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Breeding practices of Red Maasai sheep in Maasai Pastoralist Communities

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Avelsstrategier för Red Maasai-får i masaj pastoralist-områden

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Preface

This thesis was completed as a Master's thesis in Animal science combined with a Minor Field Study, MFS, at the Department of Animal Breeding and Genetics, Swedish University of Agricultural Sciences, SLU. To perform the master thesis together with an MFS gave me a good opportunity to combine my studies with research in another country and to give assistance in a project concerning developing sustainable livestock production. By performing the work in Kenya new experiences and interesting insights could be obtained. I chose the subject of investigating breeding practices among the Maasai pastoralists' communities to get a deeper knowledge regarding how appropriate breeding strategies can be implemented and prosecuted in developing countries. The subject also gave me the opportunity to learn about an interesting culture and the importance of keeping animals in pastoralists' societies.

The thesis is part of a PhD-project being undertaken by Emelie Zonabend at the Department of Animal Breeding and Genetics at SLU, in collaboration with ILRI (International Livestock Research Institute) and FAO (Food and Agricultural Organization), aiming at investigating the infrastructure that is needed for the sustainable use of Animal Genetic Resources in Eastern and Southern Africa. In this project the Red Maasai sheep will be studied as a model for design of realistic breeding strategies. ILRI is a public sector international agricultural research centre which was formed in 1994 and is headquartered in Nairobi, Kenya (ILRI, 1999). ILRI will play an important role in this study as well as in the larger investigation with their exceptional knowledge and experience in the area of livestock research in developing countries.

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Table of content

ABSTRACT	5
SAMMANFATTNING	5
1. INTRODUCTION	6
1.1 Aim of the thesis.....	7
2. BACKGROUND	8
2.1 Kenyan rangelands and Kaijado District.....	8
2.2 History of Maasai pastoralists in Kenya.....	8
2.3 The Maasai Pastoralists Communities.....	9
2.3.1 The social structure	9
2.3.2 Labour, animal holding and distribution of responsibilities.....	9
2.3.3 Purpose of keeping animals and specifically sheep.....	10
2.3.4 Experiences of droughts	11
2.3.5 Maasai agriculture and land use	11
2.4 Present situation in Kaijado District.....	11
2.4.1 Development and cultural changes in North Kaijado District.....	12
2.5 Small ruminant production in the tropics	13
2.5.1 Importance of small ruminants.....	13
2.5.2 The Red Maasai sheep.....	13
2.5.3 Introduction of new sheep breeds in Kaijado District	14
2.6 Breeding goals and strategies for small ruminants in the tropics	15
2.6.1 Breeding programmes	15
2.6.2 Appropriate breed and trait selection	16
2.6.3 Example of breeding strategies for small ruminants in the tropics	17
3. MATERIALS AND METHODS	18
3.1 Study area.....	18
3.2 Collection of quantitative data	18
3.3 Collection of qualitative data	19
3.4 Data analysis	20
4. RESULTS.....	21
4.1 Family household, economic income and farming type.....	21
4.2 Animal holding and specially sheep production	23
4.2.1 Reasons for keeping sheep	23
4.2.2 Products used from sheep.....	23
4.2.3 Important traits among sheep	24
4.2.4 Market	24

4.2.5 Diseases	25
4.3 Sources of the Red Maasai sheep and breeding practices	25
4.3.1 Reasons for keeping the specific breeds.....	25
4.3.2 Breeding strategies	26
4.3.3 Selection of sheep for breeding of subsequent generations.....	27
4.3.4 Lifespan of selected breeding sheep.....	27
4.3.5 Breeding parameters between North and South Kajiado.....	28
4.3.6 In-depth interviews in North Kajiado.....	28
4.4 Environmental effects.....	29
5. DISCUSSION	31
5.1 Methods.....	31
5.2 Family household, economic income and farming type.....	31
5.3 Sheep production.....	32
5.3.1 Reasons for keeping sheep	32
5.3.2 Important traits among sheep	33
5.3.3 Market and diseases.....	33
5.4 Sources of the Red Maasai sheep and breeding practices	33
5.4.1 Reasons for keeping the specific breeds.....	33
5.4.2 Breeding strategies	34
5.4.3 Selection of sheep for breeding of subsequent generations.....	34
5.4.4 Breeding parameters between North and South Kajiado.....	35
5.4.5 In-depth interviews.....	35
5.5 Environmental effects.....	35
5.6 General discussion and future aspects.....	36
6. CONCLUSIONS	38
7. REFERENCES	39
7.1 Personal communication:	Fel! Bokmärket är inte definierat.

ABSTRACT

A survey was undertaken to understand sheep management, breeding practices and selection criteria for Red Maasai sheep in Maasai pastoralist communities in Kajiado District, Kenya. Differences between North and South Kajiado District were investigated to gain knowledge about farmers having different prerequisites and how it can affect the sheep production. The reason for keeping sheep and the specific breeds show the multiple objectives of the Maasai farmers. Adaptive traits, such as resistance to diseases and droughts, and productive traits, such as increased growth and carcass weight, were both ranked highly. In addition to this, the sheep has a social and traditional value in Maasai culture. Although the Red Maasai sheep was ranked highly with regard to traits important for adaptation and social purposes, the population was considered to decline in numbers of pure bred Red Maasai. The breed was common in the whole district, but mostly used in crosses with Dorper in both North Kajiado and South Kajiado, whereas crosses with Blackhead Persian were more common to use in South than in North Kajiado. Most important reason for keeping sheep was food source, followed by source of cash income. When purchasing new sheep for the time being, the most important traits were body size (weight and height) and growth. Large differences in cultivation practices, herd size and herd productivity could be shown between North and South Kajiado. The differences were most likely caused by the different infrastructural and environmental conditions in the two locations. Challenges in the future, with unpredictable climate with recurrent droughts, may lead to larger demand of well adapted sheep. In this case, Red Maasai sheep would be an appropriate breed to better utilize.

SAMMANFATTNING

Denna studie gjordes för att få kunskap om fårhållning, avelsstrategier och viktiga egenskaper hos fårrasen Red Maasai i distriktet Kajiado, Kenya. Detta distrikt är framförallt bebott av pastoralister tillhörande den etniska gruppen massajer. För att få djupare kunskap om skillnader mellan olika fårraser och djurhållning i detta område jämfördes norra och södra Kajiado. Det finns många anledningar till att djurhållning och speciellt fårhållning är viktigt hos dessa massajer. Egenskaper såsom sjukdomsresistens och hög överlevnadsförmåga rankas högt tillsammans med produktionsegenskaper såsom hög tillväxt och ökad slaktvikt. Utöver dessa egenskaper har får ett socialt och traditionellt värde i massajernas kultur. Även om Red Maasai är rankad högt när det gäller egenskaper viktiga för anpassning och sociala ändamål verkar den renrasiga Red Maasai allt mer minska i antal i dessa regioner. Den här studien visar att rasen var vanlig i hela distriktet men användes nästan uteslutande i korsningsavel med framförallt fårrasen Dorper i både de södra och norra delarna. Korsningar med rasen Blackhead Persian var mycket vanligt i södra Kajiado. Viktigaste anledningarna till att hålla får var som födokälla och för att få en kontantinkomst. Vid inköp av nya får var de viktigaste egenskaperna djurets vikt, mankhöjd och tillväxtförmåga. Det fanns stora skillnader i kultivering, besättningsstorlek och produktivitet mellan norra och södra Kajiado. Skillnaderna orsakas troligen av de olika förutsättningarna som finns i de två distrikten. Utmaningar i framtiden, med oförutsägbart klimat med återkommande torra kan leda till stor efterfrågan på anpassningsbara och livskraftiga får i dessa regioner. I sådant fall skulle Red Maasai vara en mycket lämplig ras att använda i större utsträckning.

1. INTRODUCTION

Undernourishment is a central manifestation of poverty. Currently, one of four people in developing countries are living on less than US\$1.25 a day (The World Bank, 2011). This proportion is slowly going down but the population growth, together with global energy and food crisis, affects the development. Hence, in Sub-Saharan Africa (SSA) the numbers of poor has increased (FAO, 2002) and this is likely to continue. After the food crisis in 2007/2008 the situation concerning poverty and hunger in SSA degenerated and currently the demand for livestock products is increasing and needs to be more than doubled by 2030 (FAO, 2007). This notably increased demand of livestock products, referred to as the “Livestock Revolution”, can partly be explained by the population growth but also the improved incomes for groups of people in developing countries (Delgado *et al.*, 1999). The agricultural sector growth has therefore a crucial role to play in improving the livelihood and income of poor people (FAO, 2002). There are evidences suggesting that farmers who are not currently operating at commercial levels have potential to turn the poverty in agricultural economies by improving their productivity (ILRI, 2000; Hazell *et al.*, 2007). It is, however, of great importance that the growth of the agricultural sector is done properly and with sustainable goals.

The concern about global warming is increasing. The African continent is expected to face a climate change with extreme effects where areas with grass dominated vegetation will in many parts turn to dry woodland and desert. The largest changes will occur in parts of the Horn, East and West Africa (Herrero *et al.*, 2008). The increase in temperature will result in a decreasing grazing capacity with more than 30% and a higher exposure to parasites and diseases for the animals. Understanding the adaptation of livestock to their production environment will therefore be important (Scholtz *et al.*, 2010b).

Africa contains one-half of the world’s pastoral populations; thirteen million Africans are predominantly pastoral and another nine million are agro-pastoral (Fratkin, 2001). Pastoralists occupy savannahs, semi-arid or arid deserts where rain-fed agriculture is unreliable. Over the past thirty years, East African livestock farmers have faced large challenges in their economies and traditional ways of life. In Kenya and Tanzania, Maasai people and other ethnic groups of pastoralists have lost land to expanding farming populations, private ranches and expansion of tourist parks (Fratkin, 2001).

Small ruminants, sheep and goats, are important to the subsistence, economic and livelihoods of a large human population in the tropics (Kosgey, 2004). Poor families usually keep a diversity of livestock species to fulfil different functions in the household economy (Anderson, 2003). Small ruminants provide both tangible benefits, such as meat and milk for home consumptions, manure, fibre and skins, and intangible benefits, such as savings, insurance against emergencies, cultural and ceremonial purposes (Kosgey, 2004). In the tropical areas there are wide varieties of indigenous small ruminant breeds that are adapted to the harsh environmental conditions (Lebbie & Ramsay, 1999). Many of the indigenous breeds in SSA are unfortunately underutilized and even threatened by extinction. One of the most promising ways to keep the threatened breeds would be to improve their genetic potentials and keep them commercially competitive (FAO, 2006). Low genetic potential among indigenous tropical small ruminants is often assumed and the breeding plans with crosses and replacements have often been implemented unsystematically and without a long-term strategy (Baker & Grey, 2004). For a long-term sustainability with improvement of productivity, adaption and welfare of tropical small ruminant breeds, it is necessary to integrate traditional behaviours and values. Many pastoralists’ societies face large constraints, with limiting

production resources of land and water, capital and labour. It is therefore important to support them and include their knowledge and practices to be able to develop appropriate breeding strategies (Fratkin, 2001; Kosgey *et al.*, 2006).

The Red Maasai sheep is an East African fat-tailed type of sheep and is found in northern Tanzania, south central Kenya and Uganda (Mason, 1988; Wilson, 1991; Baker, 1999). They are predominantly kept by the Maasai pastoralists and by the neighbouring tribes (ILRI, 2011a). The Maasai pastoralists are a well known ethnic group that keep livestock to provide economic security and to have a way to confront natural disasters, such as frequent droughts and disease (FAO, 2010). Compared to other sheep breeds, the Red Maasai is rated highly by both agro-pastoral and pastoral farmers in terms of drought and heat tolerance (Kosgey, 2004). The Red Maasai sheep is also noted for its resistance to gastrointestinal worms (Preston & Allonby, 1978, 1979; Baker *et al.*, 2002; FAO, 2007). Despite the Red Maasai sheep's uniqueness, currently there are no accurate information on population structure, status and trends, neither are there comprehensive breeding strategies and programmes in place.

1.1 Aim of the thesis

The aim of this study was to investigate the present breeding practices of Red Maasai sheep used in Maasai pastoralists communities in Kajiado District, Kenya. The aim was also to describe possible differences in sheep production between North and South Kajiado. Furthermore, the objective, as part of a Minor Field Study, was to experience and gain knowledge about another culture and livestock keeping system.

The specific objectives for the thesis were to:

- identify if breeding of Red Maasai is common in Kajiado District
- understand the farmers perception of the importance of rearing livestock and especially the Red Maasai sheep
- get an increased understanding about what characteristics that are important when breeding sheep in Kajiado District
- identify traits and the value of traits that are important for social, marketing and economical purposes
- identify if there are any major differences in sheep production between North and South Kajiado

2. BACKGROUND

This background aims to give an explanation of the environmental challenges and present situation in Kajiado District, Kenya, and to describe the small ruminant production and breeding practiced among Maasai pastoralists in the district. Moreover, a background of Maasai communities and the importance of animal holding in these will be explained.

2.1 Kenyan rangelands and Kajiado District

The Kenyan rangelands consist of many different agroclimatic zones (Sombroek *et al.*, 1982; USDA, 2004) which influence the livestock-carrying capacity. The different zones are divided according to annual rainfall. Areas with high potential for cropping, accounts for 12% of Kenya's land area, and the semi-humid to arid regions, accounts for 88% of Kenya's land area. The Kajiado District is mostly located in medium to potential areas, semi-arid and arid zones, which means that the annual rainfall is between 600 to 1000 mm. The rain comes with "short rains" from October to December and "long rains" from March to May (de Leeuw *et al.*, 1991). The arid and semi-arid land areas (ASALs) are predominantly occupied by pastoralists and agro-pastoralists (ALRMP, 2005).

The Kajiado District is an area of approximately 21,903 km² (NCAPD, 2005) and have an estimated population of 568,554 people in 2008 (KFSSG, 2009). The district spans from the Nairobi-Mombasa railway in the north-east to the Rift valley in the west. The south boundary is the Tanzanian border. Kajiado District has three constituencies called: Kajiado North, Kajiado Central and Kajiado South. The vegetation in the Kajiado District is mostly open grasslands and the access to natural sources of surface water in Kajiado District is limited (de Leeuw *et al.*, 1991). According to de Leeuw *et al.* (1991) the land of Kajiado District has only 8% potential for rain fed cropping.

2.2 History of Maasai pastoralists in Kenya

In the mid 1800s East Africa had developed farming systems, both pastoral and intensive. In the late 1800s this was changed when the Rinderpest epidemic came and put 90-95% of the cattle to death. Another epidemic followed, the jigger (sand-flea) arrived to East Africa and the area seemed as destroyed when the early colonist arrived. In late 1800s the Maasai pastoralists occupied an area of 155 000 km² but in 1913 the land had been reduced to 40 000 km² by the British colony. In 1965 the Kenyan Government, through funds from the World Bank, initiated a group-ranching scheme for Kajiado District, which was aimed to convert the at that time subsistence way of production to more commercial livestock ranching system. The radical transformation from nomadic lifestyle and production to a sedentary, more commercial system changed the social, political and livestock management of the Maasai.

A large increase of small ruminants was recorded in Maasai district between 1968 and 1981 (de Leeuw *et al.*, 1991). The tough droughts made the Maasai's diversify their production system to rear different types of animals, like sheep and goats that better could survive rough conditions. During 1969 and 1979 a rapid increase in human population took place in Kenya, and especially in the Maasai districts where the increase was recorded to 70% (de Leeuw *et al.*, 1991). The present southern Maasai area in Kenya is limited to Trans Mara and Kajiado Districts, hence, there is a high proportion of immigrant agricultural communities in these districts today (Grandin, 1991).

2.3 The Maasai Pastoralists Communities

2.3.1 The social structure

The social relations are important to understand since it has formed and still shape the Maasai's way of practicing herding. The socio-spatial organization of the Maasais is divided into five different groups: the household, boma, neighborhood, clan and Maasai society. The first unit, household, consist of husband, wives and children. The bomas commonly include six to 12 households, but because the production is individualized, the bomas of today are more commonly of the single family boma type. A neighborhood consists of several bomas and is usually located next to a permanent water point. The neighborhoods control the local resources, such as grazing and water, which each Maasai farmer included in the neighborhood, have access to. A clan is the unit which each Maasai belong to and identifies with; it is a group of people that have the same ancestors and a newborn child automatically belong to the clan of his father. The last unit, the distinct society of Maasai, shares a culture, language and social structure (Grandin, 1991).

The socio-political organization is based on age-sets and clans. In these groups, each Maasai have a defined role with responsibilities, rights and obligations to the community. When a boy is circumcised he is included to a generational age-set and he and his cohorts experienced the stages of warrior (morán), junior elder, senior elder and retired elder together. Approximately fifteen years is spent in each stage and depending on which age-set status a man have effects his possibility to influence politically (Grandin, 1991; Tiwar pers. communication, 2011). Five major clans and 40 subclans can be found in the Kajiado District. The territory belonging to each clan should be large enough to provide grazing throughout the different seasons. As a pastoralist mobility is essential for the traditional livestock production and the Maasai therefore unite people within and across clans to enable co-residence and collaboration for better animal practices. Members of the same clan brand their animals in similar ways, with an additional brand showing the farmers unique identity. The exchange of animals as gifts is of great importance in Maasailand and results in lifelong commitment of friendship and assistance. This means however that a person with few animals is poor, not only in subsistence terms but also socially (Grandin *et al*, 1991). The Maasai community thinks of a poor person as one who has no livestock, no children, no source of income and no land (NCAPD, 2005).

2.3.2 Labour, animal holding and distribution of responsibilities

The adult married men are primarily the managers with responsibility to have information on pasture and water availability and animal marketing. They decide the herd movement and person responsible for the herding. The men have responsibility to inspect the animals and perform castration and other minor veterinary procedures when needed (Grandin *et al.*, 1991).



Figure 1. Women herding the sheep to water point (photo: Josefina Liljestrand).



Figure 2. A typical manyatta in South Kajiado (photo: Josefina Liljestrand).

The women are primarily responsible for the childcare but they do take part in the livestock management (Grandin *et al.*, 1991), especially processing and selling milk and milk products (Mwacharo & Drucker, 2005). The women make all the household work decisions, such as food preparations, collection of water and wood for fuel, building and management of the house (Mokoi pers. communication, 2011). The young boys and girls help herding and caring for the young stock (Mwacharo & Drucker, 2005). An investigation in 1991 showed that most households had too few people to be able to run the labour for herding (Grandin *et al.*, 1991). An option to manage the stock is to herd cooperatively with other households or hire a shepherd, which makes it possible for children to have more time for school. The livestock management practices are based on how the grazing and watering is managed. The Maasai people aim to minimize the distance between the boma, the water point and grazing locations both for the sake of animals and herders. Another aim is to avoid predator attacks, to get to water points at right times and to provide best grazing for the different livestock. The sheep and goats are usually herded together in a separate group from the cattle (Grandin *et al.*, 1991). The Maasai livestock management has been admired for its tolerance against the surrounding wildlife. During daytime, wildlife can often be seen near the herds of livestock (FAO, 2010).

2.3.3 Purpose of keeping animals and specifically sheep

By keeping animals the Maasai farmers have a source of income and food. The animals are kept for selling meat and milk but also for own leisure. The difference between rearing big animals compared to small animals is the economical value. A cow is very big to slaughter and cannot easily be sold for right value compared to sheep that more easily can be sold. The generation interval for the sheep is shorter than for cattle as well (Uka pers. communication, 2011). The only existing bank for the farmer is the animals and if the flock would die the farmer has to start from zero (Slingerland, 2000). Since the economic status for pastoralists is measured in form of number of livestock the wealthy livestock keepers are more concerned about droughts since the loss in wealth is through the livestock deaths. The poorer pastoralists seek however to improve their economic status first before they try to stabilize the acquired wealth status through increased drought resistance (Omondi *et al.*, 2008). According to Bosman *et al.* (1997) a farmer can have multiple goals with the livestock and may need a gradually growing herd that can manage animals being disposed if something unexpected happens. This means that an unproductive animal, which do not require hard labour, may be kept in the flock only for insurance motives (Bosman *et al.*, 1997).

A farmer reaches prestige and becomes famous in the surrounding area when rearing many animals. All domesticated animals are important for a Maasai farmer (Tiwari pers. communication, 2011) and the cultural value of keeping animals is very high. According to old tradition a Maasai should keep animals to be recognized as a Maasai. By rearing animals the Maasai can feel proud and prestigious (Uka pers. communication, 2011).

2.3.4 Experiences of droughts

Some farmers may experience a more severe drought and damage on the animals than other farmers. This is probably dependent on how the farmer manages the animals. If a farmer is being hit hard by the drought he can request the clan for help. The clan will help the farmer and make it possible for that farm to start restocking a new herd. The farmer will however not get any support if he is mismanaging the flock (Uka pers. communication, 2011). When there is a need of moving and looking for grazing area there is usually no complications to share land. If a farmer suspects that the own animals may not survive the drought it can be used as an excuse and explanation to farmers claiming to use the land for grazing (Tiwari pers. communication, 2011).

2.3.5 Maasai agriculture and land use

Originally, the Maasai people did not grow crops. However, during the last 25 years the semi-arid grazing areas have partly changed to agricultural crop lands. The reason for this change is the associated security that the land is more easily kept when cultivation is practiced compared to when only rearing livestock (FAO, 2010).

2.4 Present situation in Kajiado District

According to FAO (2011) the food crisis in the Horn of Africa is escalating and the Kenya Food Security Steering Group (KFSSG, 2009) report that the Kajiado District is moderately food insecure. The terms of trade between livestock and grains got worsened during 2009 due to the reduced value of livestock when the condition of the animals got poor after the long drought. The water sources were easily dried out in 2009 and a fast depletion of the available pasture and browse occurred across the whole Kajiado District. This led to big migrations of livestock, approximately 60%, to other areas within the district but also to outside locations (KFSSG, 2009). The most common stress for grazing animals in the tropics is the nutritional stress according to Linington (1990) and the natural pasture has lower nutritional value as well as lower tiller density when compared to pasture in a temperate environment. Common problems after long migrations with livestock are malnutrition, exhaustion and diseases like East Coast Fever (Linington, 1990). The livestock kept in the district is mostly cattle, sheep, goat, poultry, camels and donkeys. According to KFSSG the livestock accounts for 80 % of the household's income source in the pastoral livelihood compared to the crops which is estimated to contribute with nine percent in the pastoral region and 18 percent in the agro-pastoral region (KFSSG, 2009).

The drought has not only affected the access to food but had a negative effect on education. Boys and girls are commonly dropped out of schools to help their parents with search for food or moving livestock in search for pasture. The attendance rate in primary schools in Kajiado decreased and the possibility to pay for school fees were affected, and because of that the general terms became poorer (KFSSG, 2009). The major cause of poverty in Kajiado District is illiteracy but also the frequent droughts that wipe out large number of livestock, HIV/AIDS, acute water shortage and pressure on land (NCAPD, 2005). The situation can become aggravated because the possibility to diversify source of income is limited and prices of food are increasing (KFSSG, 2009). However, there are opportunities to improve their livelihoods

by increasing the value of livestock products, utilizing the small scale industries like hides, skins, horns, hoofs, milk and meat (ALRMP, 2005). To elucidate the important role of livestock in arid and semi-arid land areas it is suggested that livestock is the most viable way of utilizing the extensive rangelands. Many districts have high evaporation and salt deposits which leads to stunted grass growth, only suitable for camel, sheep and goats to eat (GOK, 2002).

2.4.1 Development and cultural changes in North Kajiado District

The group ranching in the sixties is still remembered by the community in North Kajiado. The attempt to transform the Maasai nomadic lifestyle to sedentary, commercial animal production did succeed in some parts of Maasailand. The huts and neighbourhoods in North Kajiado changed primarily to individually driven and owned farms, which seemed good but with a pastoral production system this meant that land were lost. The important socio-political organization is still based on age-sets and clans in North Kajiado. A remaining tradition among the Maasai is how labour and responsibilities are done in relation to the different age-sets and clans (Tiwari pers. communication, 2011).

Today, many ceremonies have disappeared in North Kajiado and the Maasai farmers describe the culture as diminishing. The ceremonies are still remained in certain areas, but the manner of living as a traditional Maasai has disappeared. One of the remaining ceremonies is when the elders give blessings to an age-set of men that allow them to circumcise their sons in a near future. The new age-set is made of educated men – teachers, accountants, businessmen – speaking English fluently. The contrast is large between the modern influences and traditional living but seems possible to combine (Polong pers. communication, 2011). The Maasai traditions are disappearing in North Kajiado because of the introduction of Christianity and urban migration. The Western countries are influencing the Maasai manner of living which lead to traditions getting lost and new traditions are initiated (Tiwari pers. communication, 2011).



Figure 3. Ceremonial village of 109 huts in North Kajiado (photo: Josefina Liljestränd).



Figure 4. Maasai preparations for ceremonial meeting with another clan (photo: Josefina Liljestränd).

2.5 Small ruminant production in the tropics

2.5.1 Importance of small ruminants

Small ruminants are important to the subsistence, economic and livelihoods of a large human population in the tropics (Kosgey, 2004). The small ruminants play a complementary role to other livestock when utilizing feed resources as well as being able to use vast areas of natural grassland where crop production could not be achieved (Baker & Rege, 1994). They have the possibility to convert crop residues and fibrous material of no value into high quality protein (Rege & Gibson, 2003). The small ruminants have lower feed and capital requirements compared to the larger species and are therefore more suitable for producers (Devendra, 2002) with minimal husbandry conditions. They also have shorter generation intervals, higher prolificacy and are easier to handle because of the small size (Acharya & Battacharya, 1992; Holst, 1999). Especially the indigenous sheep breeds have good possibilities to improve the livelihood of people in low-input, agro-pastoral and pastoral production systems (Kosgey & Okeyo, 2007). To be able to conserve the threatened or endangered breeds, which currently are not supported by market forces, the role as a contribution for sustainable farming systems will be important (Ruto *et al.*, 2008). The sheep production in Kenya is important with both an economic role on household level and national level (Gicheha *et al.*, 2006). According to the Kenyan Ministry of Livestock and Fisheries Development (MLFD, 2003), the sheep contributed with 15-20 percent of the consumed red meat.

Small ruminants provide both tangible benefits, such as meat for home consumptions, manure, fibre and skins, and intangible benefits, such as savings, insurance against emergencies, cultural and ceremonial purposes (Kosgey, 2004). The small ruminants provide the only long term form of storing wealth, which is of great importance when there is none functional financing system (Rege & Gibson, 2003). The productivity of tropical sheep is usually low compared to sheep in temperate regions because of the high mortality rate (Gatenby, 1986). Since the tropical sheep mostly graze natural pastures it is common that an infection with gastro-intestinal (GI) nematode parasites causes the deaths (Over *et al.*, 1992). How profitable it is to rear small ruminants in pastoral systems in the tropics has therefore been a troublesome question (Kosgey, 2004). A survey done by Kosgey in Kenya 2004 revealed the extent and purposes of keeping sheep and other important sheep production parameters. Differences in land use, herd size and nutritional supplements to the livestock between pastoralists in Kajiado District and agro-pastoralists in Kitui District located North East of Kajiado was conducted in a study by Mwacharo and Drucker (2005). A comparison between pastoralists' and agro-pastoralists' different demands regarding reason for keeping sheep was presented for two indigenous sheep breeds in Ethiopia (Getachew *et al.*, 2010). The last reported diseases occurring in Kajiado District was Foot and Mouth Disease (FMD), trypanosomiasis, ECF and other tick borne diseases (KFSSG, 2009).

2.5.2 The Red Maasai sheep

The Red Maasai is an East African fat-tailed sheep which can be found in northern Tanzania, south central Kenya and Uganda (Mason, 1988; Wilson, 1991; Baker *et al.*, 1999). The breed is a hair sheep with a red-brown colour and is occasionally pied. The Red Maasai are used for their meat and lard. They are predominantly kept by the Maasai pastoralists and by the neighbouring tribes (ILRI, 2011a). There is no accurate population information or efficient breeding strategies for the Red Maasai sheep at the present (DAD-IS, 2011).

Compared to other pure breeds, Red Maasai are rated highly by both agro-pastoralists and pastoralists in terms of drought and heat tolerance (Kosgey, 2004). The Red Maasai sheep is

also noted for its resistance to gastrointestinal worms (FAO, 2007). The breed has been shown to resist bluetongue virus infection and to be a more suited breed to survive under high trypanosome challenge (ILRI, 2011a). Evidence shows that the indigenous Red Maasai sheep are both resistant and tolerant to naturally occurring gastro intestinal nematode parasites as well as to artificial infections with nematode parasites. The Red Maasai sheep are particularly resistant to the highly pathogenic nematode parasite *Haemonchus contortus* when compared to other breeds, like the Dorper (Preston & Allonby, 1978; Baker *et al.*, 1999 & 2003). The sheep production worldwide is exposed to large economical losses because of problems with gastrointestinal parasites (Beh *et al.*, 2002; ABC, 2007; ILRI, 2011b) Internal parasites are one of the most serious health constraints to the increase of productivity of sheep and goats in sub-Saharan Africa. The control methods available at present are expensive and lead to the build-up of parasite resistance and controlled grazing, which is not practical in most pastoral and agro-pastoral settings (ILRI, 1999).

2.5.3 Introduction of new sheep breeds in Kajiado District

According to the legend the Red Maasai sheep was the first animal kept by the Maasai. They were involved in the beginning of Maasai life and rearing of animals. The sheep were kept for own consumption but when the environment changed the farmers started to run businesses with butcheries and markets for meat. Since the meat was going to be sold, the farmers looked for a breed that was heavier than the Red Maasai sheep. The Dorper breed was introduced with its heavy body with large muscles and less fat (Uka pers. communication, 2011).

In 1981 a study by King *et al.* (1984) showed that the major sheep breeds kept in South-East region of Kajiado District were Red Maasai, Blackhead Persian and some Dorper and their crosses. The most common breed was the fat-tailed Maasai sheep. In some areas the Dorper could be accounted for 20% of the sheep while in some areas only a few rich households kept Dorper (King *et al.*, 1984). The Blackhead Persian is a fat-rumped sheep with white coloured short hair on body and black colored head and neck (DAD-IS, 2011). The breed has been subjected to difficult conditions for centuries and is noted for being hardy, disease resistant and fertile (ARC, 2011). The Dorper on the other hand was developed in South Africa in the 1940s by crossing Blackhead Persian and Dorset Horn. The breed was introduced to Kenya in the 1960s (Baker *et al.*, 1999; Milne, 2000). The coat has short white hair and wool with black hair on the head (ILRI, 2011a). The Dorper has proved to be a hardy mutton sheep that develop high quality carcass relatively early in life (Milne, 2000). Merino was only recently imported to Kenya (DAD-IS, 2011) but was already in 1700s introduced to South Africa where the breed is widespread. The coat color of Merino is white with fine-wool (ILRI, 2011a). There is no accurate population information or efficient breeding strategies for the three mentioned sheep at the present in Kenya (DAD-IS, 2011).

According to a study by Baker *et al.* (2002) the Red Maasai sheep had higher productivity and flock efficiency than the Dorper sheep in a humid environment. This shows the important genotype by environment interactions for flock productivity and efficiency (Baker *et al.*, 2002) and the poor performance of the Dorper sheep in humid environments (Nguti *et al.*, 2003). Similar results were also recognized in a genotype x environment interaction study by Okeyo & Baker (2005). Research have been done to obtain a cross breed between Red Maasai and Dorper sheep, which would improve the productivity and still have resistance towards parasites and have a good tolerance against drought and heat (ILRI, 1999). In a study by Mugambi *et al.* (2005) the phenotypic performance of resistance and tolerance towards gastrointestinal nematode parasites were evaluated for Red Maasai, Dorper and double back crosses on a ranch located in the semi-arid eastern Kenya. The results showed that the Red Maasai lambs and $\frac{3}{4}$ Red Maasai lambs were consistently more resistant and tolerant than

Dorper and $\frac{3}{4}$ Dorper lambs, the differences were significant for lambs from 3 to 6 months of age. The resistance to GI nematode parasites was examined in terms of faecal egg counts (FEC) and tolerance was examined by measuring blood packed red cell volume (PCV). The Dorper lambs and $\frac{3}{4}$ Dorper lambs were however significantly heavier than the Red Maasai and $\frac{3}{4}$ Red Maasai lambs (Mugambi *et al.*, 2005).

2.6 Breeding goals and strategies for small ruminants in the tropics

2.6.1 Breeding programs

Applying effective breeding programs provide important steps to achieve the improvement of productivity and by that improve the livelihoods of poor livestock keepers, reducing poverty and developing sustainable agriculture and universal food security (Mwacharo & Drucker, 2005). The genetic improvement programs for small ruminants in the tropics have not been very successful. Livestock research and policies are often setting the goals for production, but compared with perceptions of farmers the concept of production and productivity might not be the same (Ahuya *et al.*, 2004). Other factors affecting the success or failure of a breeding program may depend on the agricultural policies and market, environmental conditions, breed recordings and characterization. These factors can fluctuate and breeding programs therefore need to be flexible and changeable to future, although long-term, scenarios (Philipsson *et al.*, 2006). In order to be able to achieve a genetic improvement program, the organizational and institutional work must have adequate funding and staff for the animal recordings to be well implemented and organized (Scholtz *et al.*, 2010a).

A simple and effective way of controlling the recordings and start conserving an indigenous breed or upgrading the local population is to implement a nucleus herd breeding scheme. This is based on selection of breeding stock in a few herds from which the selected animals can be distributed to other herds (Philipsson *et al.*, 2006). To increase the involvement of the farmers when improving local breeds a community-based breeding scheme is optimal (van Arendonk, 2011) since research shows that farmers driven breeding programs, cooperatives, with government support have been especially successful (Ahuya *et al.*, 2004). By cooperation between communities an exchange of genetic material with artificial insemination can be done, resulting in an increased rate of genetic improvement and decreased risk of inbreeding (van Arendonk, 2011).

A requirement for achieving sustainable genetic improvement programs for small ruminants is to evaluate the tangible and intangible benefits from small ruminants, as well as characterize the different farming systems (Baker & Grey, 2003; Kosgey, 2004; Philipsson *et al.*, 2006). Bichard (2000) summarized the scientists' conclusions as "When proposing improvement goals and goal values in medium and low input systems, it is important to incorporate such non-monetary values as risk management, social capital, draught usage and aesthetic value". Kosgey (2004) showed that it is important to include the role of financing and insurance in traditional production systems as long as tangible returns are counted for as well. The livestock's different socio-economic and cultural values are important to analyze to achieve appropriate breeding strategies. The most obvious solution of conserving breeds would be to keep the population viable and for that a long-term demand-driven and efficient breeding program is needed (Philipsson *et al.*, 2006).

In developing countries, several examples of technical assistance from developed countries have led to an introduction of exotic breeds with not well planed utilization programs and ignoring the important G x E interactions (Devendra & Burns, 1983; Ayalew *et al.*, 2002).

The replacement of indigenous breeds with exotic breeds and crossbreeding with exotic breeds has in low input production systems in the tropics mostly ended unsuccessfully (Rege & Gibson, 2003; Kosgey, 2004; Bosso *et al.*, 2007). The indiscriminate use of exotic breeds has led to inappropriate production systems, land degradation and loss of indigenous genetic resources (Rege & Gibson, 2003). To perform indigenous breed-based breeding programs may have a significant potential to improved development (Kosgey, 2004; Mwacharo & Drucker, 2005). The indigenous livestock breeds have the adaptive traits that make them survive and reproduce in the harshest environments and can therefore outperform crossbreeds under such conditions (Ayalew *et al.*, 2003). There are, however, examples in special tropical environments, like the highlands and peri-urban areas, showing successful introductions of exotic breeds and their crosses with indigenous livestock (Philipsson *et al.*, 2006).

2.6.2 Appropriate breed and trait selection

When selecting the most desirable breed or breed combination and selecting within a breed it is important to start by defining the breeding objective. This includes all relevant characteristics of an animal and assigns a value to each trait (Kosgey, 2004). The pastoralist's trait preferences should match the improvement programs (Zander & Drucker, 2008) so that the scientific research can focus on appropriate traits and attributes (Jabbar & Diedhiou, 2003).

A study by Omondi *et al.* (2008) evaluated the sheep genetic resources in terms of the important non-market traits and found that preferences like “rump shape and size”, “fat deposition” and “health status” traits are equally important among the pastoralists and is not influenced by producers' socio-economic backgrounds. The results also indicated that there is a need of improving the drought resistance (or the farmers' ability to manage the livestock during drought), but the focus should be on the areas that are adversely affected by droughts (Omondi *et al.*, 2008). Blackburn and Mezzedra (2006) described the importance of diverse genetic resources with special genetic potentials for both production traits as well as resistance to diseases and droughts. Fitness and adaptive traits have to be dealt with specially. Some changes in these traits may be difficult to value economically but need to be considered in the selection programme (Philipsson *et al.*, 2006). There are indications showing that selection for performance like reproduction, survival, growth etc., will lead to breeding of the most suitable animals in a stressful environment (McDowell, 1972). Since the mortality rates are high in the tropics, the lamb survival should be of great importance, the flock productivity and efficiency can therefore be measured by including the rates of lamb survival (Nguti *et al.*, 2003). The lamb survival is however not given as much emphasis as size and growth rate when designing breeding programs (Over *et al.*, 1992).

The question concerning desirable size of the animal continues to play an important part in the tropics. When selecting breeds for extensive production system this is a critical factor. According to Taylor and Murray (1988) the small animals have an obvious advantage, over larger animals, in low nutritional production systems since more energy is left for production after that the maintenance requirements have been obtained (Taylor & Murray, 1988). Productivity of small sized breeds shows a consistently superior production compared to larger sized breeds because of higher calving rates and lower calf mortality (Madalena, 2005). When selecting for body weight above specific optimum levels there is a risk that the animals become less adapted (Philipsson *et al.*, 2006).

The adaptability of an animal can be explained as the ability to reproduce and survive in a certain environment (Prayaga & Henshall, 2005). To be able to understand the different attributes and traits the adaptability is important to measure, but to measure adaptation is

complex and therefore very difficult to include in breeding objectives (Scholtz *et al.*, 2010b). Except measurements like body temperature, respiration rate, heart rate, sweating rate and skin thickness there is other tests that can be investigated. One type of test to examine heat tolerance is by measuring body temperature before and after exposure to extreme heat (McManus *et al.*, 2009). Parameters like levels of parasites in the blood, indicating level of resistance, can easily be measured and therefore included in evaluation programs (Scholtz *et al.*, 2010a). Traits like fertility and survival are highly influenced by management decisions (Scholtz *et al.*, 2010b) and need appropriate breeding technology to be developed (Scholtz *et al.*, 2010a). The progress made in molecular genetics may make it possible to get the genetic background on quantitative traits, which would be valuable information for future breeding programs (Philipsson *et al.*, 2006).

2.6.3 Example of breeding strategies for small ruminants in the tropics

The elaborated study by Kosgey *et al.* (2004) revealed that the indigenous breeds were perceived more favorable than the crosses among farmers and butchers in Kenya. Breeding parameters were compared between agro-pastoralists and pastoralists (Kosgey, 2004). In King *et al.* (1984) the breeding practices of Maasai farmers were investigated. An exploratory survey made in Ethiopia revealed knowledge about the breeding practices and selection criteria for two indigenous Ethiopian sheep. This study also compared breeding practices between agro-pastoralists and pastoralists (Getachew *et al.*, 2010).

3. MATERIALS AND METHODS

To accomplish the aim, a broad literature review was executed with additional field work including both a quantitative and a qualitative part. The quantitative part consisted of interviews including general questions about farming and breeding practices in the studied location. The qualitative part included participating approach in Maasai farmer's daily work and remaining ceremonies. Semi-structured interviews with the Maasai farmers were also performed to achieve this part.

3.1 Study area

Two areas with two slightly different Maasai societies keeping Red Maasai sheep in Kenya was chosen as the study sites and communities. The two community sites were selected based on their suitability for sheep production, market and road access and willingness to participate. The societies are located in the Kajiado District. Kajiado District is an administrative district in the Rift Valley Province of Kenya, which borders to Nairobi city and extends to the Kenya-Tanzania border further south (figure 5). The indigenous people of the area belong to the ethnic group of Maasai, but there is an increasing influx of people from other ethnic groups. The region is semi-arid, very dry and has no permanent rivers. The areas

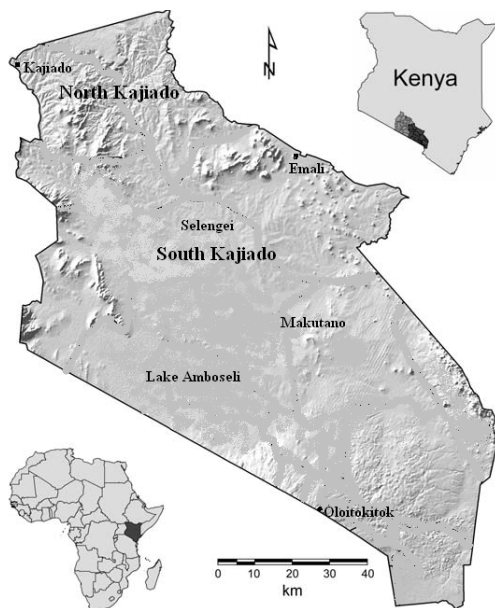


Figure 5. Kajiado District is located in South Kenya (see insets) and the South-East part of the district formed the study area (modified after Boone et al., 2005).

3.2 Collection of quantitative data

Three different questionnaire were designed so as to capture as many aspects as possible. The three questionnaires included: a) Baseline survey b) In-depth interviews c) Semi-structured qualitative interviews. The baseline survey was administered to 60 farmers to provide a general picture of the farming, sheep production and environmental effects in the studied locations. The details of the questionnaires and questions asked are found in Appendix 1. The in-depth interviews were conducted on seven randomly chosen farmers to get

information about the breeding strategies for sheep and if there are special strategies for the Red Maasai sheep, see Appendix 2. The farmers were all located in North Kajiado and had previously answered the baseline survey. A summary of the number of interviews can be seen in Table 1. The majority of the interviews were carried out with the household head. The results gained in the quantitative data show the different livelihoods for the different districts. It also explains the sheep production and breeding practices among Maasai pastoralists in the areas. A total of 67 interviews were performed using a quantitative approach, paper notes were used to collect answers from all the interviews.

The fieldwork started in February 2011 in North Kajiado District, where two persons were used as guides and interpreters during our visits. With car transport the pastoralists and farms could be visited. The farmers were easily found in the town center of Isinya where the livestock market is located. Some of the farmers were therefore interviewed in town and afterwards we travelled to the farms to look at the houses and animals. In South Kajiado District a Maasai were contact person and interpreter. In this area the farmers live close to each other and could easily be found and interviewed. All questionnaires in the two locations were answered by Maasai pastoralists.

3.3 Collection of qualitative data

The qualitative data collection was conducted by using questionnaire c) Semi-structured qualitative interviews, which were made to present the farmer's apprehensions. Here the farmer's apprehensions regarding cultural values, animal keeping and future prospects could be answered. Weight is put on the cultural aspect since it has formed and still shape the Maasai's way of practicing herding. The text is compiled after the interpretation the writer got on the interview occasions with the farmers. The questions can be seen in Appendix 3. A qualitative analysis implies that knowledge about behaviour and a pattern is searched for rather than presenting the results with figures, as in quantitative studies. A precise description of the scientific procedure and method used is given by Trost (2005).

Semi-structured interviews were held as group discussions and the results from these are presented as explanations and quotes throughout the results. This part of the study is based on semi-structured questions, meaning that the questions are open to be able to get large amounts of information based on honest and open conversations. The interviews were conducted on five farmers with historical knowledge and special interest in preserving local sheep breeds. Four of the five different farms participating in the qualitative interview were also included in the quantitative analyses. Two of the participating farmers are used as information source and enumerators by the research centre ILRI. The other farmers were contacted with help of the enumerators or by recruiting sheep keepers on the weekly sheep market held in a nearby town. The six selected farmers were exclusively men of varying ages belonging to three different clans and were all heads of their household's and involved in marketing sheep. The Maasai farmers all reared sheep, the majority being Red Maasai x Dorper crosses. The herd size of sheep on the selected farms varied from 70 to 200, which indicates a certain wealth. Locations of the farms were spread but were all located in North Kajiado. The meetings were either held on one of the farms or on a known location to the farmers. Two group discussions and two individual conversations were performed with varying time span (0.5 hours – 1 hour) depending on how much the farmers were willing to share. The facts given here is therefore only representative for the specific area and do not apply to other Maasai societies.

Table 1. Total number of interviews in the different locations of Kajiado

County	Location	Number of baseline surveys	Number of in-depth interviews	Number of qualitative discussions	Total number of interviews
North Kajiado	Isinya	34	7	5	46
South Kajiado	Selengei	26	-	-	26
Total		60	7	5	72

In addition to the data collected, a ceremony held in North Kajiado was attended. By participating at the ceremony and interacting with the farmers living in the area good knowledge on how the North Kajiado pastoralists are participating in, and embracing the local development activities, could be better understood. This information has been collected with photos, videos and a voice recorder. The ceremony was one of the few remaining in this area and were only occurring every third year.

3.4 Data analysis

The data collected was saved electronically by using Microsoft Access. Microsoft Excel was used for analyzing the tables and to calculate the frequency counts and means for specific datasets. Specifically, results for the importance of reasons for keeping sheep, have been calculated by using a weighted average of all rankings of a particular reason. Lower number (min=1) indicates a higher importance. This analysis was based on the method used in the study by Mwacharo and Drucker (2005). To analyze least square means and p-value for differences in breeding parameters in table 4, SAS was used.

4. RESULTS

4.1 Family household, income and farming type

The source of household incomes are summarized and presented in figure 6. Three farmers (5%) answered that they had other economic sources, namely employment in a town as security guard or had started a tourist camp.

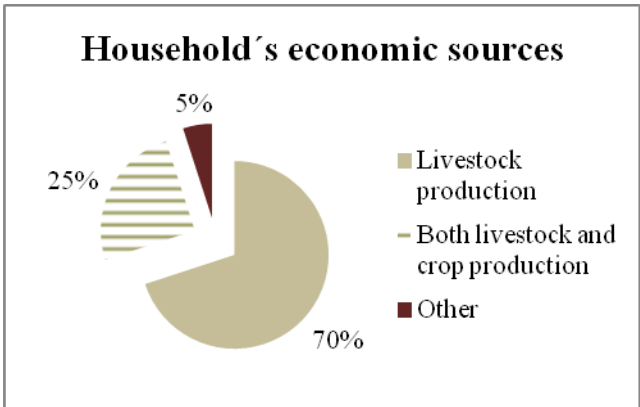


Figure 6. Distribution of the household's major economic sources.

The type of family house differed greatly between the two locations. As shown below (see figure 7a and 7b) 96% of the Maasai in South Kajiado lived in traditional houses compared to only 9% of their North Kajiado counterparts. In North Kajiado 47% of the Maasai lived in permanent houses and 44% in semi-permanent houses compared to 4% that lived in permanent houses in the South Kajiado. A traditional house is a Maasai hut, so called manyatta, which is usually inhabited for some years and then rebuilt on another location (see figure 2). The semi-permanent houses have often a framework made of wood that is covered by iron sheets. This is usually a house used when working on a permanent house made of stone bricks.

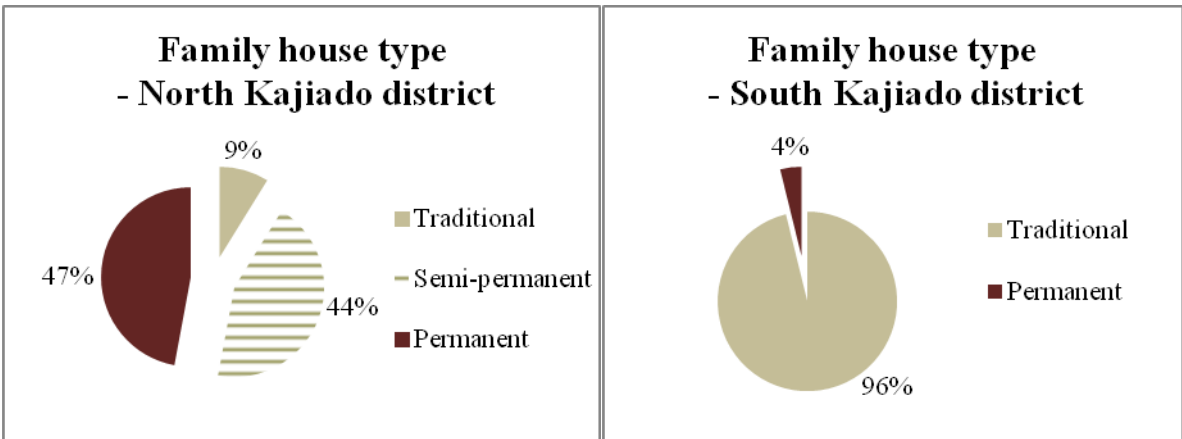


Figure 7a and 7b. A comparison of the different family house types between the two districts.

Fifty-two percent of all the interviewed farmers practiced cultivation of land and the major crops were maize and beans, some farmers grew other crops such as potatoes, tomatoes, spinach and chili. Comparing North Kajiado District with South Kajiado District shows an obvious difference. Seventy-four percent of the farmers in North Kajiado cultivated their land

compared to the farmers in South Kajiado where only 23 % of the farmers practiced cultivation (see figure 8a and 8b). The majority of the farmers in North Kajiado can therefore be referred to as agro-pastoralists and farmers in South Kajiado as pastoralists.

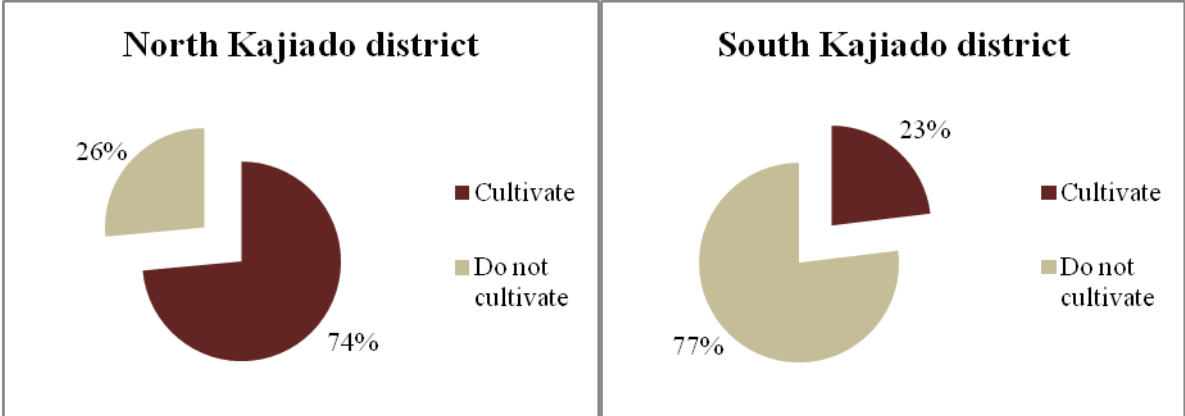


Figure 8a and 8b. A comparison of the prevalence of cultivation between the two different districts.

According to results obtained most (95%) farmers, were categorized as having pastoral production. The three farmers that had intensive (2%) and semi-intensive (3%) productions were all located in the North Kajiado District. An intensive production is characterized by using larger amounts of feed supplements and medications which result in higher production levels. The few farmers who represented the intensive and semi-intensive group in this case used feed supplements throughout the year and had quick access to drugs and veterinary services compared to the pastoral farmers.

When looking at farming type the farmers could be categorized as pastoralists, semi-commercial and commercial, see figure 9. All farmers belonging to category semi-commercial or commercial, except one semi-commercial farmer, were located in North Kajiado District. The pastoralists are characterized as mobile and move their herds in search for pasture. Depending on rainfall the animal husbandry can be mixed with agriculture. In this case the animal production was for own use while the semi-commercial farming meant that some parts of the production were sold to others or on a market. A commercial farm puts large efforts on maintaining a business out of the animal production and usually keeps the animals on the farm, even during droughts. More inputs such as feed and drugs are used to get commercially suitable animals.

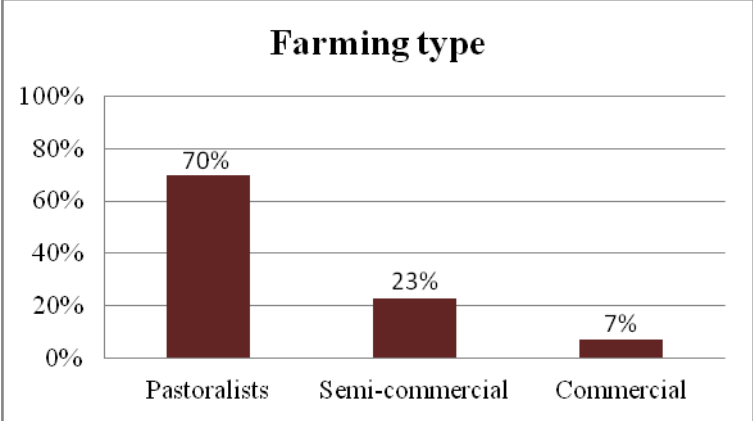


Figure 9. Distribution of farming type among the farmers.

4.2 Animal keeping and especially sheep production

One farmer mentioned that “*a Maasai without animals is not a real Maasai*” and by keeping animals “*you feel proud and prestigious*” (Tiwari pers. communication, 2011). All the sixty farmers interviewed kept sheep, 88% kept cattle and 85% kept goat. Most common cattle breed kept was Sahiwal and most common goat breed was Small East African. Other cattle breeds mentioned by the farmers were Boran and East African Zebu. Other goat breeds mentioned were Galla, Saanen and Toggenburg. One difference between the districts was that the goat breed Galla was more common than Small East African in South Kajiado compared to North Kajiado.

The average sheep herd size was about 90 sheep (varying between 20-300 sheep per farm) in North Kajiado and 28 sheep (varying between 4-80 sheep per farm) in South Kajiado. The majority (92%) of the farmers kept crosses of the breeds Dorper (D), Red Maasai (RM), Blackhead Persian (BHP) and Merino (M), see figure 13 and 14. All 60 farmers indicated that the sheep feeding was pasture based. During the dry season 97% of the farmers reported that they used minerals or concentrates as feed supplements. Pastoralists in South Kajiado used almost exclusively minerals, while the agro-pastoralists in North Kajiado mainly used concentrates from their own or neighboring farms. The housing system used for sheep was commonly fences made of wood and wire and were mostly used for protection against predators during the night.

4.2.1 Reasons for keeping sheep

Fifty-one (86%) out of 59 respondents ranked food source as the most important reason for keeping sheep, see table 2 for all results. The main differences between the districts were that none, except one farmer, in South Kajiado ranked manure as a reason for keeping sheep, while many more mentioned this as a reason in North Kajiado. For ceremonial purposes the “*elders decide for a specific ceremony how many animals that should be slaughtered*” and that “*it is important that slaughter is done when there is a purpose*” (Tiwari pers. communication, 2011).

Table 2. Importance of reasons for keeping sheep

Reason or use	Importance ^a
Food source	1.4
Breeding stock for sale	3.9
Capital accumulation	4.1
Ceremonial purpose	5.8
Cultural purpose	6.4
Manure for crops	6.4
Dowry	6.6
Supplement other income	6.6
Wool	6.8

^aThe importance rating is calculated using a weighted average of all rankings (including no ranking) of a particular reason. Lower number (min=1) indicate a higher importance, scale 1-8.

4.2.2 Products used from sheep

As for the main products used from sheep, 50 of the 60 farmers responded. Results are presented in figure 10. The results show that 100% of the farmers use meat as the main product. The second most mentioned product, with 96% of the farmers, was milk, and the third product was fat, mentioned by 94% of the farmers. The majority (68%) used the skin and (66%) the blood from sheep. Forty-six percent of the farmers used manure as well. No

major differences between districts in the use of the main products could be seen. Out of the 50 farmers indicating milk as an important product, 78 % of them milked their sheep. Some farmers answered that the milking of the sheep was especially done during dry season and some farmers milk their sheep more frequently, once a day, while others, once a week. Most farmers answered that the amount of milk per day per sheep is approximately 0.25 litre and is used for drinking tea.

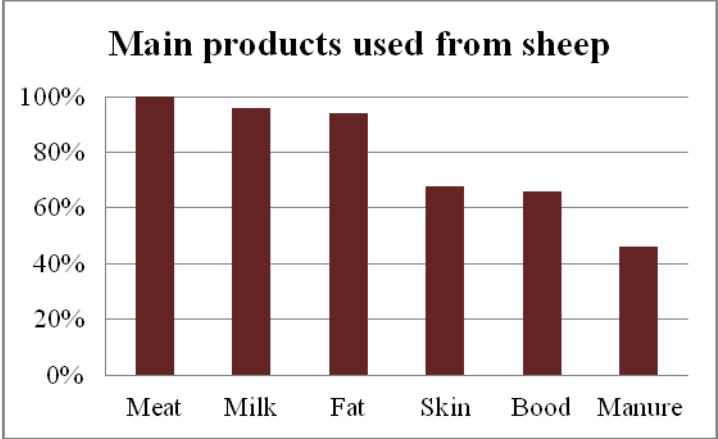


Figure 10. The order of main products used from sheep, according to fifty farmers.

4.2.3 Important traits of the sheep

Results of important traits when purchasing new sheep by 55 responding farmers are presented in table 3. Other traits mentioned by farmers but not included in table were breed, age, health, history and resistance to droughts. No major differences could be seen between the districts except that several traits were commonly mentioned in South Kajiado.

Table 3. Sheep traits farmers look for when buying new sheep

Trait	Most mentioned (%)
Body size	82
Growth	58
More fat	38
Shape (conformation, structure)	38
Colour	36
Mothering ability	27
Lambings	22
More meat	16
Milk	15
Mortality rate	5

4.2.4 Market

The most mentioned products to sell on the market were live animals, meat, skin, manure and milk. A majority of the farmers (75%) had sold sheep during the last 12 months. The farmers that did not sell sheep were, except for two farmers in North Kajiado, located in South Kajiado. The average number of sheep sold per farm in the last 12 months was 14 sheep, varying from two to 100 sheep. Most common sheep breed to sell was the Dorper and any kind of crosses. Live animals were commonly sold to butchers and the frequency of selling varied from once a month to several times a month depending on the need of money for school fees or other expenses. The age of the sheep when marketing or slaughtering them was on average 1.5 year. A majority of the farmers (53%) had also purchased sheep during the last 12 months; most of these farmers were located in North Kajiado. The average number of

sheep purchased by the farmers in the last 12 months was eight sheep, varying between one to 50 sheep. Most common sheep breed to purchase was the Dorper.

4.2.5 Diseases

All except ten farmers said they had problems with some sheep diseases. The most mentioned and commonly occurring disease was foot and mouth disease (FMD). Other diseases occurring were e.g. anthrax, worms and diarrhea. Usually a private veterinarian was used since the governmental veterinarians took too long time to get in contact with. The vaccinations given by the government veterinaries were used to prevent FMD and lumpy skin disease. Those who had access to private and/or governmental veterinaries usually needed to use them one or two days a month.

4.3 Breeds and breeding practices

4.3.1 Reasons for keeping the specific breeds

The reasons for keeping Dorper sheep were, according to the farmers, its fast growth rate, big body size and meaty frame. These characteristics make the Dorper to be economically important, easier to sell on the market and to contribute to the households' capital accumulation. Reasons for keeping the Red Maasai sheep was given as its resistance to diseases, worms and drought, their large amounts of fat and ability to walk long distances. A few farmers mentioned their relative environmental friendliness and use for ceremonial purposes. The benefits experienced by the farmers with crosses between Dorper and Red Maasai was that they grew fast and were heavier than the pure Red Maasai but still had more resistance to diseases and drought than the pure Dorper. Reason for keeping Red Maasai crossed with Merino and Dorper crossed with Black Head Persian was to get more milk. Crosses between Red Maasai and Black Head Persian contributed mostly to faster growth. One farmer reported that they reared crosses between Red Maasai and Dorper or Black Head Persian to get meaty and drought resistant animals.

Three of the farmers explained the differences between Dorper and Red Maasai during drought and mention that "*Dorper's body structure easily becomes thin and ugly when not fed properly*" and that "*Red Maasai sheep can keep up to 70% of the health status during drought*". According to three farmers a flock of Dorper is very difficult to keep when there is a drought. One farmer mentions that "*the Dorper sheep becomes very greedy and the search for pasture makes the flock of animals tear apart and disappear*" (Uka pers. communication, 2011).

During the time of ceremonies and dowry the Red Maasai is still of importance. When the Maasai give each other young sheep as gifts it should most likely be a Red Maasai. The Dorper is not preferable as a gift among the Maasai. The most important social value of the Red Maasai sheep is the color of red. To have one united color is of major value for the Maasai since the traditional costumes are colored red and the surrounding sand is red. A Red Maasai sheep is still a Red Maasai sheep today even though some may have black coat color. According to the farmers it is only the genetic make-up of color that has changed but the other attributes are still there. When a ceremony is being held a bull is usually slaughtered but if the farm cannot afford to slaughter a cattle a sheep can be used instead. When there are long dry periods the Maasai usually sacrifice a sheep for making the rain to come. The sheep to be sacrificed should have one color, without any dots (Uka pers. communication, 2011).

4.3.2 Breeding strategies

Of the 60 farmers 93% indicated that they practiced controlled/seasonal mating among the sheep. To be able to control the mating the farmers used either apron (75%) or had the ram separated (20%) from the ewe flock for a designated period of time (see figure 11). Few farmers (5%) answered that both apron and having the ram separately could be used. To have controlled mating in this case meant that indiscriminate mating was avoided and that a certain ram was chosen for appropriate breeding. The reasons for controlling the mating were primarily to avoid lambing during dry season and by that targeting the appropriate time for breeding. Other reasons were also to get high producing animals with good health and to stop unnecessary mating with young ewes.

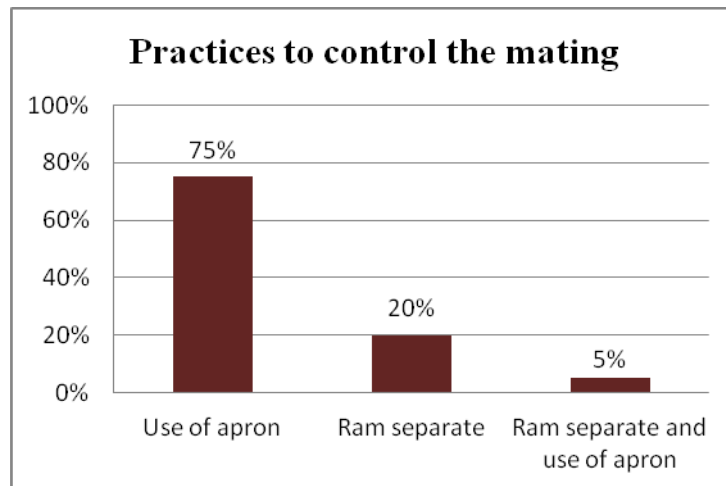


Figure 11. Percentage of farmers using different practices controlling the mating.

Crossbreeding was used by a majority (92%) of the farmers when deciding type of breeding, see figure 12. Among the farmers using crossbreeding the majority (74%) used Dorper and Red Maasai, this was primarily practiced in North Kajiado District. The second most used cross was between Black Head Persian and Red Maasai (13%), which was exclusively practiced in South Kajiado District. Crosses between Dorper and Black Head Persian (9%) were most common in South Kajiado as well. One farmer in North Kajiado reported that they reared Merino and Red Maasai crosses and two other farmers in the same area reported that they used Dorper, Red Maasai as well as Black Head Persian for crossing, see figure 13. No consideration has been done on which sex from which breed that has been used. Two farmers reported that they used cross breeding but did not mention which breeds they used. The two farmers (3%) using pure breeding were located in North Kajiado and had Merino and Dorper. Three farmers reported that they used both cross and pure breeding which suggest that they have few animals which they keep pure and at the same time practice crossbreeding with the remaining sheep.

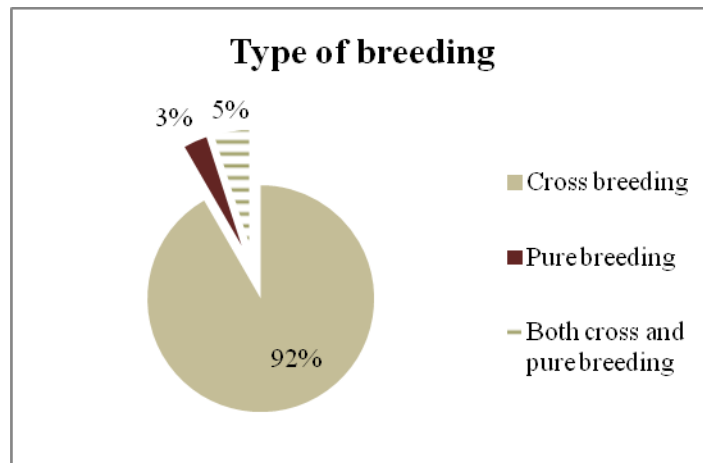


Figure 12. Type of breeding techniques among the 60 farmers.

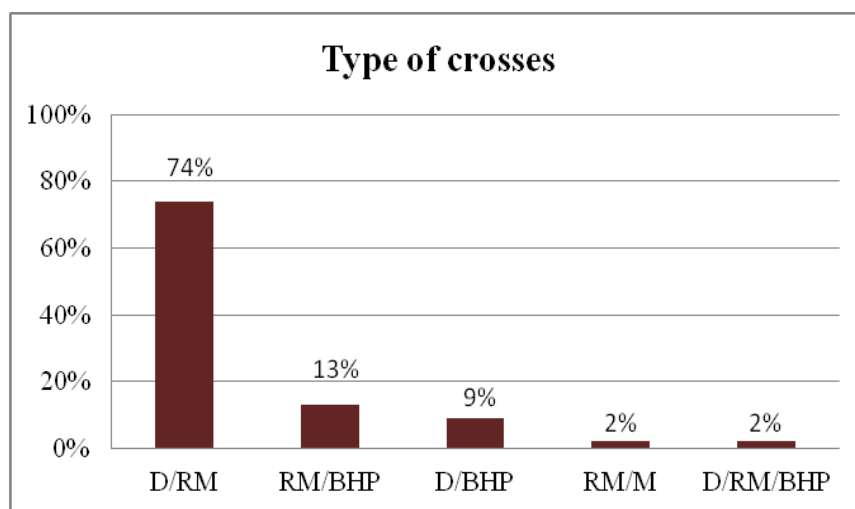


Figure 13. The different sheep breed crosses used in Kajiado District.

4.3.3 Selection of sheep for breeding of subsequent generations

The most common way of selecting sheep for the subsequent generations was to use the offspring of a successful ram and/or ewe. By comparing the performances of both the parents and their lambs the selection decision were made. Important traits that were considered in selection decisions included body structure, size, color and mothering ability. A few farmers reported that they keenly observed several ewe lambings and lambs performances (i.e. for two to three years) to make selection decisions.

4.3.4 Lifespan of selected breeding sheep

The selected rams were used on an average of 2.5 years and the ewes for 5.4 years. When comparing North Kajiado District with South Kajiado District the average was higher in south; 2.9 and 6 years compared to 2.3 and 4.8 years in the north for selected rams and ewes, respectively. The rams were on average used for 2.9 mating seasons and the ewes got birth to 5.3 lambs during their lifespan. Average lambs born per ewe each year was 1.3 and a distinct difference could be seen between the districts; 1.5 lambs born per ewe each year in North Kajiado and 1.1 lambs born per ewe per year in South Kajiado. Five farmers in North Kajiado did not report number of lambs born per ewe each year, but including them would most likely not change the result.

The average age at first parturition was 14.6 months. Out of 50 answering farmers 92% mated their sheep in June-July. The remaining farmers mated their animals in April, May or August. When two mating periods were performed per year the second period was commonly planned for November or December. The lambings occurred therefore mostly in November - December and the second lambing around April. Most common time to wean the lambs were after four months but this varied a lot and could span from two to twelve months and until the ewe rejected the lamb. The lamb survival for their first year was reported to be an estimated average of 70%. One farmer commented that the survival can be up to 100% but also as low as 10% when there is a drought, reflecting the fluctuation in these figures depending on seasonal circumstances.

4.3.5 Breeding parameters for North and South Kajiado

Differences in breeding parameters like number of lambs per ewe and year, for how long the selected animals are kept (females respectively males) and the estimated survival rate, between farmers rearing Red Maasai crosses and other crosses in North Kajiado and South Kajiado are presented in table 4. Because of lack of information from farmers keeping other crosses in North Kajiado this has not been taken into consideration in this study.

Table 4. Least square means (standard error in parentheses) and p-value for differences in breeding parameters between Red Maasai crosses and other crosses in North Kajiado and South Kajiado farms. Number of farms reporting the average figure of each parameter is presented as N

Trait	North Kajiado (RM cross)		South Kajiado (RM cross)		South Kajiado (Other cross)	
	N	LSM (SE)	N	LSM (SE)	N	LSM (SE)
Lambs per ewe	27	1.56 (0.08) ^a	19	1.16 (0.10) ^b	6	1.00 (0.17) ^b
Lifespan, females	28	4.63 (0.31) ^a	19	5.97 (0.38) ^b	6	6.17 (0.67) ^{b*}
Lifespan, males	31	2.21 (0.13) ^a	19	2.87 (0.16) ^b	6	2.83 (0.29) ^{a,b}
Survival rate	19	76.32 (3.15) ^a	18	63.94 (3.23) ^b	6	70.83 (5.60) ^{a,b}

^{a, b} = Means within each row with a different superscript are significantly different ($p < 0.01$)

^{b*} = Significantly different with $p < 0.05$

4.3.6 In-depth interviews in North Kajiado

Three out of seven farmers answered that inbreeding is not controlled and that new rams entering the herd are not being tracked. Practices to prevent indiscriminate mating would be, according to them, to keep a good shepherd. The remaining farmers that controlled inbreeding changed ram yearly or every second or third year and had a shepherd controlling the matings carefully. The household head or/and the husband, decided how the selection should be carried out and the shepherd was then performing the selection in practice. The selection was decided when selling animals or before the mating which was performed on the onset of an appropriate period with good conditions, mainly in June. Mentioned traits that characterize a good ewe were: body conformation, size, temperament and that the ewe had two teats. The traits important for a ram were: body size, medium testicles and good rear legs. No order of precedence was given. When looking at body size it was primarily the weight that was important and height the secondly important factor. All seven farmers ear marked their sheep with special flock ID to be able to separate them from other herds. Only one used branding and tattooing to get individual ID on each sheep. The specific farmer recruited help with the breeding strategies from a private veterinary apprentice and the farmer was the only one keeping records of all the animals. Dates of birth, death, sale and buying were recorded and traits like breed, color, weight, age, sex and height were included in the recordings. The reasons for keeping the records were to be able to analyze diseases, profitability and performance, and by that get better suitable animals. Four of the seven interviewed Maasai

farmers answered that they sold specifically Red Maasai sheep, three farmers sold both ewes and rams and one farmer sold only rams.

4.4 Environmental effects

Seventy-five percent of the farmers answered that water is always available for their animals. Most farmers answering that they don't have access to water for their animals were located in North Kajiado District. During the dry season most farmers gave the animals water once a day and if not possible at least three days a week as minimum, while during the wet season the animals had access throughout the day. Most common water source was borehole, pipeline or dam. During the wet season rivers could be good water sources as well.

All farmers argued that the environment had changed in the present area with more soil erosion because of the more frequently appearing droughts. Of the 57 farmers that answered the question if the environment had changed in their area all said yes, and a majority of the farmers thought that the long droughts with short rains had contributed to soil erosion and a decrease in amount of pasture. The year of 2009 was according to 67% of the 55 responding farmers the worst experienced drought during the last five years. This lead to large losses of animals and some farmers reported that they lost more than half of their sheep herd. Forty-seven of the farmers answered what type of sheep breed that died during the rough droughts, see figure 14. Merino was mentioned once but not included in the figure since it was only one farmer rearing pure Merino.

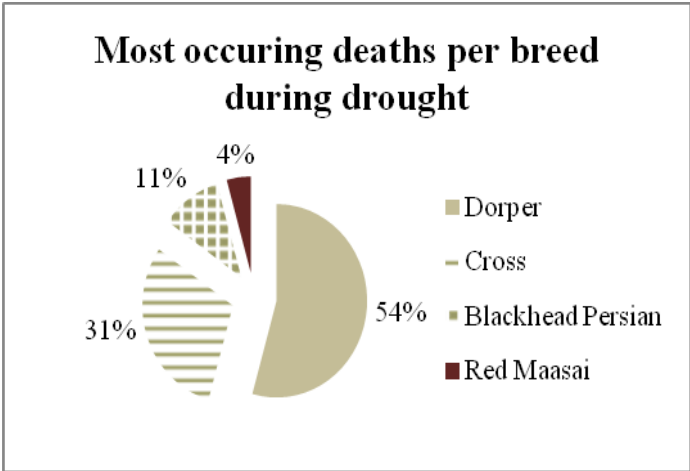


Figure 14. Percentage of farmers reporting which sheep breed that had the highest death prevalence during drought.

The prevalence of survival during drought was answered by fifty-five farmers and results showed that the Red Maasai sheep survived the drought better than any other sheep breed reared by them, see figure 15. Two farmers rearing Black Head Persian experienced this breed as the best survival and two farmers mentioned this breed as better than the Dorper but not better than the Red Maasai and Dorper x Red Maasai crosses. The Dorper was mentioned as the least surviving breed except according to one farmer only rearing Dorper.

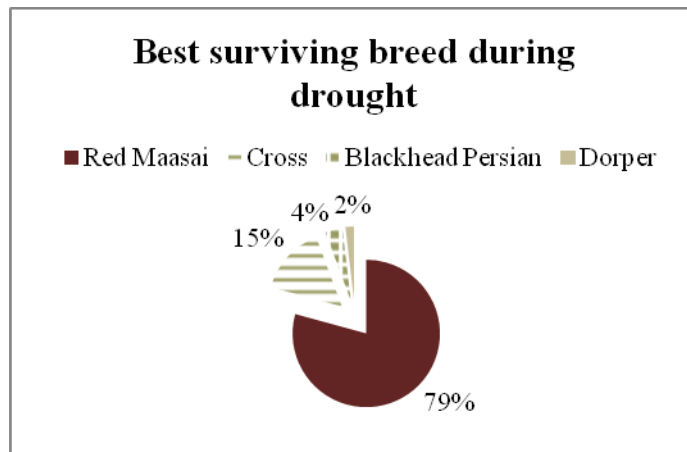


Figure 15. Percentage of farmers reporting which sheep breed that had the highest survival prevalence during drought.

According to the farmers the reasons for the Red Maasai high rate of survival during drought was caused by their small size, storage of fat in tail, worm resistance and a body structure which is more adapted to the area by managing long distance walks and less feed requirements. The handling practices used during drought was commonly to migrate to find green pasture. If needed, grass and branches could be cut and given the animals. During harsh conditions the grazing could be performed during night. A few farmers stayed and controlled the flock on the farm by buying hay. Among the sheep the ewes, lambs and sometimes the sick animals were in some cases prioritized and given more feed and water. During drought the matings and lambings were avoided and only crosses and Red Maasai sheep were preferably saved. After the drought the restocking could start and fetching of new animals, especially Dorper or Merino could begin. By this practice the meat and milk qualities could increase in the crosses.

5. DISCUSSION

The aim of this thesis was to obtain knowledge about production system and breeding practices in Maasai pastoralist communities in Kajiado district, Kenya. The Red Maasai sheep with its productive and cultural attributes were specifically investigated. The following discussion will firstly consider the methods and then main results and additionally a general discussion covering environmental changes and future aspects. The methods used in the study will initially be assessed.

5.1 Methods

The most informative approach in this study was the baseline survey; the attained results gave a general picture of the farming systems, sheep production and environmental changes in Kajiado District. It also contributed with information about how the Red Maasai sheep is utilized in this area. The in-depth interviews gave information about specific farmer's breeding strategies for sheep and in what way the selection was done. The semi-structured qualitative interviews resulted in interesting information about the indigenous knowledge of animal keeping and the Maasai culture. These discussion interviews were conducted in North Kajiado and gave an insight into how Maasai pastoralists are participating in, and embracing the local development activities.

The three different approaches used in this study were all important and complemented each other in order to attain a general picture of the animal keeping and sheep production as well as attaining an understanding for the indigenous knowledge and the part it plays in Maasai culture today. Main focus was however spent on the baseline survey and some of the questions from the in-depth questionnaire were included in the baseline survey to cover more of the breeding questions. More time was spent in North Kajiado and both the in-depth interviews and semi-structured qualitative interviews were only conducted there which made it difficult to perform comprehensive comparisons of the indigenous knowledge in Kajiado District. Even though the qualitative approach was limited a small insight into remaining culture and ceremonies could be attained in North Kajiado. To be able to capture more of the indigenous knowledge more time of participation with video recordings would be of help. Additional knowledge regarding indigenous knowledge in South Kajiado would be interesting to attain in future research.

Most farmers were very cooperative and all questions could be asked without any inconveniences. The questions may have been interpreted slightly different since two different interviewers and three different interpreters were used throughout the study. Yet, results from the different studies seem to be logic.

5.2 Family household, income and farming type

The livestock production plays an important part for the household's economy for Maasai farmers in Kajiado district. No difference could be seen between the districts and the majority (70%) of the farmers had livestock as their major economic source which corresponded fairly well with the survey done by Kosgey *et al.* (2004) which showed that 58% of the pastoral farmers had livestock as their main activity. The latter study did a comparison with agro-pastoral farmers, showing that 46% of them had livestock as their main activity.

The difference in livelihood and farm activities between North and South Kajiado contributed to knowledge regarding direction of development based on historical events. The transformation from nomadic lifestyle and animal production to a more sedentary, commercial system did succeed in parts of Kajiado, changing not only the social and political management but also the way of managing the animals (de Leeuw *et al.*, 1991).

The Kajiado district is located in semi-arid and arid zones (de Leeuw *et al.*, 1991) and the arid zones are predominantly belonging to South Kajiado leading to less annual rainfall and difficult land resources to use for cultivation or pasture. Evidently this was also the reason why the production system differed between the districts. Semi-commercial and commercial farms were almost exclusively located in North Kajiado where the annual rainfall is higher. The society development with modernized infrastructure and access to larger markets in North Kajiado seem to change the animal management and gives larger opportunities for intensification of the animal production.

5.3 Sheep production

All interviewed farmers reared sheep and the herd size varied greatly between North and South Kajiado. The result does not correspond to Getachew *et al.* (2010) and Mwacharo & Drucker (2005) where total number of livestock was higher in the pastoral system than in agro-pastoral system. The results indicate that the farmers in North Kajiado still have a big interest in rearing livestock or that the pastoralists in South Kajiado have minimal resources for being able to maintain larger herds. All farmers in this study reported pasture as the main feed for sheep and a majority of the reporting farmers used minerals or/and concentrates as feed supplement during droughts. Approximately 95% of the farmers fed supplements to the animals in both dry and wet seasons according to results by Kosgey (2004). The study by Mwacharo and Drucker (2005) reveals the same results in North-East Kajiado where the animals were herded on natural pastures with feed supplement such as mineral salt and crop residues depending on production and farming system. More minerals were used throughout the year by pastoralists compared to agro-pastoralists that used crop residues, especially during drought, from their own farm or purchased from neighboring farms.

5.3.1 Reasons for keeping sheep

A majority of the respondents ranked food source as the most important reason for keeping sheep, secondly breeding stock for sale, and thirdly capital accumulation. These results correspond fairly well to the study by Getachew *et al.* (2010) where the primary reason for keeping sheep by agro-pastoralists in Ethiopia was to generate income and secondly for meat consumption, compared with pastoralists in Ethiopia that ranked milk production as most important and meat consumption secondly. Results attained in this study as well as by Getachew *et al.* (2010) is however unexpected since the pastoralists commonly do not use sheep for home consumption but instead as regular cash income and insurance against emergencies (Kosgey *et al.*, 2004). According to results presented here and by Getachew *et al.* (2010) there seems to be an increasing trend to use sheep as daily family food source in pastoralists' communities. In this study the importance of keeping sheep for ceremonial or cultural purposes were ranked as number four and five out of nine options, which indicates that sheep still are important objects in ceremonies and represent important values in Maasai tradition and culture. The social value of rearing sheep became evident when the farmer apprehensions were investigated in the semi-structured qualitative interviews.

5.3.2 Important traits of sheep

When purchasing new sheep, important traits examined was firstly body size and growth. Other important traits mentioned, in order of priority, were more fat, shape, mothering ability, lambings and more meat. Similar results have been found by Kosgey (2004) and Omondi *et al.* (2008). Health and resistance to drought were also mentioned by the farmers but were not given as examples in the questionnaire; this may have affected the outcome of this question (see appendix 1). The results indicate that desirable size of the animals play an important role among pastoralists. This may lead to critical challenges when the animals need to be adapted for an extensive production system. As described by Philipsson *et al.* (2006) the body weight above a certain optimum may lead to less adapted animals. The small ruminants have an advantage over larger animals because more energy can be left for production when the small maintenance requirement has been obtained (Taylor & Murray, 1988; Madalena, 2005). To be able to select for traits like disease and parasite resistance or tolerance, the development of gene or marker assisted selection may in future be important (Scholtz *et al.*, 2010a; Scholtz *et al.*, 2010b).

5.3.3 Market and diseases

As expected the most common product to sell was live animals. Depending on the need of money to school fees or other expenses the frequency of selling varied. The average age when marketing or slaughtering the sheep was 1.5 year. This indicates that the sheep are not marketable and does not have enough body weight until this age has been reached. The traits of increased growth and carcass weight are therefore of great importance to be able to minimize the age of sheep to be marketed for slaughter.

Most mentioned and commonly occurring disease was Foot and Mouth Disease which was prevented by vaccinations given by government veterinaries. The long time of waiting usually led to treatment even with anthelmintic drug when having FMD on the farm. Other commonly occurring diseases were anthrax, diarrhea and helminthosis (caused by worms). Similar results have been reported earlier (King *et al.*, 1984; Kosgey, 2004; KFSSG, 2009).

5.4 Breeds and breeding practices

5.4.1 Reasons for keeping the specific breeds

The farmers in the current study explained an obvious difference between the Dorper and Red Maasai. The Dorper was kept for its fast growth, big body size and frame for meat production while Red Maasai was kept for its resistance to diseases, worms and drought, storage of fat and ability to walk long distances. This knowledge corresponds to studies made earlier (Baker *et al.*, 2002; Mugambi *et al.*, 2005; Okeyo & Baker, 2005). The benefit of keeping crosses between Dorper and Red Maasai was its faster growth and heavier body than pure Red Maasai but with a higher degree of resistance to diseases and drought compared to pure bred Dorper. According to Okeyo & Baker (2005) and Baker *et al.* (2002) the Red Maasai were more resistant and tolerant to endoparasite infections than the Dorper in both the humid and semi-arid environments. A study in semi-arid Kenya showed that Red Maasai lambs were consistently more resistant and tolerant towards gastrointestinal worms compared to the Dorper lambs (Mugambi *et al.*, 2005). The latter study also revealed that Dorper lambs are significantly heavier than Red Maasai lambs.

According to the results attained from the semi-structured interviews carried out in North Kajiado the Dorper contributed to large difficulties for the farmers during unpredictable seasons. Since the Dorper becomes greedy when the pasture is decreasing the flock of sheep may disappear and the consequence may lead to herdsmen leaving work because of

difficulties keeping the herd together. If a flock of Dorper needs to be kept during drought large efforts are needed to keep them alive. Deworming, clean water and feed supplement are prerequisites (Uka pers. communication, 2011). The discussions also gave knowledge about ceremonial and social values of keeping Red Maasai. Indications are given that when exchanging gifts and performing ceremonies the Red Maasai is the most desirable breed. Even in North Kajiado, where many traditions have been left behind, the wish to use Red Maasai for ceremonial purpose and for dowry seems to remain. The importance of having the perfect color of red is disappearing, but the desire to have sheep with ability to survive droughts and diseases is strong.

5.4.2 Breeding strategies

A majority of the responding farmers used controlled mating. Kosgey (2004) and Getachew *et al.* (2010) reported that uncontrolled mating occurred predominantly among sheep in agro-pastoralists' and pastoralists' herds. This may indicate different assumptions regarding characterizations of controlled and uncontrolled mating. In the current study, the mating was recognized as controlled when indiscriminate matings were avoided and specially selected rams were used for the mating. The most common practice for controlling mating was by using apron, also described by King *et al.* (1984). The latter study also mentions that the reason for controlling the mating is primarily to avoid lambing during dry season, which is compatible with this study.

Crossbreeding between Dorper and Red Maasai was used by a majority of the farmers in both North and South Kajiado. Type of breed of the dam and the sire has not been considered for the different crosses. Regarding whether the crosses are obtained by using pure breeds or crosses is an important factor but has not been taken into consideration in this study. Since the crosses are scattered and used all over Kajiado District certain concern about difficulties of finding pure Red Maasai exist among the farmers, and further if it will be possible to restock a sheep herd with only Red Maasai in the future (Uka pers. communication, 2011). Obviously the Red Maasai exist among the visited farmers but the purity can be questioned. The breed might continue to be called Red Maasai even though genes controlling important traits may have been lost when interbreeding. It is therefore of great importance to conserve, not only the breed, but the genes identifying the attributes of the indigenous breed. If conserving the genetic diversity, unpredictable future scenarios will be possible to overcome.

5.4.3 Selection of sheep for breeding of subsequent generations

A comparison of performance of respectively gender and their lambs was made to decide the selection. Important traits that were considered in selection decisions included body structure, size, color and mothering ability. A few farmers reported that they keenly observed several ewe lambings and lambs performances (i.e. for two to three years) to make selection decisions. How the performance of the animals is remembered is difficult to understand since the results from the in-depth interviews made in this study showed that written records were extremely rare.

Most farmers used the selected females from two to seven years; mostly common was to use the ewe for five years. Most farmers kept the rams for two to three years while some used them only once. Similar results were presented by Kosgey (2004). Lambs born per ewe each year was on average 1.3 and a distinct difference could be seen between the districts; 1.5 lambs born per ewe each year in North Kajiado and 1.1 lambs in South Kajiado. This means that every second farmer in North Kajiado District gets two lambs per ewe per year. The average age for a ewe's first parturition was on average 14.6 months and the matings were primarily performed in June-July. Farmers getting two lambings per ewe per year had the

second mating in November-December. The choice of mating period shows that the lambings coincide with the rainy seasons, “short rains” occurring from October to December and “long rains” from March to May (de Leeuw *et al.*, 1991). The lambs were commonly weaned after two to twelve months, varying a lot between the farmers.

5.4.4 Breeding parameters of North and South Kajiado

The statistical analyses comparing the breeding parameters between the districts (table 4) show that there are significant differences in lambs per ewe and year and lifespan of selected females between Red Maasai crosses in North and South Kajiado. Unfortunately, no comparison could be done with other crosses reared in North Kajiado since only one farmer with another cross could be found in the area. Significant differences could be seen between Red Maasai crosses in North Kajiado and other crosses in South Kajiado concerning lambs per ewe and year and lifespan of selected females. Survival rate showed no significant difference between the different crosses. These results indicate that there are no significant differences between different crosses within the same district, but that the district has an effect on the breeding parameters examined on Red Maasai crosses in this study. The different environmental conditions and therefore different husbandry possibilities seem to have a significant effect the productivity of the sheep.

5.4.5 In-depth interviews

The result revealed that indiscriminate mating was common but the awareness of avoiding inbreeding was mentioned by the farmers. Most important precaution was to use a good shepherd, something that the farmers using controlled breeding responded that they had.

Traits that characterized a good ewe were body conformation, size, temperament and two teats. Important traits for a good ram were body size, medium sized testicles and good rear legs. Similar results have been presented earlier (Kosgey, 2004; Getachew *et al.*, 2010) when selecting rams and ewes for both agro-pastoralists and pastoralists. These two traits are very alike, farmers responding in this study explained factors affecting body size as weight firstly and height secondly. One out of seven in-depth interviewed farmers in North Kajiado had individual ID on each sheep, indicating that it is mostly common to only use flock ID for the sheep. The farmers seemed to remember information about the individual ewes along the years in their memory. More than half of the responding farmers in the in-depth interviews sold pure Red Maasai sheep which gives a promising indication that some farmers in certain areas performing crossbreeding still purchase pure Red Maasai to achieve the crosses and do not use an uncontrolled breeding of diluted breeds.

5.5 Environmental effects

That 75% of the farmers always had water available for their animals and that the farmers not having access to water were located in North Kajiado was surprising. This indicates however that there seem to have been an improvement of water accessibility in the South Kajiado District. During drought this may not be the case and most likely the accessibility decreases dramatically. The water sources were commonly boreholes, pipelines and dams. Rivers were also used in the wet season. Corresponding results have been shown earlier (Mwacharo & Drucker, 2005; KFSSG, 2009). Even though water is accessible for the farmers the distance to water points can vary widely. The distances to walk ranged from five to ten kilometers in the pastoral area compared to two to four in the agro-pastoral area (KFSSG, 2009).

The most reported breed with high prevalence of deaths was the Dorper, followed by crosses, Blackhead Persian and Red Maasai. The least affected breed was Red Maasai and when

considering the number of Red Maasai being kept compared to the other breeds it shows its unique adaptation to droughts. The corresponding question regarding best surviving breed during droughts, the Red Maasai was mentioned by a majority (79%) of the farmers. Reasons for Red Maasai being the best surviving breed was the small size, storage of fat in tail, worm resistance and an adapted body structure managing long distance walks and not requiring high nutritional inputs. The Red Maasai has earlier been rated highly in terms of drought and heat tolerance, according to agro-pastoralists and pastoralists (Kosgey, 2004) as well as the breed's resistance to gastrointestinal worms (Preston & Allonby, 1978, 1979; Baker *et al.*, 2002; Mugambi *et al.*, 2005; Okeyo & Baker, 2005; FAO, 2007). The resistance to endoparasites found in the Red Maasai sheep (ILRI, 2011b) can be of great help in developing resistance in the Merino sheep that are highly affected by endoparasites (Beh *et al.*, 2002; ABC, 2007). According to responding farmers in the current study the Red Maasai sheep and crosses were preferably saved during drought, while Dorper or Merino was purchased when the drought had been managed to breed a heavier and faster growing sheep.

All farmers responded that the environment had changed in the present area and they explained the changes as short rains contributing to soil erosion and decrease of pasture. This study also revealed that the year of 2009 was the worst experienced drought, with large losses of livestock, during the last five years. As also described in the Long Rain Report (KFSSG, 2009) the year of 2009 was bad in Kajiado District, with reduced number of livestock because of poor conditions during the long drought. The reasons were described as reduced access to pasture, browse and crops which resulted in big migrations of livestock in the whole Kajiado District (KFSSG, 2009).

5.6 General discussion and future aspects

Most Maasai communities continue to keep as many animals as possible because of their cultural survival strategy in a very uncertain environment (FAO, 2010). According to Omondi *et al.* (2008) the wealthy livestock keepers are more concerned about droughts since the loss in wealth is through the livestock deaths while the "poorer" pastoralists seek to increase number of animals first before they try to stabilize the acquired wealth status through increased drought resistance (Omondi *et al.*, 2008). If this is the case it might lead to critical problems when attempts are made to improve survival and production rates. The result gained in current study show however that the "poorer" pastoralists in South Kajiado reared smaller herds than in North Kajiado and therefore might show interest in improving their survival capacity. Different needs are required in the two different districts but the requirements go hand in hand. To be able to get marketable animals in North Kajiado the survival capacity are as important as birth weight and growth, especially when under climatic stress. The most important general vision for the sheep breeding is to improve the production per animal and one factor contributing to this is how fast the lambs can be marketed for slaughter. A study in Ethiopia showed that different environmental and genetic interventions could double the productivity per sheep by getting reduced mortality and increased fertility, growth and yearling weight which made the lambs marketable at an earlier age (Tibbo, 2006).

According to the results attained here the Red Maasai is highly advantageous in a fluctuating environment where repeated droughts seem to occur. As described by Herrero *et al.* (2008) large changes in climate change will occur in parts of the Horn of Africa where grass dominated vegetation will turn to dry woodland and desert, resulting in decreased grazing capacity and higher exposure to parasites and diseases (Scholtz *et al.*, 2010b). The degree of adaptation to the environment will thereby play an important role for future livestock. The

genetic potentials of the indigenous breeds need to be utilized more to be able to increase productivity under tropical, and often harsh conditions.

Environmental changes and the Maasai sheep utilization and requirements need to be considered carefully to be able to make a proper balance of important traits in breeding. The differences within Kajiado District indicate that there is not only one solution but a combination of breeding strategies. Since there seem to be a need of marketable animals, especially in North Kajiado, the within breed selection can be combined with a larger breed to speed up the genetic progress. A nucleus herd providing Dorper rams/sperm to the community farmers rearing Red Maasai ewes may be a way to ensure the adaptability and survival rate but at the same time increase the production rate and marketability at an earlier age. The nucleus herd can provide the good management and environment that the Dorper requires. This assumes however that the pure Red Maasai ewes are utilized and scattered in the district. To restock with pure Red Maasai ewes may be difficult in some areas where the breed seem more diluted and would therefore need proper community-based within breed improvement. The more harsh environmental conditions and minimal husbandry conditions in South Kajiado may require a larger influence of Red Maasai when breeding crosses. For example, 75% crossbred indigenous rams could be used in every other generation to obtain ewes of approximate 62.5% Red Maasai.

Kajiado District has been experiencing many problematic events during the last hundred years. Both natural and man-made changes have led to loss of land, traditional mobility and flexibility (Grandin, 1991). Today, the district still faces challenges, such as modernization, limitations to diversify sources of income, and environmental changes. Even though new interests and traditions have evolved in Kajiado District the importance of keeping animals cannot be questioned. The animal keeping still plays an irreplaceable and important part of the Maasai life in Kajiado District and can hopefully play an essential role in the development of a sustainable community.

6. CONCLUSIONS

Breeding of Red Maasai was common in Kajiado District and mostly used in crosses, primarily together with Dorper. Important characteristics of the Red Maasai sheep was according to interviewed farmers traits such as resistance to diseases, worms and drought, their large amount of fat and the ability to walk long distances. Reasons for crossbreeding with Dorper were to increase the weight and growth rate. This breeding practice was most common in North Kajiado, where the value of traits for marketing purposes was larger. A certain concern regarding the decreased number of pure Red Maasai existed among the farmers in the district. In North Kajiado, with farmers rearing larger herds and commonly practicing cultivation of the land, the productivity were significantly higher per herd than for South Kajiado farmers, with smaller herds and only a few farmers practicing cultivation. The most important factor contributing to varying productivity was the different environmental conditions in the two locations, which affected both breeding practices and the animal's performance.

The Red Maasai still have a social part to play in Maasai communities of Kajiado District. The sheep is highly valued when it comes to exchanging gifts and use for ceremonial purposes. With a diminishing traditional Maasai livelihood in this district the marketing and economical purposes of keeping sheep is getting larger and may affect the social need of keeping Red Maasai. The unpredictable seasonal changes and recurrent droughts may however lead to larger demand of well adapted and sustainable sheep, which in this case would be a breed as the Red Maasai sheep. Increased productivity by better utilization of this breed and optimal crossing with Dorper may be instrumental for a sustainable development.

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7.1 Personal communication:

Uka, Paul. "Maasai farmer" North Kajiado, Isinya, Kenya. 2011-02-24.

Tiwar, Jason. "Maasai elder" North Kajiado, Isinya, Kenya. 2011-02-24.

Mokoi, Raphael. "Maasai farmer" North Kajiado, Isinya, Kenya. 2011-03-09.

Polong, Alex. "Maasai farmer" North Kajiado, Kajiado, Kenya. 2011-03-08.

APPENDIX 1

Questionnaire - Baseline survey

Date of interview:
District:
GPS coordinates:
Farm owner name:
Farm owner number:

General questions

Agro-ecological zone (Observed):

Household members

Age categories	Sex	Number	Schooling [Code]	Main activities (In order)	Hrs/day spent on activity
< 8 years	Male				
	Female				
8-14	Male				
	Female				
15 -21	Male				
	Female				
22-65	Male				
	Female				
> 65 years	Male				
	Female				
Total	Male				
	Female				

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

What is the household's major economic source? Livestock <input type="checkbox"/> Crops <input type="checkbox"/> Both <input type="checkbox"/> Others, specify: _____
--

House ownership [1.Owned 2.Rented 3.Borrowed 4.Others, what?]	
Floor type [1.Soil 2.Cement 3.Tiles 4.Others, what?]	
Roof type [1.Grass 2.Iron sheets 3.Tiles 4.Clay/Soil]	
Wall type [1.Soil/mud 2.Wood/Iron sheet 3. Bricks/Blocks/Stone 4. Other, what?]	
Number of rooms	

Do you practice cultivation? Yes No

What kind of crops?
What size of land do you use (Both for crops and animal grazing)?
Is the land owned/rented/communal?
Has the environment changed in this area during the last three years? How?

Farming system

Production system (Observed): [1.Intensive 2.Semi-intensive 3.Pastoral 4.Free range 5.Backyard 6.Other]
Family house type (Observed): [1.Traditional 2.Semi-permanent 3.Permanent]
Farming type (Observed): [1.Pastoralists 2.Semi-commercial 3.Commercial]
Ownership of the flock (code):
Who manages the flock (code): [1.Father 2.Mother 3.Children 4.Other, Who?]

Animal management

Fitness of the animals (Observed):

Livestock information

Livestock	Breed/Cross	Number of heads	
		Owned	Kept not owned
Cattle			
Goats			
Poultry			
Pigs			
Donkeys/Horses			
Camels			

Sheep

What type of housing system is used for sheep? [1.No housing 2.Treated wood crutch 3.Untreated wood 4.Bushes 5.Iron sheets 6.Bricks 7.Mud 8.Wire 9.Other]		
Is the feed for sheep based on pasture? Yes <input type="checkbox"/> No <input type="checkbox"/> What else: _____		
Is any supplement food given to the sheep? Yes <input type="checkbox"/> No <input type="checkbox"/>		
If yes, what supplement? [1.Roughage 2.Minerals 3.Vitamins 4.Concentrate 5.Other, what?]	Dry season	Rainy season
What are the main purposes of keeping sheep?		
Ranking:		
[1.Food source 2.Wool 3.Breeding stock for sale 4.Capital accumulation 5.Manure for crops, building material 6.Supplement other incomes 7.Cultural 8.Ceremonies 9.Dowry 10. Other, what?]		

What are the main products you use from the sheep?

[1.Meat 2.Fat 3.Milk 4.Manure 5.Blood 6.Skin 7.Wool 8.Other]

Number of sheep:

Type of sheep	Breed	Number kept on farm	
		Owned	Kept not owned
Rams			
Castrated males (>1yrs)			
Immature males (<1yrs)			
Ewes (lambd at least once)			
Ewes (no lambing)			
Pre-weaning males			
Pre-weaning females			
Total number of sheep			

What is the reason for keeping these sheep breeds?

Breed	Reason

How many of your sheep have died the last 12 months?

Breed/Cross	Suckling (number)	Weaned (number)	Adult (number)
Reason			

Have you sold any sheep the last 12 months, what kind, why and how many?

Breed/Cross	Number	Type (code)	Reason

Animal type: [1.Ewe 2.Ram 3.Hogget 4.Immature male 5.Other, what?]

Have you purchased or obtained any sheep in the last 12 months?

Breed/Cross	Number	Type (Code)	Reason

Animal type: [1.Ewe 2.Ram 3.Hogget 4.Immature male 5.Other, what?]

What traits do you look for when you buy new sheep?

[1.Body size 2.Growth rate 3.Color 4.Mothering ability 5.Mortality rate 6.Calvings 7.More fat 8.More meat 9.Shape 10.Milk 11.Other]

Do you milk your sheep? Yes No

If yes, answer following questions:

Since when?
How often do you milk?
How much do you milk per 24 hours?
What is the milk used for?

Breeding

What type of mating occurs among the sheep? Controlled Uncontrolled

If controlled, how? _____

Why do you use this? _____

How do you select sheep for coming generations?

Do you use cross or pure breeding?

If crossbreeding, what breeds? _____

For how many matings are the selected rams used? _____

What is the average number of offspring per dam? _____

What is the average age at first parturition? _____

How many years do you keep selected animals? Male: _____ Female: _____

When does mating occur? _____

When does lambing occur? _____

When are the lambs weaned? _____

How many lambs are born per ewe each year? _____

Of total lambs born, how many survive the first year (%)? _____

Market

What sheep products do you sell and for how much?

Product	Type of market [1.Informal 2.Open market 3.Informal with middleman 4.Open market with middleman]	How often do you sell this product? [1.Once a day 2.Once a week 3.Several times a week 4.Once a month 5.Several times a month 6.Other]	Cost per unit

How much do you sell an average ram for? _____

How much do you sell an average ewe for? _____

How much do you sell an average ewe hogget for? _____

How much do you sell an average castrate for? _____

At what age do you market your sheep? _____

At what age do you slaughter your sheep? _____

How often do you slaughter your sheep? _____

Diseases

Do you have any problems with diseases? Yes No

Disease	Treatment	Parasite control methods	
		Dry season	Wet season

Do you ever recruit help from outside to treat your animals? Yes No

If yes, who?	How often?
What type of access do you have to veterinary services? [1.Govt veterinary 2.Private vet 3.veterinary drugs 4.Extension service vet 5.Community Assistant vet 6.NGO vet 7.Other, what?]	
What vaccinations are given by the government?	

Drought

Is water always available for household use? Yes No
 for your animals? Yes No

Water for animals	Dry season	Rainy season
How frequently do you give your sheep 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		
Distance to watering point?		
Do you have to pay for the water? Yes or No		
How is the water quality? [1.Excellent 2.Good 3.Acceptable 4.Poor 5.Bad]		

During the last five years, when did you have the worst drought?
How many animals did you have before that drought?

Which animals died during this dry period?

Breed/Cross	Suckling (number)	Weaned (number)	Adult (number)
Reason			

What animal managed the long dry period better than the others? Rank 1 to 3. Cow <input type="checkbox"/> Sheep <input type="checkbox"/> Goat <input type="checkbox"/>
What sheep breed survived the dry period better than the other sheep breeds?
Why did this breed survive better you think?
What handling practices are used during drought?
Are some animals prioritized with feed and water during the dry period? Which animals?
Do you use some special breeding practices during drought?
Do you use some special breeding practices after drought?

APPENDIX 2

Questionnaire – In-depth interview

Date of interview:
District:
GPS coordinates:
Farm owner name:
Farm owner number:

Breeding strategies

Do you ever recruit help from outside to decide breeding strategies? (Yes or No)
If yes, from whom?

Inbreeding

Is inbreeding controlled?	How?
How do you keep track on new rams coming into the herd?	
Does indiscriminate mating occur?	
What can be done to prevent indiscriminate mating?	
Is the current ram shared with other farmers? Yes <input type="checkbox"/> No <input type="checkbox"/>	

Selection and performance

Who decide the selection?
Who perform the selection?
Who decides the sale of animals?
When is the selection decided?
When is the selection performed?
How is the selection performed?

When you are about to select the best animals, what traits do you look for? [1.Body size 2.Growth rate 3.Color 4.Mothering ability 5.Mortality rate 6.Calvings 7.More fat 8.More meat 9.Shape 10.Milk 11.Other]
What traits characterize a good ram?
What traits characterize a good ewe?

Do you have different breeding strategies for different years? Yes No

If yes, how does it differ?

Breeding details

What kind of identification system do you use?

[1.None 2.Name 3.Tag number 4.Branding 5.Notching 6.Tattooing 7.Colour 8.Other]

Is it flock ID or individual ID? Flock ID Individual ID

Do you keep any records of your animals and in what way?

What traits are recorded?

What are the purposes for you to keep these records?

Are there other sheep breeds you would choose instead/together with Red Maasai? Yes No

If yes, why?

Other

Do you sell Red Maasai sheep? Yes No

If yes: ewes or rams or both?

From where can you buy new Red Maasai sheep?

Do you sell Red Maasai sheep products? Yes No

If yes, what kind of products?

How do the Red Maasai sheep handle diseases compared to other breeds?

APPENDIX 3

Questionnaire – Semi-structured qualitative interview

Date of interview:
District:
GPS coordinates:
Farm owner name:
Farm owner number:

Breeding strategies

Discussion about the breeding strategies which can include questions like:

- From whom did you learn the breeding practices?
- When did you learn the breeding practices?
- For how long have the breeding strategies been practiced?
- Does everyone in the household know the same practices?
- Do women and men have the same role to manage and breed the animals? How is it different?

The meaning and utility of keeping animals:

- What is the benefit of keeping animals?
- What is the benefit of keeping sheep compared to other animals?
- What is the benefit of keeping Red Maasai compared to other sheep?
- What social value does the Red Maasai sheep have for you in comparison to other sheep breeds?
- What economical value does the Red Maasai sheep have for you?
- Is it important to keep Red Maasai for you? Why?

Indigenous knowledge

- On what occasions do you slaughter sheep?
- What are the traditional values of keeping Red Maasai sheep?
- What are the ritual values of keeping Red Maasai sheep?
- Are these still practiced?

Drought

Discussion about how the dry periods affect the animals and the farming.

- When did the worst drought occur during the last five years?
- How long did it last?
- How many animals died?
- Water and feed supply?
- Different management practices?
- Loss of income because of the long drought?
- How is the socioeconomic structure changed after a long drought?
- Are you worried about the coming years?
- Do you have a plan for the animal management in the future?