION

1.1 BACKGROUND

Production of indigenous goats contribute greatly into the livelihood of poor farmers. Goats have potential to produce meat, manure and skin; however, to conserve the goats, integration of indigenous knowledge, with the farmers' preferred phenotypic characteristics and breeding practices on the indigenous goats is important. Local animals are more resistant to local diseases than crossbreeds or exotic breeds and can survive harsh conditions of drought and little food than the exotic ones or their crosses; they are preferred for some of their phenotypes which are beneficial in one way or the other i.e. the smooth coats of Boran cattle protect them from ticks, Boran cattle breeders society (2007-2013). There is also lack of awareness on breeding of goats and provision of good husbandry practices, Manzi *et al.,* (2013).

Julie Ojango, a Kenyan animal scientist at International Livestock Research Institute (ILRI), said that what should be done is to encourage pastoralists to conduct 'selective breeding, retaining pure-bred indigenous breeds such as the red Maasai, coupled with strategic use of exotic and crossbred Dorper rams in more favourable environments', Karaimu (2014).

Mathew Kenyanjui said he did a study in 1992 on Baobab farm Mombasa; 3/4 Red Maasai Dorper crosses were resistant to ticks, tick -borne diseases and helminthic worm loads and had a higher growth rate than pure local breeds, Karaimu (2014). Indigenous goats are adapted to the harsh life in the ASAL regions. They are also resistant to tropical livestock diseases like Tripanosomisis in Kenya. It has been suggested that the Galla and Small East African goats have more resistance than imported breeds' i.e Saanen goats, Gray *et al.,* (1995). Of late some farmers are keeping exotic breeds as Bett *et al.,* (2007) noted that the

Kenya Dual purpose Goat has been recommended for use by the small holder systems in Kenya. Some farmers prefer the crosses of indigenous goats with their exotic counterparts, this is meant to improve the performance of the local Galla and SEA goats.

1.1.1 Indigenous knowledge and the Galla and SEA goats (*Capra hircus)*

Indigenous knowledge is knowledge that is unique to a particular community. This knowledge helps in conservation and disaster preparedness, Naanyu (2013). Local goats in Kenya have been scantily described when we consider indigenous knowledge based on conservation. There is a threat of loss of unique genotypes and loss of adaptation due to new practices, for example, crossbreeding with exotic breeds. Adaptability to certain terrain and disease resistance through indiscriminate crossbreeding has seriously reduced,

In Kenya the classification of the local goats based on phenotype/morphology identifies three breeds, Small East African (SEA) goats, the Galla and crosses of SEA and the Galla, NAFIS (2009). Galla goats are indigenous to the North areas of Kenya. They are also known as the Boran or Somali goat.

The Small East African goat is one of the most successful domestic goat breeds for the semi-arid lands. They are found all over East Africa from the arid land to urban areas. They are kept mainly for their meat, as milk production usually is only enough for the single kid. In their present unimproved form their greatest advantage is the ability to survive in almost any environment, NAFIS (2009)

1.1.2 Problem statement

The Livestock sub-sector contributes about 10% of the Gross Domestic Product (GDP) in Kenya and accounts for over 30% of farm gate value of agricultural commodities. Sheep and goat industry contributes about 30% of the total red meat consumed in the country. In the year 2003 there were 11.9 million goats in Kenya, Kiptarus (2005). According the 2009 census, there were 25,250,865 heads of goats in ASAL regions of Kenya, Behnke (2011). The indigenous goats are adapted to the drought prone Arid and Semi-arid Lands (ASAL) region of North Eastern Kenya. Their inherent characteristics such as resistance to dehydration, diseases, preference for browse and wide ranging feeding habits, enable them to thrive well in regions that receive less than 750mm of rainfall. The local people living the ASAL regions have their skills of selection of the animals they believe can give the best production. They also have breeding practices that they use to maintain these animals in these hardship zones. However, these skills and practices are not documented. This study sought to integrate indigenous knowledge on the farmers' preferred phenotypic traits and breeding practices on indigenous goats in Kajiado and Makueni Counties. This will help design better conservation and management methods. The breeding practices learnt shall be used to make decision on how to improve the management so that these local goats can be conserved. Production of livestock is nowadays considered best when farmers either keep exotic or their crosses. Studies have shown that exotic livestock or their crosses are not better than the indigenous livestock especially for the farmers that keep these goats for subsistence. Kisiangani, (2008), noted that as a result of up-grading the local breeds for improved production in Kenya, there is loss of valuable indigenous genetic diversity. There is need to reverse this trend and he recommended documentation of indigenous knowledge on livestock breeds and breeding practices in the different communities in Kenya.

1.2 OBJECTIVES

1.2.1 Overall objectives

The overall objective was to study the integration of indigenous knowledge with the famers' preferred phenotypic traits of Galla and SEA goats and breeding practices in Kajiado and Makueni Counties.

1.2.2 Specific objectives

1. To describe farmers' preferred phenotypic traits of the Galla and the Small East African goats.

2. To determine communities' indigenous breeding practices and management methods on the Galla and SEA goats in Kajiado and Makueni Counties.

CHAPTER 2.0 LITERATURE REVIEW

2.1 Production of livestock in Kenya

Livestock Farming in Kenya contribute greatly to the livelihood and comprises mainly dairy and meat production, eggs, hides, skins and wool from cows, sheep, goats and poultry. The Government has stepped up plans to increase livestock production through investment in genetic improvement, SOFTKENYA (2011).

Exotic and crossbred animals were liked most but the indigenous animals were still doing better because they are better adapted to the ASAL regions of Kenya. For example, a recent study of livestock markets in Kajiado County, in the dry rangelands of South Eastern Kenya, showed that the most popular animals among sheep traders were purebred imported Dorper, as well as Dorper cross-breeds. Less important to the traders is the price for the animals, and the age or sex of the animals being sold. Though exotic and crossbred Dorper sheep are in high demand in Kajiado, these animals pose threats to the livelihoods of the region's pastoral livestock herders. Keeping these high-producing exotic breeds alive and productive in these dry, drought-ridden, rangelands is difficult. Unlike exotic breeds, the region's native stock, though less productive, are well adapted to semi-arid climates and tolerate intestinal worms and other parasites, Karaimu (2014).

In the past production of indigenous goats was very successful in Kenya's Arid and Semi-Arid Lands (ASAL) and the goats were doing well in areas like Makueni, and Kajiado. This success was linked to various reasons, for example in addition to the traits already stated, their body structure and colour might also be a consideration into this adaptation like for example they had a wonderful growth rate after prolonged drought and their large size enable them to reach browse better than sheep and cattle, Jonsson (2010). The local people living with a lot of local knowledge about disasters in these regions and how to deal with such

disasters. They also know the traits that make the animals they keep survive or some other reasons why they like such traits. This indigenous knowledge is important for conserving the local goats. The indigenous knowledge has suffered a great setback because many people think it is not important and so relied on the modern knowledge. This is not true because we realise that the indigenous knowledge can lead to sustainability as people will know about disasters like drought and will also know how to solve the problems that might arise due to such disasters. This study is important because we want to conserve the adaptive traits in these goats so that production from indigenous goats is not reduced.

2.2 Advantages of indigenous farm animal breeds

Indigenous livestock breeds have many unique characteristics. They are very fertile, have long productive lives, experience low mortality, are characterized by good feed conversion rates and low maintenance requirements, and blessed with tick resistance and tolerance to tick-borne diseases. They generally perform better than exotic breeds under low input conditions, climatic stresses and especially during times of drought. Thus they provide many advantages especially to smallholders. Furthermore, research conducted since the 1970s has demonstrated that, besides producing well in challenging environments, indigenous breeds also have the potential for higher production if provided with higher levels of input. By breeding the best of the locally adapted animals, farmers and pastoralists can achieve sustainable genetic improvements whose benefits can be reaped for generations to come without further investment. Another point to consider is that, according to current models used for predicting climate changes, the Arid and Semi-arid areas in which the South African Development Community (SADC) region falls, are likely to experience an increase in the frequency, severity and length of droughts as well as in ambient temperatures. Under such conditions, locally adapted breeds will have even more competitive advantages over exotic ones. In Ethiopia From 1989 until 1997 a dairy goat development programme was undertaken

in Ethiopia that promoted the cross-breeding of indigenous Somali and Hararghe Highland goats with imported Anglo-Nubian goats. A survey of 158 households keeping cross-bred and indigenous goats evaluated the benefits that had accrued to participants in a holistic manner, i.e. taking into account marketable products, manure, assets, and security. Intra household comparisons showed that the cross-bred goats were no better than the indigenous goats in terms of composite productivity indices. Instead it was shown that improved management increased the productivity of the indigenous goats to a similar level as that of the cross-bred goats. It was concluded that cross-breeding is inappropriate for subsistence producers, Ayalew *et al.,* (2003).

2.3 Management of local goats

To manage the indigenous goats we must learn what the local people refer to as good traits. In this case the effects of indigenous knowledge to know the farmers' preferred phenotypes and breeding practices would be important.

Knowledge of the adapted goat genetic resource is a pre-requisite for designing appropriate breeding and utilization programmes. Characterization of livestock breeds based on their morphological traits variations Delgado *et al*., (2001) are the first step towards the use of the available animal genetic resource (AnGRs), Lanari *et al*., (2003). Morphometric measurements have been used to evaluate the characteristics of various breeds of animals, and could provide first-hand information on the suitability of animals for selection, Nesamvuni *et al*., (2000); Mwacharo *et al*., (2006); Martins *et al*., (2009); Yakubu (2010a) and for further characterization studies using modern molecular methods.

Phenotypic characterization studies may pave the way for genetic improvement or conservation programmes. In the low external input production environments of developing countries, the reasons for raising particular types of livestock include a range of adaptation

traits and non-marketable service functions. In stressful environments, tolerance of feed and water scarcity, disease and parasite burden, occasional drought and extremes of temperature may be prioritized over production traits. Similarly, mothering ability, fertility, and capacity to provide traction services or to meet socio-cultural roles may be priority traits in some production systems, CGRFA-13/11/Inf.19 (2011)

Unfortunately, these traits are difficult to record during phenotypic characterization studies. Recent advances in the field of economic valuation of Animal Genetic Resource (AnGR) have developed, adapted and tested new data-collection and analysis tools for assessing such traits in ways that can inform genetic CGRFA-13/11/Inf.19 improvement and conservation plans Drucker *et al*., (2001); Drucker et al., (2004). Drucker *et al*. (2001) provide a critical evaluation. Such tools can be applied during phenotypic characterization studies. Two basic examples are:

1) Determining the economic importance of the breed under consideration by asking key stakeholders specific questions about breed preferences (i.e. relative importance of the breeds taking into account all relevant economic traits); and

2) Identifying all the relevant traits and putting them in priority order based on livestock keepers' trait preferences.

The morphological differences in various breeds of livestock have important socio-cultural and economic values to the Kenyan communities; as a result, most farmers have specific consideration and choices for goat coat colours followed by body sizes. For instance, the Somali prefer bright colour animals because they are prestigious, easy to market and are beautiful. The Maasai prefer spotted animals for dowry and a uniformly coloured animal for sacrifices. Among the Borana and Somali communities, a brown coloured head in Galla goat

is thought to indicate good milking characteristics. This has become evident after years of breeding, Kisiangani (2008).

2.4 Cross breeding

Regardless of the above mentioned merits, the local goat genetic resources has been regarded as less productive, hence, subjected to replacement and crossbreeding with imported goat breeds like Boer. However, indiscriminate crossbreeding of indigenous goats can cause genetic erosion, loss of genetic diversity and reduction of adaptive value and opportunities for efficient utilization of the existing adapted goat genetic resources. This threat is in line with the Food for Agricultural Organisation report FAO (1999), which states that animal genetic resources in developing countries in general, are being eroded through the rapid transformation of the agricultural system, in which the main cause of the loss of indigenous Animal Genetic Resources (AnGRs) is the indiscriminate introduction of exotic genetic resources, before proper characterization, utilization and conservation of the untapped indigenous genetic resources.

A crossbreed goat is a combination of a local breed with a different local or exotic breed. For example, a farmer might want to serve their local goats with exotic breeds such as the Toggenburg. The offspring or daughter born of the two breeds is known as a crossbreed or F1. To improve the cross, the F1 is again served with another buck of the same breed, Toggenburg in this case. The resulting offspring is called the F2. The farmer can go further in crossbreeding by mating the F2 with another F2 goat. The resulting breed is known as the crosses or a completely new breed of goat that has no particular characteristic of any breed. The cross can be mated with other crosses until they reach the last stage called stabilization stage. The character of the new goat breed is noted and a standard set by the Kenya Stud Books (KSB) in preparation for the registration of the new breed, Organic farmer, the magazine (2011)

We need to apply conservation management strategies for the dry land goats. Georgoudis (1995) observes that: of the 313 goat breeds in 18 Mediterranean countries in Africa, Asia and Europe ,entered in the FAO Global Database for Animal Genetic Resources (1993),32 are considered endangered or in critical state as regards numbers FAO (1993).

In addition, with crossbreeding the quantity of product is being changed, quality may also be affected. Sometimes the change in quality could be in an undesirable direction. Therefore, sufficient information on quality aspects needs to be gathered before embarking on a large-scale crossbreeding operation. For example, skin from most sheep and goats in Ethiopia is desirable for the leather industry. With crossbreeding, the quality of the skin may become undesirable for the leather industry. On the other hand, skin from lowland sheep is usually undesirable and crossbreeding (particularly local × local) may improve the skin quality of animals from this area. Crossbreds may also produce meat with undesirable taste or fat content (lack or excess) and this also needs to be considered in selection of the improver breed for crossbreeding, Abegaz *et al.*, (2005).

Crossbreeding should be considered if:

- The trait to be improved has a low heritability;
- The current management of local animals is good, or if there is an effective extension program that is improving management;
- The environment has the potential to allow real improvements in management;
- Quick results are needed; and
- There are no changes in quality of products from crossbred animals or these changes are acceptable.

Crossbreeding should be considered only if the crossbreds are going to live in an environment that allows them to express their improved potential and perform well. To get real benefits from crossbreeding, the environment should have the potential for improvement.

One major advantage of crossbreeding, which is rarely considered, is the effect it can have on an extension program. The crossbred sheep or goat is a new animal, it may look different, it can certainly perform differently, and so it quite quickly captures the interest and enthusiasm of producers. This can be a vital boost to extension programs and, in the process of breed improvement, can motivate owners to adopt the improved management strategies being promoted simultaneously.

In choosing improver breeds for crossbreeding, the following factors need to be considered:

Environment: The crossbred should have the ability to perform well under the environmental conditions where production would take place.
Desired production characteristics: The crossbred should show the type and level of production which is set as a goal.

Desired adaptation characteristics: The crossbred should show the desired adaptation in terms of ability to survive, reproduce and produce.

Past experience: It would be very helpful if information is available on the performance of the crossbred in the area or other similar areas to which the crossbred is to be used.

Ease of access to new breed: Sustainability of a crossbreeding program usually depends on the availability of the two parental breeds. This should be considered before embarking on a crossbreeding program.

Cost of new breed: Paying prohibitive prices to acquire one or two of the breeds involved in the crossbreeding program can affect the profitability and sustainability of a crossbreeding program, Abegaz *et al*., (2005).

2.5 Indigenous Knowledge

According to Nuffic and UNESCO (2001), the definition of indigenous knowledge differed depending on the case at hand and even on the specific aspect the author would like to emphasise. They further added that indigenous knowledge could refer to knowledge that identifies with a specific ethnic group, for example: 'indigenous knowledge is the local knowledge that is unique to a given culture or society'. It is the basis for local-level decision-making in agriculture, health care, food preparation (gastronomy), education, natural resource management and a host of other activities in rural communities'. In essence, indigenous knowledge is that knowledge used to run/manage all the sectors and sub-sectors of the traditional or local or rural economies/society. Davis (2007) arrived at the following aspects of Indigenous Knowledge Systems that appear to be more or less specific to indigenous knowledge. He defined it as: locally bound, indigenous to specific area; culture and context-specific; non-formal knowledge; orally transmitted and generally not documented, dynamic and adaptive; holistic in nature and; closely related to survival and subsistence of many people worldwide.

Today, things are changing very fast and that if more efforts are not put the preservation of sustainable indigenous knowledge, sooner than later, it will be a matter of the past – only found in literature rather than in practice. For instance in most developing countries, students learn about the major inventions or innovations made by west, and rightly so, but rarely do they learn about traditional knowledge driven inventions, leave alone, those developed by local individuals, institutions or communities within their respective countries.

In recent years; indigenous knowledge has been identified as a significant factor in disaster preparedness. Disaster preparedness programmes are recognising the value of integrating the indigenous knowledge of the community into disaster education and early warning systems. There are four advantages to using indigenous knowledge and practices in humanitarian response work, Rogge (1992).

1. Indigenous practices and strategies can be generalised to other communities in similar situations,

2. Integrating indigenous knowledge into practices and policies encourages and empowers community members to play a leading role in disaster preparedness,

3. Indigenous knowledge provides valuable information about the context of a disaster.

4. The informal method of sharing indigenous knowledge can be used to disseminate other educational material on disaster preparedness.

Indigenous knowledge is particularly valuable in communities that experience recurring disasters such as drought, famine, disease, floods, etc. While these events often occur in the poorest countries, local individuals have valuable information and successful strategies for managing such occurrences. They have used their local knowledge and practices for generations, long before technology was even developed or applied. Indigenous communities often employ local knowledge to cope with the effects of natural disasters. This knowledge consists of known facts and those learned from experience, observation, and study. It has allowed them to solve problems and manage natural disasters. Elders are often the ones who predict emergencies, especially when the signs are complicated and require interpretation. Other times, natural disasters are obvious to everyone and the community instinctively responds and prepares for the impending event. For example, the most common

warning signs come from observing vegetation, trees, winds, air and water temperatures, clouds, earth movements and celestial bodies, and the behaviour of animals, birds and insects. The Onge tribe of India's Little Adaman Island were the first to leave the coast before the tsunami in the year 2004 because they knew that nature was warning them of impending disaster. An elder of the Jarawa tribe led his people to the hilltop after he perceived the sudden dizziness of a young boy as an indicator of the earth tremors that precede a tsunami. For natural disasters like drought and famine, people in parts of Africa use the water beetle to find potable water in streams and ponds. Other areas have learned how to prepare for famine by using beanstalk ashes to preserve grain. Still others can predict drought and famine by observing the intestines of their goats. The agro-pastoral communities in some African areas practiced controlled grazing and rotation of areas to conserve vegetation. The Maasai in Kenya and Tanzania were considered pure pastorals and moved their herds seasonally to different areas for grazing, depending on the amount of rain and grass. Along the Indian Ocean people were dependent on water resources for their livelihood; they adopted practices and technologies to help sustain the harvesting of their water resources, Action Aid International (2003).

Food security is also based on indigenous knowledge and practices. Some of the practices include use of indigenous seeds, cultivation of drought-resistant crops, mixed cropping, valley farming, livestock diversification, harvesting wild fruits and berries, food storage and preservation. There are varying ways in which indigenous communities alert the population to an impending emergency. These may include the beating of drums and sounding of horns. Others may have more advanced technology such as lights and sirens. Preparedness makes early warning systems particularly valuable, Action Aid International (2003).

Indigenous knowledge can easily be lost during times of development, migration or when younger people move away. Much of this information has not been written down and the

younger generation, even if they remain in the area, is less likely to adhere to traditional rituals and customs. Science and technology are also challenging the traditional systems of indigenous people. To avoid losing valuable information and solutions to disaster response and preparedness, there needs to be an integration of the two systems, Action Aid International (2003) by doing the following:

1. Research must be done on indigenous knowledge and the resulting data must be catalogued.

2. Indigenous knowledge needs to be documented while elders are still available to share information.

3. Indigenous knowledge needs to be incorporated into national policy and integrated with modern knowledge.

4. Laws need to be created to safeguard indigenous knowledge.

5. Indigenous knowledge needs to be preserved by teaching it in schools and community programmes.

CHAPTER 3.0 MATERIALS AND METHODS

3.1 Study areas and morphological traits measurements

The study was conducted in two counties namely; Makueni and Kajiado, **(Fig 1).** Makueni County (formerly Makueni District) is in the former Eastern Province of Kenya. It is dominated by the Kamba community. Its capital and largest town is Wote. The County is bordered by Kajiado County to the west, Machakos County to the north. Kitui County to the East and Taita Taveta County to the south. The County covers an area of 8,008.9 km², out of which 474.1 square kilometres form the Tsavo West National Park and 724.3 square kilometres form the Chyulu Game Reserve. The hilly parts of the County receive 800 to 1200mm of rainfall per year. The rest of the district receives less rainfall at about 500mm per annum. Because of this pattern of rainfall, Makueni is classified as both arid and semi-arid land, Counties of Kenya (2014)

Kajiado County is in the former Rift Valley Province of Kenya. The community living in this County are the Maasai. It has an area of 21,903 km². The County borders Nairobi city and extends to the Kenya-Tanzania border further south, Counties of Kenya (2014).

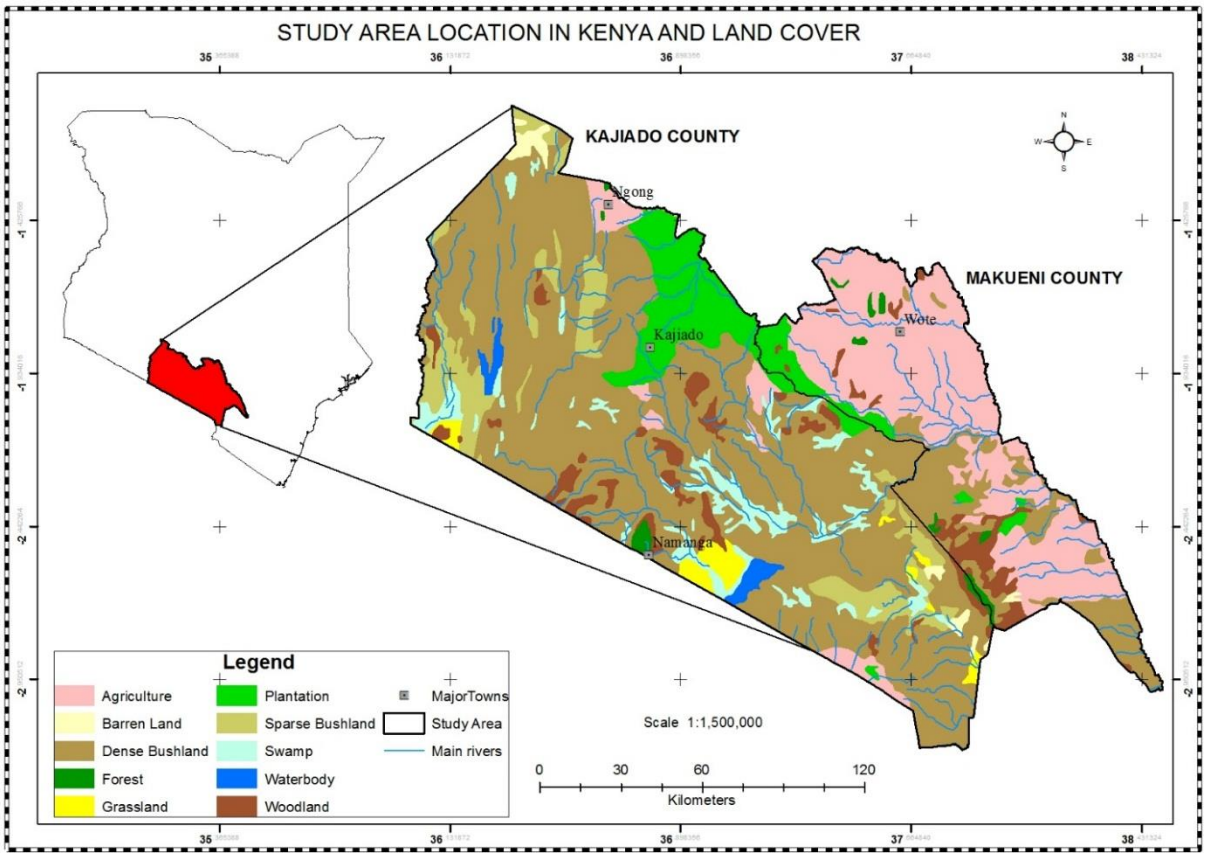

Figure 1: Study area location in Kenya and land cover (Adopted from SOFTKENYA (2011)

3.2 Sampling

Random sampling was used in this study Hassen *et al*., (2012). Morphological trait measurements were taken from total of 360 goats in the two Counties, 180 animals per County **(Fig 2)** and the details were entered in a structured questionnaire, **(appendix I), CGRFA**-Center for Genetic Resource (CGRA) (2011). Generally, there is consensus among scientists that any sample size larger than 30 sampling units is sufficient, Naanyu (2013). Three goats per flock across the different areas were sampled, Hassen *et al*., (2012). Visiting the homesteads was done in the morning hours because, first it was during the dry season and animals were driven out early to start feeding. Secondly, the data collection was done in the morning to avoid taking wrong values on weight Yakubu *et al*., (2010b).

Data was obtained from observations of physical appearance of the selected goats including qualitative traits like, coat colour, sex, ear orientations and, presence or absence of mane, tassel presence or absence of beards, presence or absence of horns, and horn orientation, head orientation, rump profile , and measurements of quantitative traits like back length, weight, heart girth width, height, ear length, udder circumference, hair length, chest girth length ,body length, horn length and horn length, amongst other attributes were recorded and questions related to the management of goats were also asked. Quantitative traits measurements involving weight was done using a hanging scale weighing balance of (0-100 kg), while the measurements involving length was done using a fiberglass tape measure of (0-100 cm), Yunusa (2013). GPS was used to record specific locations/co-ordinates where the specific data/information was collected, Kumar *et al*., (2013).

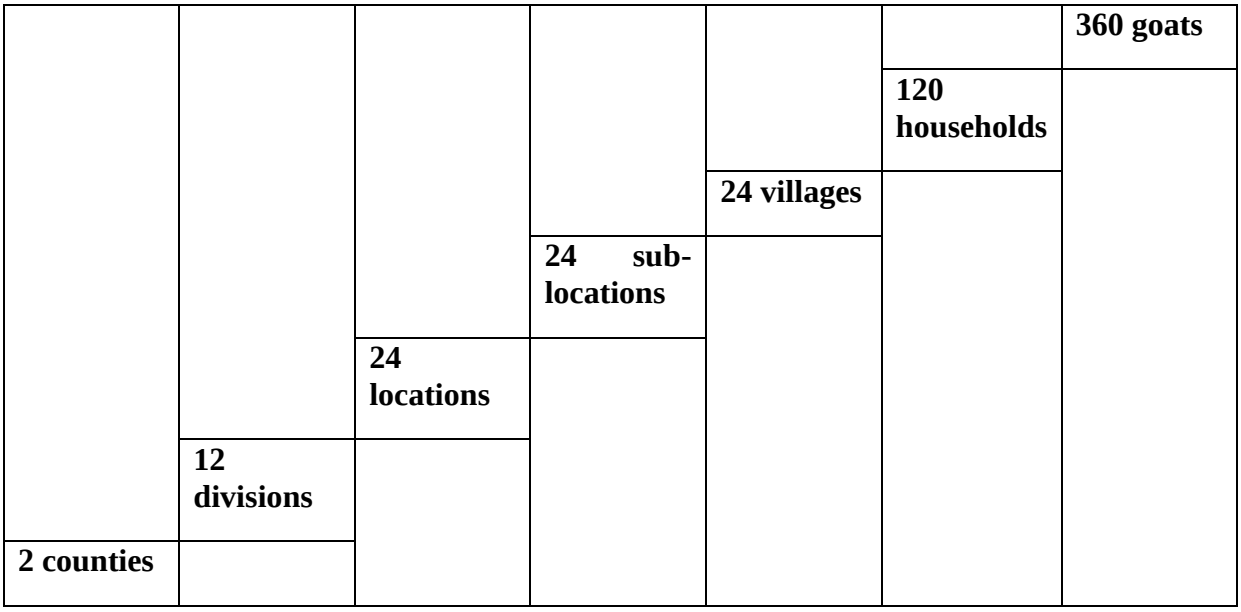

Figure 2: The flow chart showing multistage sampling procedure used

3.3 Administration of questionnaire.

Quantitative traits; body weight, height at withers, body length, heart girth width/length, ear length, horn length, number of off-springs born, udder circumference and amount of milk produced and qualitative traits; coat colour and pattern, head profile, head shape, ear form, udder shape, skin colour, horn orientation and hair type, Food and Agriculture Organization of the United Nations FAO (1986) was recorded in a questionnaire along with visual appraisal of the appearance of the goat types/ direct observation, Imana *et al.*, *(*2008). A total of 120 questionnaires was administered to study the representatives. Besides, focus group discussions were held with livestock keepers and knowledgeable key informants for generating general information regarding the history of the various goat types, special distinguished features of the targeted goats, production systems, and knowledge on the husbandry practices, challenges and opportunities of indigenous goats. As farmers never had birth record of their animals, quantitative traits measurements was done on adult only.

3.4 Identification of Small East African and Galla goats.

Goats were identified using description by NAFIS (2009), thus all Galla goats are be white haired with black skin, nose, feet and under tail. They are also large in size. The colour of fur of SEA goat ranges from pure white to black over a variety of spotted and reddish brown colour. The males often have a pronounced mane running the full length of the back.

3.5 Statistical data analyses and processing

The data collected was entered in excel and later exported to the statistical package (SAS Version 9.0) for analysis. Different models in the SAS software were used to analyse the data. Descriptive statistics (central tendencies and dispersion measures) was used to describe the average numbers of goats, breeding practices, goat housing and equipment used by the farmers in goat production, goat feeds and feeding practices, goat diseases, uses of goats and marketing and farmer suggested interventions for the identified constraints using the model ; proc means N mean std max and min.

The effects of factors affecting weight, height, heart girth length and back length was analysed using proc GLM (Generalised Linear Model) for ANOVA (Analysis of variance) analyses at $p<0.05$, $p<0.01$, and $p<0.001$ and LSM (Least Square Means) and weight, height, heart girth length and back length as the variables.

Correlation analysis was done using the model proc corr data with the variables being weight, height, heart girth length and back length.

Frequencies were also done using proc freq model in the SAS system software. Chi-square and fisher`s test was also used to find significant effects of variables at $p<0.05$ (Snedecor *et al.,* (1967). Univariate analysis graph was drawn using SAS software using proc univariate data.

Map was drawn using arc view GIS (Global Information System) software, (Fig 5).

CHAPTER 4.0 RESULTS

4.1 The distribution of the socio-economic characteristics in Kajiado and Makueni

The average family size for the interviewed households was 5.75 in Kajiado and 5.55 in Makueni. Their ages ranged between 22 years and 67 year. Of the 60 farmers who were interviewed per County, 42 (70.00%) were males and 18 (30.00%) were females in Kajiado while 53 (88.33%) were males and 7 (11.67%) were females in Makueni. Majority of the flocks were owned by the family heads, 50 (83.33%) in Kajiado and 58 (96.67%) in Makueni. Farming was chosen as the main activity by the majority of the farmers at 58 farmers (96.67%) in Kajiado and 42 farmers (70.00%) in Makueni. Police and business were equal at 1 farmer (1.67%) in Kajiado. The number of farmers who chose both farming and business came second at 11 farmers (18.33%), Police and business came third at 4(6.67%) and fourth 3 (5.00%) respectively in Makueni. Fifty four interviewees (90.00%) from Kajiado attained primary education, 4 (6.66%) reached secondary school level and 2 (3.34%) managed post-secondary school. In Makueni, 34 farmers (56.66%) attained primary school, 23 farmer reached secondary and 3 farmers managed post-secondary school level. The type of land ownership was such that in Kajiado 34 farmers (56.67%) managed their land under individual ownership while 26 farmers (43.33%) managed their land in communal farming system and in Makueni 56 farmers (93.33%) managed their land under individual ownership while 4 farmers (6.67%) under communal land ownership. Semi-commercial and pastoralism were the main types of farming in Kajiado at 37(61.66%) and 23 (38.34%) respectively. In Makueni, mixed farming was the main farming type at (90.00%) and pastoralism and semi-commercial farming were equal at 5% each (**Table 1)**.

Table 1: The distribution of the socio-economic characteristics in Kajiado and Makueni

		Kajiado		Makueni	
Factor	**Variable**	**N (mean)**	**%respondents**	**N (mean)**	**%respondents**
Family size		(5.75)		(5.55)	
Gender	Male	42	70.00	53	88.33
	Female	18	30.00	7	11.67
Flock owner	Father	50	83.33	58	96.67
	Mother	5	8.33	2	3.33
	Children	5	8.33	0	0.00
Manager	Father	27	45.00	49	81.67
	Mother	25	41.67	1	1.67
	Children	8	13.33	10	16.67
Main activity	Farming	58	96.67	42	70.00
	Police	1	1.67	0	0.00
	Business	1	1.67	0	0.00
	Teaching	0	0.00	4	6.67
	Farming and business	0	0.00	11	18.33
	Mechanics	0	0.00	1	1.67
	Pastors	0	0.00	2	3.33
Education	Primary	54	90	34	56.66
	Secondary	4	6.66	23	38.34
	Post-sec.	2	3.34	3	5.00
Land ownership	Individual	34	56.67	56	93.33
	Communal	26	43.33	4	6.67
Farming type	Pastoralism	23	38.34	3	5.00
	Semi-commercial	37	61.66	3	5.00
	Mixed	0	0.00	54	90

	farming				

4.2 Flock structure and average number of goats in Kajiado and Makueni

The mean number of goats in Kajiado was 100 ± std 49 goats and in Makueni the mean was 12 ± std 6 goats. Flocks were dominated by the breeding females at mean of 41 ± std 21 in Kajiado and 5 ± std 3 in Makueni while the weaned males came second in Kajiado at 41 ± std 21 and female kids in Makueni were second at 1 ± std 1. The breeding bucks came last at a mean of 1 ± 0 in Kajiado and in Makueni, male weaners with 2 testicles came last at 0 ± std 0. There were no male weaners with 1 testicle, male kids with 1 testicle and no male adults with 1 testicle, **(Table 2).**

The univariate description of the number of goats in Kajiado and Makueni. The coefficient of variation (CV) in Makueni was higher than that of Kajiado as the CV in Makueni was 52.66 **(Fig 3)** while in Kajiado it was 49.56, **(Fig 4).**

Table 2: Flock structure and average number of goats in Kajiado and Makueni

Kajiado				**Makueni**		
Average no. of goats						
N	**Mean**	**SD**		**N**	**Mean**	**SD**
6039	100	49		737	12	6
structure	Kajiado			Makueni		
	N	Mean	SD	N	Mean	SDS
Female kids	513	8	7	118	1	1
Male kids	393	6	5	89	1	1
Weaned females	859	14	10	75	1	1
Weaned males	2486	41	21	43	1	0
Weaners	0	0	0	0	0	0

with 1 testicle						
Castrate weaners	648	10	9	0	0	0
Weaners with 2 testicles	228	3	4	37	1	0
Kids with 1 testicle	0	0	0	0	0	0
Kids with 2 testicle	379	6	5	80	1	1
Adults with1 testicle	0	0	0	0	0	0
Adults with 2 testicle	64	1	0	70	1	0
Castrate male adults	1013	16	13	0	0	0
Mature males	1077	17	13	70	1	0
Breeding females	2507	41	21	328	5	3
Breeding bucks	64	1	0	70	1	0

Figure 3: Univariate analysis of the number of goats in Kajiado County.

Figure 4: Univariate analysis of the number of goats in Makueni County

4.3 Goat breeds descriptions in Kajiado and Makueni

The mean and the standard deviation for linear measurements including weight, height, ear length, back length, heart girth length, hair length, horn length, udder circumference and amount of milk are well illustrated for the Galla and the SEA and for both females and males. The mean weight for the Galla goats breed was higher than that of the SEA. The height of female Galla is a mean of 68.42 cm ± std 2.60 cm in Kajiado and 66.72 cm ± std 5.2 cm in Makueni, a significant difference of $p<0.05$. Female SEA is 59.81 cm ± std 3.41 cm in Kajiado and 58.00 cm ± std 4.04 cm in Makueni, a significant difference of $p<0.05$. The male Galla is 76.04 cm ± std 3.80 cm in Kajiado and 74.17 cm ± std 4.76 cm in Makueni, no significant difference as $p>0.05$. The male SEA goats have 66.20 cm ± std 4.23 cm in Kajiado and 62.49 cm ± std 6.03 cm in Makueni, a significant difference at $p<0.05$. The ear

length also showed significant differences. The ear length of a female Galla goat is 8.78 cm ± std 1.31 cm in Kajiado and 7.41cm ± std 0.72 cm in Makueni. The female SEA is 8.00 cm ± std 0.93 cm in Kajiado and 7.34 cm ± 0.75 cm in Makueni. The ear length of the male Galla is 13.71 cm ± std 1.87 cm in Kajiado and 15.91 cm ± std 1.44 cm in Makueni. The male SEA is 13.29 cm ± std 2.34 in Kajiado and 15.43 cm ± std 1.59 cm in Makueni. A female Galla has a back length of 59.46 cm ± std 1.99 cm in Kajiado and 59.65 cm ± std 1.84 cm in Makueni. The female SEA is 54.49 cm ± std 2.33 cm in Kajiado and 54.61 cm ± std 2.20 cm in Makueni, no significant difference of $p>0.05$. The male Galla is 68.73 cm ± std 3.23 cm in Kajiado and 69.47 cm ± std 2.19 cm in Makueni. The male SEA is 61.60 cm ± std 4.35 cm in Kajiado and 60.68 cm ± std 3.06 cm in Makueni. Heart girth length of the males showed significant difference. A male Galla is 18.36 cm ± std 0.82 cm in Kajiado and 17.17 cm ± std 2.17 cm in Makueni. The SEA is 16.54 cm ± std 0.99 cm in Kajiado and 14.88 cm ± 1.40 cm in Makueni. The average amount of milk production per Galla goat was a mean 0.75 ± std 0.00 liters per lactation and 0.52 ± std 0.07 liters for SEA per lactation in Kajiado. In Makueni, the average amount of milk per lactation was 0.72 ± std 0.08 litres for Galla goats and 0.51 ± std 0.05 litres for SEA goats, **(Table 3).**

The significant effects of fixed factors on weight, height, heart girth length and back length while table 5 shows the least square means for the factors. County has highest significant effect on weight at $p<0.001$ and Least square mean of 43.20 ± 0.49 kg in Kajiado and 35.54 ± 0.48 kg in Makueni. It also has higher effect on heart girth length at $p<0.01$ and a least square mean of 18.80 ± 0.36 cm in Kajiado and 17.81 ± 0.19 cm in Makueni. Breed and sex had the highest significant effects on weight, height, heart girth length and back length at $p<0.001$. Farming type had effects on back length at $p<0.01$ with the goats kept under pastoralism showing highest least square mean of 62.69 ± 0.51 cm. Interaction between County and sex caused highest significant effect on weight at $p<0.001$ with the males in Kajiado showing

highest least square on weight of 51.68 ± 0.70 kg while the female SEA goats in Makueni showed the smallest least square mean of 31.25 ± 0.52 kg. Interaction between breed and sex caused the highest significant effect on weight at $p<0.001$ with the male Galla goats in Kajiado recording highest least square mean of 54.87 ± 0.58 cm and the female SEA in Makueni had the smallest least square mean of 28.19 ± 0.45 cm. In height, male Galla goats in Kajiado had the highest least square mean of 75.44 ± 1.18 cm while female SEA in Makueni had the least of 59.39 ± 1.11 cm ($p<0.01$). The interaction of breed and sex also caused highest significant difference in heart girth length and high significant difference in back length at $p<0.01$ with the male Galla goats having the highest least square mean, **(Table 4).**

Qualitative traits description of the Galla goats and SEA goats in Makueni is shown in appendix **ii**.

Weight, height, heart girth length and back length were highly correlated at $p<0.001$ according to analysis done using the Pearsons correlation coefficient model. The correlation co-efficient for all the variables was higher than 0.76, **(Table 6).**

Table 3: The mean and the standard deviation of the measurements on quantitative traits of Galla and SEA in Kajiado and Makueni

TRAIT		KAJIADO				MAKUENI			
		Breed		**Galla**	**SEA**		**Galla**		**SEA**
		mean	**std**	**mean**	**std**	**mean**	**std**	**mean**	**std**
Weight (kg)	Female	40.78	3.18	30.18	2.77	30.63	6.04	28.32	5.3
	Male	62.11	6.79	42.07	7.30	443.04	11.88	30.14	4.08
Height (cm)	Female	68.42	2.60	59.81	3.41	66.72	5.2	58.00	4.04
	Male	76.04	3.80	66.20	4.23	74.17	4.76	62.49	6.03
Ear length (cm)	Female	8.78	1.31	8.00	0.93	7.41	0.72	7.34	0.75
	Male	13.71	1.87	13.29	2.34	15.91	1.44	15.43	1.59
Back length (cm)	Female	59.46	1.99	54.49	2.33	59.65	1.84	54.61	2.20
	Male	68.73	3.23	61.60	4.35	69.47	2.19	60.68	3.06
Heart girth length (cm)	Female	18.36	0.82	16.54	0.99	17.17	2.17	14.88	1.40
	Male	21.71	1.79	18.80	1.01	21.22	2.29	17.68	2.07
Hair length(cm)	Female	0.80	0.04	0.79	0.04	0.79	0.07	0.80	0.06
	Male	0.93	0.90	0.80	0.00	0.82	0.04	0.76	0.27

Horn length (cm)	Female	6.80	2.80	7.30	2.15	7.49	2.24	7.02	2.45
	Male	11.15	7.90	18.00	2.05	15.05	5.80	16.27	4.75
Udder circumference (cm)	Female	51.23	4.23	46.78	2.16	51.47	2.61	47.62	2.57
Milk amount (l)	Female	0.75	0.00	0.52	0.07	0.72	0.08	0.51	0.05

Table 4: ANOVA description showing the effects of fixed and variable factors on weight, height, back length, heart girth length

ANOVA	**C**	**B**	**S**	**FT**	**FS×FM**	**S×C**	**B*S**	**FS**
WT (kg)	***	***	***	_	_	***	***	**
HT (cm)	NS	***	***	_	*	_	**	_
BL(cm)	NS	***	***	**	_	_	***	_
HGL (cm)	**	***	***	_	_	_	**	_

* significant at P<0.05; ** significant at P<0.01; *** significant at P<0.001; NS-Not _significant;× interactions, WT – weight, HT – height, BL – back length, HGL – heart girth length

County (C), Breed (B), Sex(S), Farming type (FT), Flock size (FS), interactions between; Flock size (Feeding method) FS×FM, Sex (County) S×C, Breed*Sex (B*S)

Table 5: Least square means (LSM) for the factors causing significant difference on weight, height, back length, heart girth length

LSM		**MEAN**	**SE**
Weight (Kg)			
County	Kajiado	43.20	0.49
	Makueni	35.54	0.48
Breed	Galla	46.33	0.36
	SEA	32.41	0.41
Sex	Female	32.99	0.30
	Male	45.75	0.43
Breed*Sex	Galla Female	37.78	0.42
	Galla males	54.87	0.58
	SEA Female	28.19	0.45
	SEA male	36.63	0.67
Sex*County	Kajiado Female	34.72	0.53
	Kajiado Male	51.68	0.70
	Makueni Female	31.25	0.52
	Makueni Male	39.82	0.68
Height			
County	Kajiado	67.55	1.18
	Makueni	66.00	1.14
Breed	Galla	71.65	1.12
	SEA	61.90	1.10
Sex	Female	63.62	1.09

	Male	69.93	1.12
Breed*Sex	Galla Female	67.85	1.14
	Galla Male	75.44	1.18
	SEA Female	59.39	1.11
	SEA Male	64.41	1.20
Back length			
County	Kajiado	61.19	0.55
	Makueni	62.28	0.52
Breed	Galla	65.02	0.48
	SEA	58.45	0.44
Sex	Female	57.81	0.44
	Male	65.66	0.47
Farming type	Semi-commercial	61.38	0.51
	pastoralism	62.69	0.51
	Mixed farming	61.14	0.61
Breed*Sex	Galla Female	60.26	0.50
	Galla Male	69.79	0.54
	SEA Female	55.36	0.46
	SEA Male	61.54	0.51
Heart girth length			
County	Kajiado	18.80	0.36
	Makueni	17.81	0.19
Breed	Galla	19.61	0.25
	SEA	17.00	0.26
Sex	Female	16.75	0.24
	Male	19.85	0.26
Breed*Sex	Galla Female	17.80	0.26
	Galla Male	21.41	0.28

	SEA Female	15.70	0.26
	SEA Male	18.29	0.31

Table 6: Pearson's correlation for weight, height, heart girth length and back length

	Weight	**Heart girth length**	**Height**	**Back length**	**Significant level**
Weight	1.00	0.78	0.81	0.77	***
Heart girth length	0.78	1.00	0.81	0.76	***
Height	0.81	0.81	1.00	0.77	***
Back length	0.77	0.76	0.77	1.00	***

The values in the table × (multiplied) by 100% shows the percentage correlation, * significant at p<0.001.**

4.4 Management methods in Kajiado and Makueni

The best feeding method in Kajiado was free range from the response of 55 farmers and both free range and tethering came second. Tethering was ranked first in Makueni with 33 farmers chose it as the best feeding method, 15 farmers did both free range tethering and 12 farmers did free range alone. The best housing type was by building goat houses using wood and thorn in Kajiado and mud house was the best house type used for goats in Makueni, **(Table 7).**

Table 7: Management methods in Kajiado and Makueni

Management	**Kajiado**		**Makueni**	
	No. of respondents	**rank**	**No. of respondents**	**rank**
Feeding method				
Free range	55	1	12	3
Free range and tethering	5	2	15	2
Tethering	0	3	33	1
Housing type				
Wood and thorn	39	1	14	2
Wire and thorn	19	2	7	3
Mud	1	3	35	1
Wood	1	3	4	4

4.5 The spatial distribution of the flocks of the Galla goat breed, the SEA goat breed and the mixed Galla and SEA

There was even distribution of the flocks of Galla, SEA and mixed Galla and SEA in Kajiado and Makueni. The co-ordinates of the homes where sampling were done are shown in **appendix III**. This was caused by cross breeding of the Galla goats and the SEA goats**, (Fig 5)**

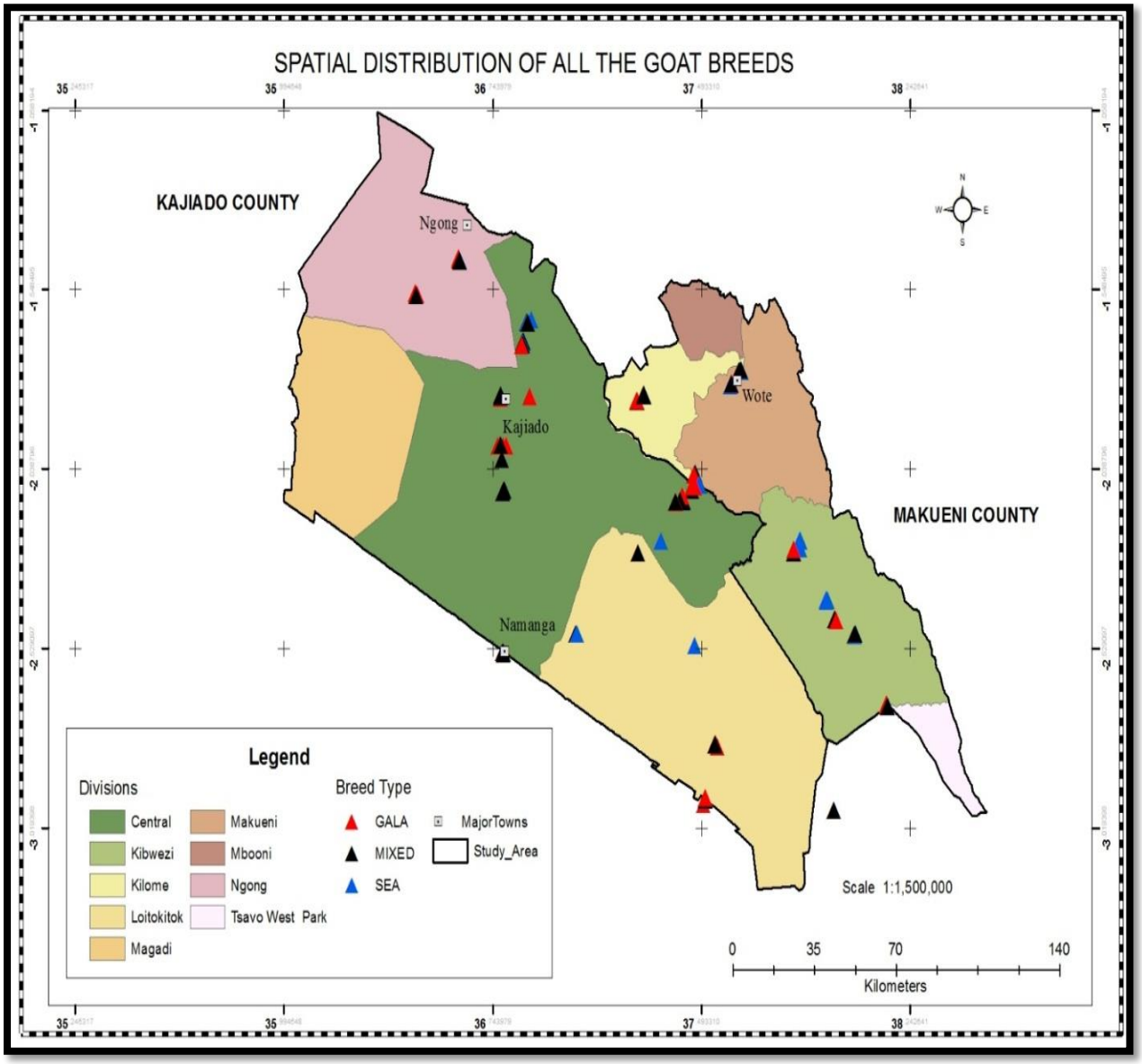

Figure 5: Spatial distribution of the flocks of Galla goat breed, SEA goat breed and the mixed Galla and SEA

4.6 Catastrophes in goat management in Kajiado and Makueni Counties

Drought caused the highest effects with a mean of 1.87 ± 1.64 animals lost whenever there was drought for both the Counties. Diseases came second at a mean loss of 0.29 ± 0.59 goats.

Rustling was ranked last at a mean loss of 0.08 ± 0.28 animals. One farmer in Namanga lost 3 goats which were predated on by a leopard.

4.7Animal health in Kajiado and Makueni Counties

Pneumonia, diarrhoea and rabies caused a lot of problems in the two Counties. Ticks and fleas were the major parasites. Treatment of the goats were done by the farmer. Other farmers called either private or government vets, **(Table 8).**

Table 8: Diseases, parasites and their treatments in Kajiado and Makueni Counties

	Kajiado			**Makueni**		
Factor	**N**	**%respondents**	**rank**	**N**	**%respondents**	**rank**
Disease						
Pneumonia and diarrhoea	28	46.66	1	31	51.66	1
Pneumonia	22	37.66	2	27	45.00	2
Pneumonia and rabies	9	15.00	3	0	0.00	4
Rabies	1	1.66	4	2	3.34	3
Parasites						
Tick and fleas	42	70.00	1	44	73.34	1
Ticks	18	30.00	2	16	26.66	2
Treatment						
Self	46	76.67	1	46	76.67	1
Private vet	14	23.33	2	14	23.33	2
Govt vet	4	6.67	3	4	6.67	3

4.8 Ethno-medicine in Kajiado and Makueni

Traditional medicines used in the treatment of goats are indicated in the table below. Pneumonia was treated using mavuavui, mukomole, mukenia, and mwezenze. Diarrhoea was

treated using uswe while retained placenta was removed by giving goats a handful of maize, **(Table 9).** There was no herbal drug to cure rabies and farmers sought veterinary assistance in cases of rabies.

Table 9: The local name, scientific name (in bracket) of the herbs and what they treat

Herb (Scientific name).	**What it treats.**
Mavuavui (*Steganotaenia araliacea*)	Pneumonia
Uswe (*Cissus quaragularis*)	Encourage peristalsis / Treat stomach problems
Mukomole (*Tapiphyllum schimanii*)	Treats pneumonia
Kitanyu kamwene	Normalises blood pressure
Kyatha (*Synadenium compactum*)	Treats lymph problems
Mwenzenze (*Boscia salicifolia*)	Treats pneumonia
Muumba (*Clerodendrum myriocoides*)	Treats malaria
Mukenia (*Fagara chalybea*)	Relieves common cold and treat pneumonia
Muvinda vinde (*Trimeria glandiflora*)	Relieves cough and cleans blood
A handful of maize	Removes retained placenta

4.9 Management of goats during drought

The major water sources in Kajiado were government constructed water points and pipeline while some farmers used rivers, stream, and dams. The major water sources in Makueni were streams, river and government constructed water points while wells, dam and pipeline, were used by a few people. Water was always available and reliable. Farmers in Kajiado cut leaves from trees, pick leaves, cut and buy commercial feeds, (**Table 10**).

Table 10: Goat management during drought in Kajiado and Makueni

Management	**Kajiado**			**Makueni**		
	N	**%respondents**	**rank**	**N**	**%respondents**	**rank**
Water source						
Govt constructed water points	33	55	1	11	18.33	3
Pipeline	13	21.67	2	7	11.67	5
River	6	10.00	3	13	21.67	2
Stream	6	10.00	4	19	31.67	1
Dam	2	3.33	5	1	1.67	6
well	-	-	-	9	15.00	4
Water availability/reliability	60	100		60	100	
Food provision						
Cut leaves from trees	48	80.00	1	8	13.33	3
Collect and cut leaves and buy commercial feeds	9	15.00	2	7	11.67	4
Collect/pick leaves	3	5.00	3	23	38.33	1
Collect and cut leaves	0	0.00	_	22	36.67	2

4.10 Factors considered when selecting breed in Kajiado and Makueni Counties

The farmers in Kajiado considered body size then drought resistance, colour of fur, age, disease resistance, milk production, physical appearance, conception rate, docility, growth rate, posture and gait in that order. Most farmers in Makueni considered age and drought resistance then disease resistance, milk production, physical appearance, conception rate, growth rate, docility, body size and posture and gait in that order, **(Table 11).**

Table 11: Factors considered when selecting breed in Kajiado and Makueni

Factor	Kajiado			Makueni		
	No. of respondents	**Percent**	**Rank**	**No. of respondents**	**Percent**	**Rank**
Body size	58	96.67	1	5	8.33	11
Drought resistance	57	95.00	2	59	98.33	1
Colour of fur	57	95.00	3	11	18.33	8
Age	54	90.00	4	59	98.33	1
Disease resistance	52	86.67	5	52	86.67	3
Milk production	49	81.67	6	28	46.67	4
Physical appearance	43	71.67	7	26	43.33	5
Conception rate	7	11.67	8	21	35.00	6
Docility	7	11.67	9	6	10.00	9
Posture and gait	4	6.67	10	5	8.83	11
Growth rate	2	3.33	11	14	23.33	7

4.11 Factors considered when selecting females and males in Kajiado and Makueni

Females were selected by considering mothering ability, body size, coat colour was third and body structure was last**.** Most farmers considered, age, body size, disease resistance, reduction of inbreeding, physical appearance and improvements in the order when selecting males, **(Table 12).**

Table 12: Factors considered when selecting females and males in Kajiado and Makueni

Females		
Factor	No. of respondents	Percent
Mothering ability	101	84.17
Size	80	66.67
Colour of fur	59	49.17
Body structure	17	14.17
Males		
Factor	No. of respondents	Percent
Age	110	91.67
Body size	109	90.83
Disease resistance	108	90.00
Reduce inbreeding	77	64.17
Physical appearance	47	39.17
Improvement	43	35.83

4.12 Importance of goats in Kajiado and Makueni

All the farmers kept goats for cash. Farmers in Kajiado also kept goats for blood, chevon, dowry, milk and circumcision ceremony, skin, manure, gift, church functions and for children naming ceremony. Farmers in Makueni kept goats for dowry, manure, chevon, milk and blood, circumcision ceremony, skin, gifts and church functions, **(table 13).**

Table 13: Importance of goats in Kajiado and Makueni

	Kajiado		Makueni	
Use	**No. of respondents**	**Percent**	**No. of respondents**	**Percent**
Cash	60	100.00	60	100.00
Blood	60	100.00	40	66.67
Chevon	58	96.67	43	71.67
Dowry	58	96.67	60	100.00
Milk	57	95.00	42	70.00
Circumcision	51	85.00	29	48.33
Skin	39	65.00	26	43.33
Manure	31	51.67	54	90.00
Gift	30	50.00	26	43.33
Church	28	46.67	2	3.33
Naming	3	5.00	0	0.00

CHAPTER 5.0 DISCUSSION

5.1 The distribution of the socio-economic characteristics in Kajiado and Makueni

The average number of family members was 5.75 and ranged between 2-10 members in Kajiado while it was an average of 5.55 and a range of between 2-11 people in Makueni **(Table 1**). This means that goat production supported a higher number of family members in Kajiado who practiced more pastoralism than Makueni. The study by Tekleyohannes *et al., (*2012) was similar to this study as he reported that goat production in South Omo zone supported larger family size of the pastoral communities on average than the agro-pastoral regions.

Out of the 60 farmers interviewed in Kajiado 42 farmers were males while 18 were females. In Makueni, 53 were males and 7 were female farmers, (**Table 1**). A chi square test reveals a significant difference in gender of the farmers who were interviewed $p<0.001$. This means that majority males associated themselves with farming of goats than females.

In most of the families, goats were owned by the family heads. Of all the flocks sampled in Kajiado, 50 flocks (83.33%) were owned by male family heads. Out of the 60 flocks sampled in Makueni, 58 flocks (96.67%) were owned by the male family heads, (**Table 1**). There was gender bias in flock ownership as it was evident that most of the flocks were owned by the male family heads. This agrees with Stroebel's finding that in Kenya generally the ownership of animal flocks were male dominated, Stroebel (2004).

Of all the farmers interviewed per County, 49 famers (81.67%) in Makueni and 27 farmers (45.00%) in Kajiado were household heads as overall managers. The number of women who managed the goats was 1 (1.67%) in Makueni, while in Kajiado they were 25 women (41.67%). The number of children who did the same were 10 (16.67) in Makueni and 8 children (13.33%) in Kajiado, **(Table 1)**. This means that the duties concerning management

were mostly shared among family members. These family members drive the animals out in the morning to feed, bring them back to shelter in the evening, they provide water, look for treatment means whenever the animals are sick, provide special attention in terms of feeding the goats during drought. The duty of milking was shared among family members except that milk processing was left for the women both in Kajiado and Makueni. Slaughtering of goats was done by the male family members. This result was similar to Stroebel (2004) and Oluka *et al*., (2004) who also found that milk processing was done by women and slaughtering of goats was done by the male family members.

Farming was the main activity according to 58 farmers (96.67%) in Kajiado and Makueni Counties, **(Table 1).** This clearly indicates that farming was the major source of livelihood in the two Counties

The education of the farmers were such that 34 farmers (56.66%) in Makueni and 54 farmers (90.00%) in Kajiado attained primary education, 23 farmers (38.33%) in Makueni and 4 farmers (6.67%) in Kajiado attained secondary school education. There were 4 farmers (6.67%) in Makueni and 2 farmers (3.33%) in Kajiado who got to post-secondary education. A chi-square test ($p<0.001$) and a likelihood ratio ($p<0.001$) revealed significant difference in education level of the farmers in the two counties. These results indicate that most farmers in Makueni attained secondary education than the farmers in Kajiado. Goat management does not only need formal education only in order to bring prosperity but including indigenous knowledge is also important. This is evidence in this research where a few farmers in Kajiado had not attained the basic secondary education but managed many goats than the farmers in Makueni County where many farmers had the basic secondary education. Education had also created awareness to various agricultural developmental issues or programmes that support agriculture in Makueni; for example Micro Enterprise Support Programme Trust (MEST) based in Wote division. This result is similar to Kwallah (1992) who found that the Maasai

have traditionally shied away from education and only one in six children is being educated. Maasai parents and leaders continue to place value on livestock and a way of life centred on cattle-rearing. They do not see that school education will help children to enter this traditional way of life.

5.1.1 Land ownership, farming types and dominant goat breed in Kajiado and Makueni Counties

The type of land ownership in Kajiado and Makueni were different. Land was majorly individually owned (93.33%) in Makueni. Nearly half of the land was communally owned (43.33%) in Kajiado, **(Table 1)**. The type of land ownership and land use in Kajiado encouraged goat production because there was no restriction about where to feed the goats. The vast available land was for livestock grazing. This finding was similar to Imana *et al*., (2008) who also found that most of the land in the pastoral regions was still communally owned.

Different farming types were used in Kajiado and Makueni Counties as 23 farmers (38.33%) were pastoralists while 37 farmers (61.67%) practiced semi-commercial types of farming in Kajiado. Three farmers (5.00%) practiced pastoralism and another 3 farmers (5.00%) practiced semi-commercial type of farming while 54 farmers (90.00%) practiced mixed farming in Makueni, **(Table 1**). This clearly means that there was a lot of semi-commercial farming and pastoralism in Kajiado. Pastoralism in Makueni was done by the Maasai farmers who crossed from Kajiado to graze their goats in Makueni County especially around Emali in Mbitini division (The border of Kajiado and Makueni County). Those who practiced pastoralism did it in search for pasture and not in search for water. The major type of farming in Makueni was mixed farming. Farmers in Makueni practiced mixed farming as a method of diversification to reduce risks of total loses in case of catastrophes like drought and also to get maize which is a staple food for the Kamba community living in this county. Crop

production in Kajiado was done in Kimana where tomatoes were grown and Loitokitok where maize and beans were grown but none of the farmers interviewed claimed to own these farms. The farmers in Kajiado majorly kept livestock under semi-commercial and pastoralism and so rely majorly on livestock production. Imana *et al*., (2008) found that many pastoralists in Turkana farmers moved long distances with their livestock. They moved to places where the host communities were accommodative and where there were abundant pastures and less animal diseases. The difference between this and Imana's study is that in this study, the farmers did not say that they considered places with less disease. The two studies found that the pastoralism was done in search of pasture nowadays and security was considered by all the farmers. Imana *et al.,* (2008) did not mention water as a cause of pastoralism similar to this study where the farmers said that water was available and reliable in Kajiado and Makueni, **(table 10**). Kithama *et al*., (2011) found that in the lower part of Kibwezi district, migrations of cattle and camels enroute to Taita Taveta ranches from Tana river had been noted. The Maasai herdsmen had started moving their livestock to Chyulu and Tsavo National Parks in addition to relocating their herds to Makueni County along the Mombasa road. This was similar to current study.

Out of the 180 goats sampled in Kajiado, 128 (71.11%). A chi-square test showed that there was significant difference in the number of Galla and SEA goats, $p<0.001$. Out of the 180 goats sampled in Makueni, 111 (61.67%) goats were SEA and again chi-square test showed that there was a significant difference between the number of Galla goats and SEA goats in Makueni, $p<0.001$. These results indicate that the Galla goat was the dominant goat breed in Kajiado while SEA goat was the dominant goat breed in Makueni. According to Coffey *et al*., (2004) there were approximately 200 goat breeds in Kenya. These included SEA and Galla goats. Ahuya *et al*., (2001) noted that exotic dairy and meat goats were imported into Kenya starting in the 1950s and more rigorous in the 1970s and early 1980s. In Kajiado and

Makueni, only the Galla and the SEA goats were found. These were local goats that were able to survive in these two Counties because they were tolerant to environmental problems like drought. Coffey *et al*.,(2004) and Ahuya *et al*.,(2001) studies were similar to this study.

5.2 The average number of goats per household and flock structure in Kajiado and Makueni

The mean number of goats in Kajiado was 100 ± std 49 goats. The mean number of goats in Makueni was 12 ± std 6 goats, **(Table 2**). Univariate analysis in the normal distribution curve showed that in Kajiado the coefficient of variation (CV) was 49. 56 and a range of 23 goats to 256 goats **(Fig. 3)** while Makueni had a CV of 52.62 and a range of 3 goats to 33 goats, **(Fig.4)**. This means that the farmers in Kajiado produced more goats than the farmers in Makueni. This could also be attributed to land use. Most of the farmers in Makueni practiced mixed farming, that is, they kept goats and other domestic animals as well as growing of crops like mangoes, oranges, beans, maize, green grams, bananas and sorghum. The farmers in Kajiado majorly practiced livestock production whereby they kept goats and other domestic animals like cattle, sheep, donkeys except in Kimana where tomatoes were grown and Loitokitok where maize and beans were grown. The farmers in Kajiado therefore had a lot of land space to graze their animals than the farmers in Makueni. This encouraged free ranging system of feeding and made them keep many goats. These showed that pastoralists kept many goats compared to the farmers in non-pastoral communities. Even Imana *et al*., (2008) found similar result that the farmers in Southern part of Turkana district who were pastoralists kept flocks sizes of 20-50 goats while the Northern part kept 50-100 goats. Although the numbers were different, pastoral communities kept many animals because this was the main source of livelihood. Kithama *et al*., (2011) found that in Makueni each household had an average of 10 goats nearly similar to this study. Tekleyohannes *et al*., (2012) also found had similar results that in Ethiopia, pastoralists kept on average more goats

than the agro-pastoralists areas; he reported a herd size of 66.7 ± 54.2 goats for pastoralists and 41.8 ± 31.2 goats for agro-pastoralists areas.

The flock structure consisted of female kids, male kids, weaned females, weaned males, mature females, and mature males, male weaners with two testicle, male castrate weaners, adult males with two testicles, male castrate adults, breeding females and breeding males in Kajiado**.** There were no; males adults with one testicle, male kids with 1 testicle and castrate male weaners with one testicle as this type of castration whereby the one testis is removed and the other is left was not practiced. There were also no castrate kids. The average number of female adults was highest in both the two Counties by 41 ± std 21 in Kajiado and 5 ± 3 in Makueni. The average number of castrate weaners was 10 ± std 9 in Kajiado and none of the weaned animals were castrated in Makueni. Castrate male adults were 16 ± std 13 in Kajiado. None of the adult animals were castrated in Makueni. An average of 1 ± std 0 of the goats were intact male adults with two testicles in Kajiado and 1 ± std 0 in Makueni **(Table 2).** Kosgey *et al*., (2004) found that small holder farmers in Kenya owned an average of 2 ± 3 (SD) kids, 2 ± 4 weaners, 5 ± 7 adults – maximum of 16 kids, 21 weaners and 33 adults. While the pastoral farmers had 9 ± 12 kids, 8 ± 11 weaners, 23 ± 31 adults – maximum of 100 kids , 70 weaners and 200 adults. Galvin *et al*., (1994) found that herds typically consisted of 66% milk providing females, while neutered males were raised for meat consumption, traditional and market exchange. Galvin's finding was similar to this study. Kosgey's research put goat kids last in number very different from this research. Kosgey's difference can be explained in that the production of goats in Kenya as a whole might not be uniform. Some farmers in Kenya does not regard goat rearing as the main source of wealth. This gives a smaller average in comparison to research done where goat production is the main source of livelihood or part of livelihood. In my research female goats dominated the

flocks because they were used to add the size of the flocks by breeding them. The males were majorly kept for cash and only one or two was left to breed with the females.

5.3 Breed description in Kajiado and Makueni

5.3.1 Colour of the skin and fur

The colour of the skin was such that; 82 (98.80%) of the female Galla goats in Kajiado had pigmented black skin. The female Galla goats in Makueni had 35 (76.09%) having black pigmented skin. The male Galla goats in Kajiado had 43 (95.56%) of their number having black pigmented skin while the male Galla goats in Makueni had 18 (78.26%) having black pigmented skin colour. Six (16.22%) female SEA in Kajiado, 67 (50.00) female SEA in Makueni, 2 (13.33%) male SEA goats in Kajiado and 11 (29.73%) male SEA in Makueni had black pigmented skin. Over 90% of the Galla goats had white colour of fur, some had white patchy black colour, **(appendix ii).** These results were totally different from what is supposed to be a typical Galla and SEA goat as the findings were different from NAFIS (2009). The white colour of fur was still the dominant in Galla goats. The appearance of white patchy black colour in some of the Galla goats indicates the introduction of genes for white patchy black colour into the population of the Galla goats. This was as a result of cross breeding between the Galla and the SEA. The Maasai farmers in Kajiado preferred white coloured goats since they had higher market value. The findings by Kisiangani's (2008) that the Maasai's liked spotted animals for dowry and uniformly coloured animals for sacrifices never featured in this study.

5.3.2 The average amount of milk per lactation of the SEA and the Galla goats

The average amount of milk produced by the female Galla goats and the female SEA goats in Kajiado was 0.75 ± 0.00 litres and 0.52 ± 0.07 litres respectively. In Makueni, the average amount of milk produced by a female Galla goat was 0.72 ± 0.08 litres and 0.51 ± 0.05 litres

by the SEA, **(Table 3)**. The results indicate that Galla goats produced more milk than SEA goats. This is because they are genetically superior in milk production than the SEA. These finding was similar to Joy (2013) who noted that SEA goats in Uganda produced 0.75 litres of milk or less and that they were predominantly kept for meat in Uganda.

5.3.3 Factors causing effects on quantitative traits

County caused the high significant effect on weight of goats at $p<0.001$, **(Table 4)**. This is explained by the difference in the methods of selection by the farmers in the two Counties, **(Table 13)**. Kajiado goats had high least square mean of 43.20 ± 0.49 kg (table 5) because the farmers consider large body size when doing selection of breed while Makueni recorded as low as 35.54 ± 0.48 kg because the farmers did not consider body size when selecting breed, **(Table 11).** The Galla goats weighed heavier at a least square mean of 46.33 ± 0.36 kg than the SEA goats at a least square mean of 32.41 ± 0.41 kg. This finding was similar to NAFIS (2009). Sex had effects on weight and height with the males giving a high least square mean weight which was 45. 75 ± 0.43 kg while females had 32.99 ± 0.30 kg and in height, the males had 69.93 ± 1.12 cm while the females had 63.62 ± 1.09 cm. This means that the males grew to a bigger size than the females. The result on the effects of sex was similar to the finding by Zahraddeen (2008) who noted that the male kids had higher daily weight gain than their female counterparts.

Farming types caused significant effects on back length ($p<0.01$). Goats kept under pastoralism had longer back length with least square mean of 62.69 ± 0.51 cm. The semi-commercial feeding type had a least square mean of 61.38 ± 0.51 cm and mixed farming type had 61.14 ± 0.61 cm. The longer back length of goats kept under pastoral situation could be because of the adaptation to walking for longer distances; they had to adapt to speed and also to climbing hilly places to get browse from hills during dry season. This result was similar to the finding by Safari *et al*., (2014). Sex also had effect on back length as the males recorded a

longer back length of least square mean of 65.66 ± 0.47 cm and the females had 58.81 ± 0.44 cm. The result by Ikpeze *et al*., (2004) was similar to the finding in this study since she found that sex had significant effect on body length of *Rodentia thryonomyidae*.

Sex had significant effect on heart girth length with the males having higher least square mean of 19.85 ± 0.26 cm and the females 16.75 ± 0.24 cm .This study was different from Nsoso (2003) who found no consistent effects of sex on heart girth. The effect of sex on heart girth length could be explained by the difference physiological characteristics and endocrine system type and measure of hormone secretion, especially sexual hormones. This study was similar to Ikpeze *et al.,* (2004) who also found that sex had significant effect on back length of *Rodentia thryonomyidae*.

Flock size caused significant effect on weight at $p<0.01$ while interaction between flock size and feeding method caused significant effect on height at $p<0.05$. This was because goats fed under free ranging system especially in Kajiado County, **(Table 7)** were kept in large numbers and this encouraged competition and efficiency on feed use; they therefore had higher weight on average, **(Table 3)** than the goats kept in Makueni that were constantly tethered at one point continuously regardless of season and this made the goats in Makueni to have low mean weight. This study was different from Krestchmer *et al*., (2005) who noted that Tethering may be practiced in order to improve the effectiveness and efficiency of production. Tethering restricts animals' movement and exercise opportunity so that improved nutrient utilization for production such as fat deposition and body weight gain.

Interaction between sex and County caused significant differences in weight ($p<0.001$) while interaction between breed and sex caused significant differences in weight, height, heart girth length and back length. These were so because of the general effects on County, breed, and sex.

Weight, wither height, heart girth length and back length were highly correlated at ($r<0.001$), **(Table 6).** This means that live weight of goats in Kajiado can be reasonably estimated using wither height, heart girth length and back length. This result was similar to Kunene *et al., (*2009) who reported that weight, wither height, heart girth length and back length were correlated in his study.

5.4 Breeding of goats in Kajiado and Makueni

5.4.1 Important factors that influence choice of breed of goats

The farmers in Kajiado County considered, adaptability, age and market value based on size: 57 farmers (95.00%) considered drought resistance, 52 farmer (86.67%) considered disease resistance whereby they selected the goats they knew would survive these problems; 58 (96.67%) farmers considered big body sized goats, 57 farmers (90.00%) considered white coloured goats, 54 farmers (90.00%) considered young adults, 49 farmers (81.67%) for milk production and 43 (71.67) farmers, **(Table 11)** considered physical appearance are the factors considered for high market value. The farmers in Kajiado believed that a white coloured goat would fetch a lot of money than a black coloured goat if they were of the same size. White colour was also considered for heat tolerance since a white material reflects light and hence heat. Farmers in Makueni majorly considered adaptability and age, 59 farmers (98.33%) considered drought resistance, 52 farmers (86.67%) considered disease resistance for adaptability; 59 farmers (98.33%) considered young adults for selection, **(Table 11)**. The farmers preferred young adults for breeding. Tekleyohannes *et al., (*2012) reported that the farmers in Hamer in South Omo zone 95% of the farmers and in Bena-Tsemay 82% of the farmers valued adaptive traits of goats such as tolerance to drought and disease resistance above performance traits. His study was similar to this study.

5.4.2 Factors considered when replacing the breeding males and females in Kajiado and Makueni

Several factors were put into consideration when replacing the breeding males; age, body size and disease resistance were the main factors the farmers considered across the two Counties. Inbreeding was also another factor the farmers wanted to eradicate. Males were chosen by considering young adults with big body size, disease resistance, reducing inbreeding, physical appearance, and improvement, **(Table 12**). Some farmers in Makueni translocated their female goats to Kajiado where there were males of big body size. Big body sized males were considered because their off springs grew very fast and overpowered environmental problems in these regions. Offspring suffered most in case of the environmental problems; like drought and diseases like pneumonia and so most of them died. During drought they don`t get enough milk from their mothers. Translocating the females helped reduce inbreeding and helped in genetic improvement. The best way of selecting female goats for the breeding of subsequent generations was to use the offspring of a successful nanny. By comparing the performance of both the parents and their kids the selection decision were made. The farmers believed that the offspring of a successful nanny would also be successful. Important traits that were considered in selection decisions included; size, colour of fur and mothering ability, **(Table 12).** Good mothering ability was the most important factor considered by 101 farmers (84.17%) in Kajiado and Makueni while big body size was second and colour of fur came third where by farmers preferred white coloured females than black ones and this happened especially in Kajiado. Tekleyohannes *et al., (2*012) finding was similar to this study as he also recorded that the farmers in Ethiopia chose breeding bucks based on body size, height, coat colour and performance history and higher percentage of farmers in Hamer in Ethiopia 71% considered good mothering ability, large body size, and conformation when selecting females for reproduction.

5.4.3 Mating and breeding systems

The major mating system used in the two Counties was natural uncontrolled mating since there were 113 farmers (94.17%) who used this method. Natural uncontrolled method was done to allow the goats to breed freely to increase the size of the flock. The farmers who practiced natural controlled breeding, did it to timing mating in June or July so that the young ones are born when there was plenty of food for the goats. Kosgey *et al*., (2004) reported uncontrolled mating within the household's flock was predominant (an average of 42%) for Small holder and 54% for pastoral farmers for goats. He also reported group mating, in which a group of does were left with one or more bucks to mate for a predetermined period. His findings were similar the findings in this study.

The farmers used either pure breeding or cross breeding of the Galla and SEA goats in Kajiado and Makueni Counties. Of the 120 farmers interviewed in the two counties, 85 farmers (70.83%) used pure breeding while 35 farmers (29.17%) did cross breed the Galla and SEA. Two farmers said that pure Galla goats from Garissa County were sold in markets in the two Counties. Cross breeding with exotic breeds did not happen because the exotic breeds and their offspring could not adapt to the harsh environmental conditions. This means that the best system for breeding local goats in Kajiado and Makueni was pure breeding of two indigenous goat breeds. This result was similar to Semakula *et al., (*2010) who noted that in Uganda the main breeding system was pure indigenous breeding in a research done in Arua and Soroto districts.

5.4.4 Average age at first parturition and lifespan of the goats

Most the respondents said that parturition started at the age of between 1.2-1.5 years and with a mean of 1.44 years for both the breeds. The farmers added that the lifespan was around 7-8 years for both the SEA and the Galla goats. Kosgey *et al*., (2004) reported similar results that small holder farmers mated animals for the first time at about 10-11 months meaning that

kidding occurred at 15.5-16.5 months. A slightly big range that he recorded was 9-12 months first time mating in pastoral communities which meant that kidding occurred at 14.5- 17.5 months. This result means that local goats in Kajiado and Makueni late because of the stress conditions that interfere with the breeding conditions like during drought the males are weak and rarely mate with the females.

5.4.5 Factors affecting goat breeding in Kajiado and Makueni Counties

5.4.5.1 Shared markets and translocation of goats

The shared markets like Emali, Makindu, Wote, Salama, Mtito Andei and Kibwezi and Simba encouraged cross breeding between the two goat breeds in the two Counties. In these markets any farmer sold or bought any type of breed of goat. This way the farmers in Kajiado bought SEA goats and the farmers in Makueni bought Galla goats and vice versa. Some goats mate at the market. The farmers in Makueni County translocated the SEA female goats to Kajiado County to get mated with the large male Galla goats.

5.4.5.2 Drought, diseases, livestock rustling and predation

The major catastrophes in Kajiado and Makueni were drought, diseases, livestock rustling and predation which caused losses and at the same time affected breeding. Drought was the most problematic as an average of 1.87 ± std 1.64 goats died because of this, disease was second at a mean of 0.29 ± std 0.59 while rustling was last at 0.08 ± 0.28. One farmer in Namanga lost 3 goats which were predated on by a leopard. Drought reduced population and flock sizes for various farmers. It caused feed to be less. These caused stress and reduced reproduction rate. The goats become thin and fetched little cash from the market. Milk output also reduced. Migrating with the animals to graze away from home to where they could get enough feed for the goats caused risks of being attacked by cattle rustlers, diseases and parasites and also caused cross-breeding of goats since different flocks of goats met and

mated. Rustling caused loss of flocks and also conflicts and even loss of lives and market for goats. Goats were stolen from one County to another and this led to transfer of genes and hence encouraged cross-breeding. Imana *et al*., (2008) found that in Turkana district the major catastrophes facing the farmers were drought, diseases and rustling. She similarly noted that pastoralists in Turkana district suffered from chronic insecurity, provoked by cattle raiding and the competition for access to water and grazing area. Imana went ahead to say that insecurity resulted into reduced access to market for sale of livestock. Convoy *et al.,* (2000) study was similar to this as they found that drought was the major cause of deaths of goats.

5.4.5.3.1 Common diseases and parasites of goats recorded in Kajiado and Makueni

Pneumonia (Maasai call it orkipei), rabies, diarrhoea were the major disease problems in the two Counties. A total of 22 farmers (37.66%) in Kajiado said that pneumonia caused the greatest problem, 1 farmer (1.67%), said rabies affected his flocks, 9 farmers (15.00%) claimed both pneumonia and rabies while 28 farmers (46.67%) said both pneumonia and diarrhoea were the most dangerous diseases. A total of 27 farmers (45.00%) in Makueni claimed pneumonia (Kamba call it mavua), 2 farmers (3.33%) said rabies interfered with their flocks and 31 farmers (51.67%) claimed both pneumonia and diarrhoea, **(Table 8).** Chi-square test $p<0.05$ showed that there was a significant difference between the diseases causing the problems. This result was similar to Kosgey *et al*., (2004) who noted that pneumonia and diarrhoea was common among livestock of Kenyan pastoral communities though he did not mention rabies as a problem. In the current study, the two Counties classified as ASAL regions were very hot during the day time and very cold at night. The type of housing in Kajiado County could also fuel the rate of contracting pneumonia because the goats were not protected from cold at night. There was high chance of contracting pneumonia because of this environmental stress. Drought caused less feed and overheating

caused stress. The stress reduced the immune system of the goats and enhanced the chances of contacting pneumonia. Rabies infection happened when goats were left to graze in the bushes where there were jackals and wild dogs and hyenas that were reservoirs to this disease could spread it. Mashuru division was a migratory corridor for animals migrating from Amboseli national park to Maasai-mara national park so that the wild animals and domestic animals shared a range land. The intermingling of domestic animals and the pastoralist nature that existed in the two Counties also contributed greatly to the spread of goats' diseases. Coffey *et al*., (2004) also noted similar results that all Kenyan pastoralists face high risk of animal diseases because of aspects such as mobility of the animals based on the livestock production system. Kosgey *et al*., (2004) also found that 95% of households in Kenya reported incidences of diseases in Small holder and pastoralist/ extensive farming systems.

Ticks and fleas were the most common external parasites the respondents said were menace in the two Counties, **(Table 8).** A total of 18 farmers (30.00%) claimed that ticks were the greatest problem for their goats while 42 farmers (70.00%) claimed that both ticks and fleas were a problem in Kajiado. Of all the farmers interviewed in Makueni 16 farmers (26.67%) said ticks were the problem while 44 farmers (73.33%) said that both ticks and fleas were problem. Chi-square test $p>0.05$ showed there was no significant difference in the effects of these parasites. The two Counties were surrounded by game parks and game reserves namely, Amboseli national park, Maasai Mara national park, Tsavo west national park, Tsavo East national park and Chyulu game reserve. The animals in these parks migrated from one park or reserve to the other. During these migratory periods, ticks and fleas were dropped that later climb and parasitise on the goats. The free ranging feeding system, **(Table 7)** for goats also encouraged the spread of the two parasites. This way it become difficult to break the life cycle of the two parasites because the animals kept visiting the ranging areas. Coffey *et al*., (2004) finding was similar to the finding in this study as he also found that goats were

susceptible to endo and ecto-parasites. Kosgey *et al*., (2004) finding was also similar to the findings in this study as he noted that helminthosis and tick borne diseases were more prevalent among the Kenyan pastoralist farmers.

5.4.5.4 Solutions to the factors causing losses of goats

5.4.5.4.1 Treatment of goats in Kajiado and Makueni

Most of the treatments were done by the farmers individually in Kajiado and Makueni Counties (table 9). Forty six farmers (76.67%) in Kajiado treated the animals by themselves, 14 farmers (23.33%) used private vets while 4 farmers (6.67%) use government veterinarians. A total of 46 farmers (76.67%) in Makueni treated the animals individually, 14 farmers (23.33%) used private veterinarians and 4 farmers (6.67%) use government veterinarians, **(Table 8).** The farmers also controlled ticks and fleas by spraying using acaricides. Most farmers treated the animals themselves because it was either not easy to get a veterinarians or it was expensive to use a veterinary doctor. Some farmers used traditional medicine, **(Table 9).** The study by Ahuya *et al*., (2005) is similar to the finding in this study since they found that Maasai treat their animals themselves and rarely have access to a veterinarian. The report by Wamukoya et al., (1995) is similar to this study as it showed that the farmers treated the animals themselves because the veterinarians had unease in accessing the farmers in the remote areas and that it was expensive to travel to these remote areas.

5.4.5.4.2 Housing type for goats in Kajiado and Makueni Counties

The housing type determines whether goats will suffer from pneumonia, predated on or the success of thieves to steal the goats. Out of the 60 farmers interviewed per County, 39 farmers (64.00%) in Kajiado, **(Table 7)** and 14 farmers (23.34%) in Makueni built the houses of goats using wood and thorns. Nineteen farmers (31.66%) in Kajiado and 7 farmers (11.66%) Makueni used wire and thorns while 1 farmer (1.66%) in Kajiado and 35 farmers

(58.34%) in Makueni used mud. A few people used wood only. Using wood and thorn or wire and thorn in Kajiado helped to prevent predators and thieves at night and so most farmers resorted to this type of housing. Mashuri is a division in Kajiado and is a migratory corridor for animal migrating between Amboseli national park and Maasai mara national park. This poses high risk to predation because the farmers have homes built in this wild life migratory corridor and hence they used the shown house types. The houses of goats made of mud were the best to prevent thieves at night in Makueni. A chi-square test $p< 0.001$ done revealed that there was a significant difference in the methods of housing. The farmers believed that reinforcing the walls of the goat houses with thorns further reduces the problem of predation from wild animals at night since the two Counties were surrounded by other game parks like Tsavo East and Tsavo West, Amboseli, Maasai Mara and game reserves like Chyulu where animals came from especially during migration and may be when they just crossed the fence to roam about. Woodroffe *et al., (*2005) noted that in Laikipia district, farmers use acacia thorn, stone, wooden posts, wire mesh to construct livestock houses so that the domestic animals are not predated on by the wild carnivores at night. His finding was similar to the finding in this study.

5.4.5.5 Water sources

Water was available and reliable according to all the respondents in Kajiado and Makueni Counties. The farmers sourced water from boreholes, dams, piped water, sand wells, government constructed water points, streams and rivers (table 11). A total of 33 farmers (55.00%) get water from government constructed water points, 13 farmers (21.67%) get pipeline water and 2 farmer (3.33%) get dam water in Kajiado while the majority of the farmers in Makueni get water from streams 19 (31.67), 13 farmers (21.67%) get water from the river, 11 farmers (18.33%) get water from government constructed water points, 7 farmers (11.67%) get piped water, 1 farmers (1.67%) get dam water and 9 farmers (15.00%)

get well water. When goats met at these water points, they mated and genes were passed from a particular flock in a particular County to another flock in another County. According to Mukindia *et al.,* (2014) water was sold at an exorbitant price given that a twenty (20) litre jerry can cost on average K.shs 10 in Kajiado. A report by Makueni County government (2013) states that the County has two permanent rivers; Athi and Kibwezi. There are four protected springs and 117 boreholes. Households with piped water are 12671 while 27752 households have access to potable water. There are 289 water pans and 159 surface dams. The study by Mukindia and information by Makueni County government were similar to this study.

5.4.5.6 Methods of feeding goats used in Kajiado and Makueni

Goats were majorly grazed by the free ranging system in Kajiado according to the response of 55 (91.66%) out of 60 farmers in this County. Only 5 farmers (8.34%) practiced both free range and tethering in Kajiado. The animals were allowed to graze anywhere and without restriction. There was free ranging and tethering systems in Makueni. Out of the 60 farmers, 33 farmers (55.00%) practiced tethering, 15 farmers (25.00%) practiced both free range and tethering and 12 farmers (20.00%) practiced free range, **(Table 7).** Chi-square test analysis $p<0.001$ showed that there was a significant difference in the methods of feeding. During free ranging goats from different flocks and breeds meet and mate; a free ranging male goat can also easily mate with a female goat that is tethered. Coulibaly (2006) also recorded that in Mali, tethering was the method of feeding used when dealing with few animals during the cropping season and especially the small ruminant. This clearly supports the case feeding method in Makueni County.

Food provision to goats during drought was such that most farmers in Kajiado thus; 48 farmers (80.00%) cut leaves from up tree to feed their goats during drought, 9 farmers (15%) collected/ picked leaves, cut and buy commercial feeds while 3 farmers (5.00%) collect/pick

leaves. Most farmers in Makueni thus; 23 farmers (38.33%) cut leaves from trees to feed their goats during drought, 23 farmer (38.33%) collect/ pick leaves, cut and buy commercial feeds while 22 farmers (36.67%) collect/pick and cut leaves, 8 farmers (13.33%) collect/ pick leaves and 7 farmers (11.67%) collect, cut and buy commercial, **(Table 10)**. Most farmers did not buy commercial feeds because they said it was expensive. The goats also survived by eating dry leaves and tree bucks. The finding in this study was different from, Kosgey *et al*., (2004) finding that over 85% of the farmers bought food supplements for goats whenever there was drought. This finding was similar to Smith *et al*., (2002) that found that goats adapt to a wide variety of climatic conditions and survived on browse material not normally utilised by other livestock and were more resistant to drought and adaptable to harsh environment. These finding is also the similar to Tolera *et al*., (2007) who noted that in Ethiopia, when grass become depleted from the grazing land the farmers lop the leaves and branches of trees and feed to their animals.

5.4.6 Breeding problems of goats in Kajiado and Makueni

Abortion was the main breeding problem. Fifty four farmers (93.92%) in Kajiado had the problem of abortion affecting their goats, 3 farmers (5.22%) said still birth was a problem while 3 farmers (5.22%) said both abortion and still birth was a problem. Fifty five farmers in Makueni (95.66%) had the problem of abortion. These breeding problems were of greatest threats during drought when there was little food for the animals and the female goats aborted or underwent still birth because of stress. These problems reduced the number of kids born and hence the expected increase in population size reduced. Imana *et al*., (2008) had similar findings as he reported that in Turkana district which is also an ASAL region that abortion caused the number of off springs born to be limited and production restricted.

5.4.7 Importance of goats in Kajiado and Makueni

All the 60 (100.00%) farmers interviewed in Kajiado kept the animals to get money and all the farmers used blood from the animals for food, 58 farmers (96.67%) used goats for meat, 58 farmers (96.67%) for dowry, 57 farmers (95.00%) for milk, 51 farmers (85.00%) use goats during circumcision ceremonies, 39 farmers (65.00%) used the skin when they are slaughtered and 31 farmers (51.67%) sold their dung as manure to farmers in Makueni who practiced crop production, **(Table 13)**. All the farmers interviewed in Makueni kept the animals for cash and dowry. Three goats were used during marriage, two were used to pay dowry while one was slaughtered on the day the bridegroom visited the family of the bride. Fifty four farmers (90.00%) used the manure on their farms for crop production in their farms. Goats were majorly kept for cash both in Kajiado and Makueni. This was used to pay school fees for children and to buy other family belongings. The findings was similar to Hefferman *et al*., (2002) who found that the goats were kept for milk, meat. Galvin (1992) and Selleh (1996) also found that unlike commercial ranches that raised a limited number of animals solely for market off take in confined areas, pastoralists relied on their herds for daily subsistence. Pastoralists diet was milk, meat, blood obtained from their animals and cereals within grown or obtained from trading their animals. Joy (2013) noted that in Uganda the hide of a SEA goat gave the best quality leather. Galvin's and Joy's findings were similar to the finding in this study.

CHAPTER 6.0 CONCLUSIONS AND RECOMMENDATIONS

1. The Galla and the Small East African goats are adapted to the life in drought prone ASAL regions. Even in case of a dangerous drought, not all the goats will die. Cross-breeding with the exotic breeds should not be introduced as this will interfere with the already existing adapted genes. There was a lot of crossbreeding between Galla goat breed and Small East African goats encouraged by factors like; shared markets, translocations, drought, rustling, watering points, feeding methods like free range and tethering so that the existing populations were neither pure Galla goats nor pure SEA goats but crossbreeds of the two breeds.

2. The major diseases that hinder the production of goats in Kajiado and Makueni were Pneumonia and diarrhoea. Rabies affected the animals in Kajiado and Makueni. The dangerous parasites were ticks and fleas. To control pneumonia and problems like diarrhoea, the government should deploy vets to deal with the problem by providing vaccinations against this disease. Rabies could be controlled by discouraging farmers from making homes or grazing in migratory corridors for wild animals. Grazing livestock animals in the wild life corridors also encouraged tick infestations. This would also reduce the level of infection by tick borne diseases. Ethno medicine should not be ignored because not everywhere would agro vets to buy drugs or vet officers to treat the animals be found. The herbalists who know good drugs that could treat various diseases should be encouraged to treat the goats to reduce the levels of deaths experienced.

3. Farmers in Kajiado majored in Livestock production as a major land use and an investment. Crop production was practiced in few areas like in Kimana and Loitokitok. The farmers in Makueni practice mixed farming. The system in Makueni ensured that there was no total loss when the animals are attacked by calamities. The farmers in Kajiado kept many

animals so that in case of calamity, some remained and continue to express the tolerant genes and also to save in the livelihood.

5. Water was available except that the farmers bought it expensively. Animals died due to lack of enough feed during drought. Farmers should be encouraged to plant artificial plants like *Leucaena leucocephala* which are very leafy; even if they were to be managed under irrigation. Secondly, they should have grazing reserves well fenced to keep off even wild animals; these can help to provide food during drought.

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CHAPTER 8.0 APPENDICES

8.1 Appendix I: Questionnaire

1. PRELIMINARY INFORMATION

Farmer Name	
Enumerator name	
County	
Division	
Location	
Sub-location	
Village	
GPRS (GPS) Reading	
Date	

2. GENERAL QUESTIONS

Sex of the interviewee	Number of family members	Schooling (code) of the interviewee	Main activities of interviewee	Hrs/day spent on activities
Male				
Female				

Schooling: [1.None 2.Pri school 3.Secondary school 4.Post-secondary school]

Farming type……..

[1.Pastoralists 2.Semi-commercial 3.Commercial 4.mixed farming]

Ownership of the flock…….
[1.Father 2.Mother 3.Children 4.Other, Who?]
Who manages the flock…….
[1.Father 2.Mother 3.Children 4.Other, Who?]
Roles during management

3. GOAT MANAGEMENT

a. Flock structure

Number of goats in farm/household……

What breed(s) do you keep?

Small East African goat	
Galla	
Other (specify)	
Structure	Number
Female kids	
Male kids	
Weaned female	
Mature female	
Weaned male	
Intact male weaners 1 testicle	
Castrate weaners	
Intact male weaners both testicle	
Mature female	
Intact male kids 1 testicle	
Intact male kids both testicles	

Intact male adults 1 testicle	
Intact male adults both testicle	
Castrate males adults	
Mature male	
Breeding females	
Breeding buck	
Total	

b. Selection of breed

Criteria used for the selection of the best animal for phenotypic and genotypic characterization.

Factors	Tick appropriately
adaptability	
age at maturity	
body size	
conception rate	
disease resistance	
Docile	
drought resistance	
fecundity	
growth rate	
heat tolerance	
high market value	
milk production	
physical appearance	
posture and gait	

Prolificacy	
skin colour	

ii. If you keep more than one breed what is the advantage of doing this?……..

c. Purpose of keeping goats

What role(s) do goats play in your farm/community? (Tick one or more)

	Tick	Rank
Chevon		
Milk		
Manure		
Blood		
Skin		
Mohair		
Cashmere		
Cash from sales		
Investment		
Dowry		
Ceremonies		
Cultural		

Others (specify)……....

Where do you graze your animals……....

Who owns the land…….....

(individual, community)

Do you market? .....Name the market place.....

d. Catastrophes

What are the major catastrophes that occur within your area?

Factor	Tick appropriately	Number of animals lost
Droughts		
Disease outbreaks		
Rustling		
Other (explain)		

What is the number of animals lost in the recent catastrophe? (Fill as appropriate)

	Breed	Kids	Weaned	Does	Males
Drought					
Disease outbreak					
Rustling					
Other					

Diseases /parasites

Do you have any problems with parasites? Yes ……..No…….

Do you have any problems with parasites? Yes ……..No…….

Parasites	Parasite control method
1.	
2.	
3.	
4.	
5.	

Do you ever recruit help from outside to control the parasites?

Yes …….No…….

List the common diseases that occur in goats within your farm/household (i.e. from symptoms that are seen by the farmer in his animals)

Disease	Treatment given	No treatment given

Who normally treat your animals?

Government vet.	
Private vet.	
Veterinary drug supplier	
Extensive service	
Yourself	
None	

Other (specify)……

How often do you treat your animals ……..

Drought

Is water always available for household use?

Yes…….. No …….

Water for animal	Dry season	Rainy season
How frequently do you give your goats water? [1.Once a day 2.Twice a day 3.Thrice a day 4.Throughout day 5.Other, what?]		
Water source [1.Borehole 2.Dam 3.Well 4.River 5.Spring 6.Stream 7.Natural occasions 8.Constructed water points 9.Rainwater harvesting 10. Pipeline 11.Other, what?]		
Is this water source reliable? Yes or No		
Do you have to pay for the		

water? Yes or No		

When did you have the worst drought in the last five years?

What goat breed survived the long dry period than others? .....

Died……Survived……

Why did this breed survive better than you think? .....

What handling practices are used during drought?.....

Are some animals prioritised with feeds and water during dry periods?.....

What type of housing is used for the goat?

[1.Wire + thorn 2. Wood + thorn 3.Mud 4.Wood]

e. Feeding

Is the feed for goats based on pasture? Yes…….. No…….....

Is any supplement food given to the goats? .....

What else: …….....

What grazing methods do you use for your goats? .....

(1. Free range 2. Tethering 3. Free range and tethering)

f. Breeding

i. Who make decisions on breeding? .....

ii. Which breeding system(s) do you use?

Pure breeding…….

Crossbreeding……

Why do you use this system?

……

……...

Practice cross-breeding and they gave the following selection criteria.

Cross breeding criteria	
Body size	
Early maturity	
Growth rate	
Market value	
Meat quality	
Milk production	

Breed description/production

Description	Breed Sex	Length where necessary
Colour coat	a)	
	b)	
	c)	
Skin colour	a)	
	b)	
	c)	
Ears (Drooping/erect)	a)	
	b)	
	c)	

Mane (Present/ Absent)	a)	
	b)	
	c)	
Tassel (present/absent)	a)	
	b)	
	c)	
Hair (short/long)	a)	
	b)	
	c)	
Horns (Straight/ Curved/ Hornless)	a)	
	b)	
	c)	
Horn orientation (curved backward/curved forward/straight)	a)	
	b)	
	c)	
Back profile (straight, curvedup, curved down)	a)	
	b)	
	c)	
Weight	a)	
	b)	
	c)	
Height(m)	a)	
	b)	
	c)	
Back length(m)	a)	
	b)	

	c)	
Heart girth length(cm)	a)	
	b)	
	c)	
Hair length (cm)	a)	
	b)	
	c)	
Beard (present/absent)	a)	
	b)	
	c)	
Horn length (cm)	a)	
	b)	
	c)	
Udder circumference	a)	
	b)	
	c)	
Udder shape	a)	
	b)	
	c)	
Amount of milk if female	a)	
	b)	
	c)	
Birth number(twinning/single)	a)	
	b)	
	c)	

Mating system

Which mating systems do you use?

Natural controlled……..

Natural uncontrolled……..

Artificial insemination……..

Reasons for choosing this mating system

……..

(e.g. types of birth, kidding seasons etc)

Method for controlling mating.....

1. Apron 2. Castrate 3. Relocate males 4. Apron + Castrate 5. Castrate +Relocate)

What is the average age at first parturition? .....

How many years do you keep selected animals?

Male: …….. Female: …….

When does mating occur?.....

When does kidding occur?.....

When are the kids weaned?.....

What factors do you consider when selecting a male for breeding?.....

What factors do you consider when selecting a female for breeding?.....

Breeding problems

Reported problem	Tick
abortion	
deformed kids	
still birth	
diseases	
Abortion and still birth	

Do you milk your goats? Yes……. No ……..

Other aspects of indigenous knowledge

What traditional herb do you use when goat is sick?

Herb……What it treats……

8.2 Appendix II: Qualitative traits frequencies

Colour of fur	Frequency	Percent
Female Galla in Kajiado		
white	80	96.39
white patchy black	3	3.61
Female Galla in Makueni		
white	42	91.30
white patchy black	4	8.70
Male Galla in Kajiado		
White	44	97.78
white patchy black	1	2.22
Male Galla in Makueni		
white patchy black	21	91.30
Female SEA in Kajiado	2	8.70
White	23	62.16
White patchy black	8	21.62
White patchy brown	6	16.22
Female SEA in Makueni		
white	40	54.05
white patchy black	17	22.97
white patchy brown	12	16.22
brown	4	5.41
grey	1	1.35
Male SEA in Kajiado		
white	10	66.67
white patchy brown	5	33.33
Male SEA in Makueni		
white	50	67.57

White patchy black	14	18.92
White patchy brown	4	5.41
brown	4	5.41
grey	2	2.70
Skin colour-black pigmented skin		
Female Galla in Kajiado	82	98.80
Female Galla in Makueni	35	76.09
Male Galla in Kajiado	43	95.56
Male Galla in Makueni	18	78.26
Female SEA in Kajiado	6	16.22
Female SEA in Kajiado	67	50.00
Male SEA in Kajiado	2	13.33
Male SEA in Makueni	11	29.73
Ear orientation		
Female Galla in Kajiado		
erect	78	93.98
drooping	5	6.02
Female Galla in Makueni		
erect	43	93.48
drooping	3	6.52
Male Galla in Kajiado		
erect	43	95.56
drooping	2	4.44
Male Galla in Makueni		
erect	22	95.65
drooping	1	4.35
Female SEA in Kajiado		
erect	36	97.30

drooping	1	2.70
Female SEA in Makueni		
erect	72	97.30
drooping	2	2.70
Male SEA in Kajiado		
erect	15	100.00
Male SEA in Makueni		
erect	34	91.89
drooping	3	8.11
Mane-presense		
Female Galla in Kajiado	1	1.20
Female Galla in Makueni	1	2.17
Male Galla in Kajiado	43	95.56
Male Galla in Makueni	17	73.91
Female SEA in Kajiado	37	100.00
Female SEA in Makueni	1	1.35
Male SEA in Kajiado	13	86.67
Male SEA in Makueni	36	97.30
Tassel-presense		
Female Galla in Kajiado	13	15.66
Female Galla in Makueni	7	15.22
Male Galla in Kajiado	7	15.56
Male Galla in Makueni	6	26.09
Female SEA in Kajiado	4	10.81
Female SEA in Makueni	14	18.92
Male SEA in Kajiado	2	13.33
Male SEA in Makueni	5	13.51
Horn orientation-frequency missing refer to hornless goats		

Female Galla in Kajiado		
Straight	57	87.69
Curved backward	2	3.08
Curved forward	6	9.23
Frequency Missing = 18		
Female Galla in Makueni		
Straight	41	100.00
Frequency Missing = 5		
Male Galla in Kajiado		
straight	27	90.00
curved backward	2	6.67
curved forward	1	3.33
Male Galla in Makueni		
straight	19	95.00
curved forward	1	5.00
Frequency Missing = 3		
Female SEA in Kajiado		
straight	11	34.38
curved backward	13	40.63
curved forward	8	25.00
Frequency Missing = 5		
Female SEA in Makueni		
straight	43	69.35
curved backward	6	9.68
curved forward	13	20.97
Frequency Missing = 12		
Male SEA in Kajiado		
straight	6	50.00

curved backward	6	50.00
Frequency Missing = 3 **Male SEA in Makueni**		
straight	16	48.48
curved backward	17	51.52
Frequency Missing = 3		
Beard-presence		
Female Galla in Kajiado	19	22.89
Female Galla in Makueni	19	82.61
Male Galla in Kajiado	19	42.22
Male Galla in Makueni	19	82.61
Female SEA in Kajiado	9	24.32
Female SEA in Makueni	21	28.00
Male SEA in Kajiado	5	33.33
Male SEA in Makueni	29	78.38
Udder shape		
Female Galla in Kajiado		
oval	59	71.08
circular	24	28.92
Female Galla in Makueni		
oval	39	84.78
circular	7	15.22
Female SEA in Kajiado		
oval	28	75.68
circular	9	24.32
Female SEA in Makueni		
oval	57	77.03
circular	17	22.97

Twinning rate-produces twins		
Female Galla in Kajiado	39	30.23
Female Galla in Makueni	11	23.91
Female SEA in Kajiado	24	47.06
Female SEA in Makueni	21	28.38

8.3 Appendix III: The co-ordinates for places where sampling was done and flocks of Galla goat breed, SEA goat breed and mixed Galla and SEA

Division	Location	Sub-location	Village	breeds in flocks	SOUTH	EAST
mashuri	poka	emali	maroloi	Galla goat breed	S02˚.12752'	E037˚.43051'
mashuri	poka	emali	maroloi	Galla goat breed	S02˚.08944'	E037˚.47145'
mashuri	poka	emali	maroloi	Mixed Galla and SEA goat breed	S02˚.09912'	E037˚.46046'
mashuri	poka	emali	maroloi	Galla goat breed	S02˚.08947'	E037˚.45997'
mashuri	poka	emali	maroloi	Mixed Galla and SEA goat breed	S02˚.12740'	E037˚.43030'
mashuri	nkama	nkama	samulei	Mixed Galla and SEA goat breed	S02˚.12917'	E37˚.42775'
mashuri	nkama	nkama	samulei	Galla goat breed	S02˚.13198'	E037˚.42687'
mashuri	nkama	nkama	samulei	Mixed Galla and SEA goat breed	S02˚.12787'	E037˚.41628'

mashuri	nkama	nkama	samulei	Galla goat breed	S02.13139'	E037˚.40228'
mashuri	nkama	nkama	samulei	Mixed Galla and SEA goat breed	S02˚.12904'	E37˚.40155'
loitokitok	ololoopon	kuku	loitokitok	Galla goat breed	S02˚.95567'	E037˚.50090'
loitokitok	ololoopon	kuku	loitokitok	Mixed Galla and SEA goat breed	S02˚.94538'	E037˚.50863'
loitokitok	ololoopon	kuku	loitokitok	Mixed Galla and SEA goat breed	S02˚.94328'	E037˚.50909'
loitokitok	ololoopon	kuku	loitokitok	Mixed Galla and SEA goat breed	S02˚.94106'	E037˚.50885'
loitokitok	ololoopon	kuku	loitokitok	Galla goat breed	S02˚.93939'	E037˚.50733'
loitokitok	kimana	kimana	kimana	Galla goat breed	S02˚.79827'	E037˚.55246'
loitokitok	kimana	kimana	kimana	Mixed Galla and SEA goat breed	S02.79268'	E037˚.54582'
loitokitok	kimana	kimana	kimana	Galla goat breed	S02˚.79286'	E037˚.54496'
loitokitok	kimana	kimana	kimana	Mixed Galla and SEA	S02˚.79301'	E037˚.54361'

				goat breed		
				Mixed Galla and SEA		
loitokitok	kimana	kimana	kimana	goat breed	S02˚.79405'	E37˚.54149'
kajiado				Mixed Galla and SEA		
central	suguta	eldamat	ndagorikajo	goat breed	S01˚.83699'	E036˚.77424'
kajiado						
central	suguta	eldamat	ndagorikajo	Galla goat breed	S01˚.84202'	E036˚.77496'
kajiado				Mixed Galla and SEA		
central	suguta	eldamat	ndagorikajo	goat breed	S01˚.84149'	E036˚.77286'
kajiado						
central	suguta	eldamat	ndagorikajo	Galla goat breed	S01˚.84609'	E036˚.77299'
kajiado				Mixed Galla and SEA		
central	suguta	eldamat	ndagorikajo	goat breed	S01˚.84228'	E036˚.77361'
kajiado						
central	enkaroni	kumpa	kumpa	Galla goat breed	S01˚.97810'	E036˚.78236'
kajiado	enkaroni	kumpa	kumpa	Mixed Galla and SEA	S01˚.97610'	E036˚.77080'

central				goat breed		
kajiado						
central	enkaroni	kumpa	kumpa	Galla goat breed	S01˚.97701'	E036˚.79400'
kajiado						
central	enkaroni	kumpa	kumpa	Galla goat breed	S01˚.97630'	E036˚.76467'
kajiado				Mixed Galla and SEA		
central	enkaroni	kumpa	kumpa	goat breed	S01˚.97550'	E036˚.77350'
				Mixed Galla and SEA		
namanga	loronguswa	libisil	orinei	goat breed	S01˚.09852'	E036˚.78489'
				Mixed Galla and SEA		
namanga	loronguswa	libisil	orinei	goat breed	S02˚.01420'	E036˚.77869'
				Mixed Galla and SEA		
namanga	loronguswa	libisil	orinei	goat breed	S02˚.10211'	E036˚.78269'
				Mixed Galla and SEA		
namanga	loronguswa	libisil	orinei	goat breed	S02˚.09777'	E036˚.78635'
namanga	loronguswa	libisil	orinei	Mixed Galla and SEA	S02˚.10400'	E036˚.77936'

				goat breed		
				Mixed Galla and SEA		
namanga	namanga	loinyorok	meto	goat breed	S02˚.54566'	E036˚.78189'
namanga	namanga	loinyorok	meto	Galla goat breed	S02˚.54087'	E036˚.78020'
				Mixed Galla and SEA		
namanga	namanga	loinyorok	meto	goat breed	S02˚.54090'	E036˚.78020'
				Mixed Galla and SEA		
namanga	namanga	loinyorok	meto	goat breed	S02˚.54124'	E036˚.78262'
				Mixed Galla and SEA		
namanga	namanga	loinyorok	meto	goat breed	S02.54314'	E036˚.78492'
	central					
ngong	keekonyokie	oltepesi	oltepesi	Galla goat breed	S02˚.01558'	E036˚.46794'
	central					
ngong	keekonyokie	oltepesi	oltepesi	Galla goat breed	S01˚.56101'	E036˚.46884'
	central					
ngong	keekonyokie	oltepesi	oltepesi	Galla goat breed	S01˚.56059'	E036˚.46785'

	central					
ngong	keekonyokie	oltepesi	oltepesi	Galla goat breed	S01˚.56482'	E036˚.47580'
	central			Mixed Galla and SEA		
ngong	keekonyokie	oltepesi	oltepesi	goat breed	S01˚.56686'	E036˚.46984'
	north					
ngong	keekonyokie	keekonyokie	keekonyokie	SEA goat breed	S01˚.46879'	E036˚.62375'
	north					
ngong	keekonyokie	keekonyokie	keekonyokie	Galla goat breed	S01˚.46731'	E036˚.62303'
	north					
ngong	keekonyokie	keekonyokie	keekonyokie	Galla goat breed	S01.46444'	E036˚.62202'
	north			Mixed Galla and SEA		
ngong	keekonyokie	keekonyokie	keekonyokie	goat breed	S01˚.47028'	E036˚.62532'
	north			Mixed Galla and SEA		
ngong	keekonyokie	keekonyokie	keekonyokie	goat breed	S01˚.47345'	E036˚.62629'
isinya	ototo	ototo	kisaju	SEA goat breed	S01˚.63331'	E036˚.88163'
isinya	ototo	ototo	kisaju	Mixed Galla and SEA	S01˚.63928'	E036˚.86581'

				goat breed		
				Mixed Galla and SEA		
isinya	ototo	ototo	kisaju	goat breed	S01˚.63983'	E036˚.86780'
isinya	ototo	ototo	kisaju	SEA goat breed	S01˚.64112'	E036˚.86615'
				Mixed Galla and SEA		
isinya	ototo	ototo	kisaju	goat breed	S01.˚64099'	E036˚.87091'
				Mixed Galla and SEA		
isinya	isinya	isinya	isinya	goat breed	S01˚.69243'	E036˚.85577'
isinya	isinya	isinya	isinya	Galla goat breed	S01˚.69213'	E036˚.85350'
isinya	isinya	isinya	isinya	SEA goat breed	S01˚.69509'	E036˚.85350'
				Mixed Galla and SEA		
isinya	isinya	isinya	isinya	goat breed	S01˚.70088'	E036˚.85379'
isinya	isinya	isinya	isinya	Galla goat breed	S01˚.10221'	E036˚.84823'
wote	wote	kamunyulu	kavati	SEA goat breed	S01˚.77301'	E037˚.63769'
				Mixed Galla and SEA		
wote	wote	kamunyulu	kavati	goat breed	S01˚.77068'	E037˚.63004'

				Mixed Galla and SEA		
wote	wote	kamunyulu	kavati	goat breed	S01˚.77219'	E037˚.63445'
wote	wote	kamunyulu	kavati	SEA goat breed	S01˚.77257'	E037˚.63579'
				Mixed Galla and SEA		
wote	wote	kamunyulu	kavati	goat breed	S01˚.76996'	E037˚.63554'
wote	unoa	unoa	malavani	SEA goat breed	S01˚.80938'	E037˚.60082'
wote	unoa	unoa	malavani	SEA goat breed	S01˚.800759'	E037˚.60132'
wote	unoa	unoa	malavani	Galla goat breed	S01˚.80529'	E037˚.60193'
wote	unoa	unoa	malavani	SEA goat breed	S01˚.81199'	E037˚.59694'
				Mixed Galla and SEA		
wote	unoa	unoa	malavani	goat breed	S01˚.80872'	E037˚.60277'
makindu	kisingo	kisingo	kisingo	SEA goat breed	S01˚.23549'	E037˚.84906'
makindu	kisingo	kisingo	kisingo	SEA goat breed	S01˚.23665'	E037˚.84919'
makindu	kisingo	kisingo	kisingo	SEA goat breed	S01˚.25694'	E037˚.84957'
makindu	kisingo	kisingo	kisingo	SEA goat breed	S02˚.23731'	E037˚.34787'
makindu	kisingo	kisingo	kisingo	SEA goat breed	S02˚.23634'	E037˚.84559'

makindu	makindu	manyatta	manyatta	SEA goat breed	S02˚.26959'	E037˚.82537'
makindu	makindu	manyatta	manyatta	Mixed Galla and SEA goat breed	S02˚.26966'	E037˚.82622'
makindu	makindu	manyatta	manyatta	Mixed Galla and SEA goat breed	S02˚.26739'	E037˚.26739'
makindu	makindu	manyatta	manyatta	Mixed Galla and SEA goat breed	S02˚.26739'	E037˚.82633'
makindu	makindu	manyatta	manyatta	Galla goat breed	S02˚.26064'	E37˚.82655'
kibwezi	kikumbulyu	mukuyuni	kibwauni	SEA goat breed	S02˚.40063'	E037˚.94302'
kibwezi	kikumbulyu	mukuyuni	kibwauni	SEA goat breed	S02˚.40050'	E037˚.94639'
kibwezi	kikumbulyu	mukuyuni	kibwauni	SEA goat breed	S02˚.40018'	E037˚.94570'
kibwezi	kikumbulyu	mukuyuni	kibwauni	SEA goat breed	S02˚.39887'	E037˚.94550'
kibwezi	kikumbulyu	mukuyuni	kibwauni	SEA goat breed	S02˚.39772'	E037˚.94267'
kibwezi	masongaleni	masongaleni	masongaleni	Mixed Galla and SEA goat breed	S02˚.49143'	E038˚.04183'
kibwezi	masongaleni	masongaleni	masongaleni	Mixed Galla and SEA	S02˚.49201'	E038˚.04275'

				goat breed		
kibwezi	masongaleni	masongaleni	masongaleni	SEA goat breed	S02˚.49927'	E038˚.04453'
				Mixed Galla and SEA		
kibwezi	masongaleni	masongaleni	masongaleni	goat breed	S02˚.49126'	E038˚.04633'
kibwezi	masongaleni	masongaleni	masongaleni	SEA goat breed	S02˚.47149'	E038˚.04781'
mtitoandei	utiithi	mashinani	usalama	Galla goat breed	S02˚.45006'	E037˚.97352'
mtitoandei	utiithi	mashinani	usalama	Galla goat breed	S02˚.45139'	E037˚.97352'
mtitoandei	utiithi	mashinani	usalama	SEA goat breed	S02˚.97299'	E037˚.96963'
mtitoandei	utiithi	mashinani	usalama	Galla goat breed	S02˚.45196'	E037˚.97099'
mtitoandei	utiithi	mashinani	usalama	Galla goat breed	S02˚.45497'	E037˚.97841'
mtitoandei	mtitoandei	mtitoandei	kikwazuni	Galla goat breed	S02˚.68367'	E038˚.16004'
mtitoandei	mtitoandei	mtitoandei	kikwazuni	Galla goat breed	S02˚.68486'	E.38˚.15875'
				Mixed Galla and SEA		
mtitoandei	mtitoandei	mtitoandei	kikwazuni	goat breed	S02˚.68670'	E038˚.15946'
				Mixed Galla and SEA		
mtitoandei	mtitoandei	mtitoandei	kikwazuni	goat breed	S02˚.68835'	E038˚.16164'

mtitoandei	mtitoandei	mtitoandei	kikwazuni	SEA goat breed	S02˚.68946'	E038˚.16269'
				Mixed Galla and SEA		
mbitini	mulala	katuni	iteta	goat breed	S02˚.05134'	E037˚.47193'
mbitini	mulala	katuni	iteta	SEA goat breed	S02˚.05217'	E037˚.47554'
				Mixed Galla and SEA		
mbitini	mulala	katuni	iteta	goat breed	S02˚.05317'	E037˚.46985'
mbitini	mulala	katuni	iteta	SEA goat breed	S02˚.05477'	E037˚.46902'
mbitini	mulala	katuni	iteta	SEA goat breed	S02˚.05628'	E037˚.46788'
		sultan	sultan			
mbitini	sultan hamud	hamud	hamud	Galla goat breed	S02˚.08532'	E037˚.48826'
		sultan	sultan			
mbitini	sultan hamud	hamud	hamud	SEA goat breed	S02˚.08532'	E037˚.48644'
		sultan	sultan			
mbitini	sultan hamud	hamud	hamud	Galla goat breed	S02˚.08509'	E037˚.48826'
		sultan	sultan			
mbitini	sultan hamud	hamud	hamud	SEA goat breed	S02˚.08481'	E037˚.48730'

		sultan	sultan			
mbitini	sultan hamud	hamud	hamud	SEA goat breed	S02˚.08482'	E037˚.48501'
kilome	mukaa	mtaingo	kithata	Mixed Galla and SEA goat breed	S01˚.85417'	E037˚.26193'
kilome	mukaa	mtaingo	kithata	Mixed Galla and SEA goat breed	S01˚.85619'	E037˚.26170'
kilome	mukaa	mtaingo	kithata	Mixed Galla and SEA goat breed	S01˚.85640'	E037˚.26293'
kilome	mukaa	mtaingo	kithata	Galla goat breed	S01˚.85607'	E037˚.26456'
kilome	mukaa	mtaingo	kithata	Mixed Galla and SEA goat breed	S01˚.85459'	E037˚.26347'
kilome	kiimakiu	kiimakiu	kiimakiu	Mixed Galla and SEA goat breed	S01˚.83900'	E037˚.28777'
kilome	kiimakiu	kiimakiu	kiimakiu	Mixed Galla and SEA goat breed	S01˚.83802'	E037˚.28706'
kilome	kiimakiu	kiimakiu	kiimakiu	Mixed Galla and SEA	S01˚.83759'	E037˚.28600'

				goat breed		
kilome	kiimakiu	kiimakiu	kiimakiu	SEA goat breed	S01˚.83850'	E037˚.26819'
kilome	kiimakiu	kiimakiu	kiimakiu	Mixed Galla and SEA goat breed	S01˚.84022'	E037˚.28849'