



Maasai herding and milking strategies – A case study of goals and decision-making within the household

*Massajernas betes- och mjölkningsstrategier
– En fallstudie av målsättningar och beslutsfattande inom
hushållet*

Joanna Lindell



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I denna serie publiceras olika typer av studentarbeten, bl.a. examensarbeten, vanligtvis omfattande 7,5-30 hp. Studentarbeten ingår som en obligatorisk del i olika program och syftar till att under handledning ge den studerande träning i att självständigt och på ett vetenskapligt sätt lösa en uppgift. Arbetenas innehåll, resultat och slutsatser bör således bedömas mot denna bakgrund.

PREFACE

This master thesis was carried out as a Minor Field Study (MFS) at the Department of Animal Environment and Health at the Swedish University of Agricultural Science (SLU), in collaboration with South Rift Association of Land Owners (SORALO) and Lale'enok Research Centre in Magadi, Kenya. The master thesis covers 45 credits within the Agricultural Science Programme, with focus on animal science.

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SUMMARY

In Kenya the Maasai pastoralists have based their livelihoods on dairy production and the production goal is to maintain a sufficient milk supply throughout the year. The pastoral dairy production has two vital characteristics; breeding and milking. Traditionally, breeding is the men's responsibility, while milking is the duty of women. Depending on this partition of chores between men and women, they also have different management routines, ambitions and strategies regarding the milk production. Normally, the herd owners' emphasis is on increasing the herd size, animal welfare and herd productivity. The decision where to graze the cattle is influenced by many factors and it can be difficult to find an ideal decision that results in the highest profit. Herd owners decide on a target grazing location every morning and all decisions made during the day will affect the milk production of their herds. However, the actual milk off-take is determined by the flexible milking strategies of the women. The women's essential goals are calf survival, sustain the family and possible milk sales hence, the goals affect the milking strategy and the amount of milk off-take. Normally, Maasai women milk two teats in each cow and leave the remaining two teats for the calf to suckle until the end of lactation.

The present work was a case study of the Maasai in the semi-arid areas Olkiramatian and Shompole, Kenya, conducted in collaboration with South Rift Association of Land Owners (SORALO) and Lale'enok Research Centre in Magadi. The aim was to investigate what goals and strategies herd owners and women had regarding cattle milk production, and upon which factors their respective decision making were based. Additionally, the possible effects of herding strategies, milking strategies, season, and timing of calving and lactation on the milk production was investigated. Data were obtained through semi-structured interviews with both herd owners and women during October-December 2012. During twelve days, 22 herd owners and 32 of the herd owners' women were interviewed. The studied households were chosen because they were currently collaborating with SORALO within another research project. Descriptive statistics and "eyeballing" were used to reveal relationships between the answers.

This study confirms information obtained in other studies, e.g. regarding goals, ambitions and decision-making factors of herd owners and women. In addition, it is concluded that milk production indirectly is one of the factors that primarily affect the herd owners' decisions regarding herding strategies. The herd owners also have an extensive control over milk off-take and a higher interest in milk production than expected. Other conclusions are that the women's ambition with cattle milk production is to maximise the milk off-take and that the milking strategies differs with each woman. The seasonal impact on milk production and the herd owners' dry season herding strategies corresponds to literature. While, women's dry season strategies revolve around the calves. Lastly, compared to literature the Maasai heifers in the study area have a higher age at first calving and the cows have longer calving intervals and lactation periods, than perceived to be beneficial for the maximum milk yield possible.

SAMMANFATTNING

I Kenya har den pastorala folkgruppen massajer baserat sitt uppehälle på mjölkproduktion och målet är att upprätthålla produktionen året om. Den pastorala mjölkproduktionen har två viktiga aspekter, uppfödning och mjölkning. Uppfödning är traditionellt männens ansvar medan mjölkning anses vara kvinnornas plikt. Beroende på denna uppdelning av sysslor mellan män och kvinnor, har de också olika rutinerna, ambitioner och strategier gällande mjölkproduktionen. Normalt är djurägarens ambition att öka djurvälståndet, samt besätningens storlek och produktivitet. Besluten angående var korna ska betas påverkas utav ett flertal faktorer och det kan vara problematiskt att finna en idealisk lösning som resulterar i högst avkastning. Varje morgon beslutar djurägaren var korna ska beta och alla beslut som fattas under dagen kommer att påverka deras mjölkproduktion. Dock är det kvinnornas flexibla mjölkningsstrategier som avgör den reella andelen mjölk tillgänglig som livsmedel. De väsentliga målen för kvinnorna är kalvens överlevnad, familjens försörjning, och eventuell mjölkförsäljning. Dessa mål påverkar därmed deras mjölkningsstrategier och mängden mjölk som används som livsmedel. Normalt mjölkar massajkvinnorna två spenar på varje ko och lämnar två spenar åt kalven att dia till laktationens slut.

Detta arbete var en fallstudie av massajerna i halvökenområdena Olkiramatian och Shompole, Kenya, och genomfördes i samarbete med South Rift Association of Land Owners (SORALO) och Lale'enok Research Centre i Magadi. Syftet var att undersöka vilka mål och strategier djurägare och kvinnor hade angående mjölkproduktion och på vilka faktorer deras respektive beslutsprocesser grundades. Dessutom undersöktes vilka eventuella effekter betesstrategier, mjölkningsstrategier, säsong, och tidpunkt för kalvning och laktation kunde ha på mjölkproduktionen. Data samlades in genom semistrukturerade intervjuer med både djurägare och kvinnor i oktober-december 2012. Under tolv dagar intervjuades 22 djurägare och 32 utav djurägarnas kvinnor. De intervjuade hushållen valdes ut genom att de för närvarande samarbetade med SORALO inom ett annat forskningsprojekt. Beskrivande statistik och "eyeballing" användes för att urskilja samband mellan svaren.

Denna studie bekräftar information som erhållits i andra studier, t.ex. angående djurägarnas och kvinnornas mål, ambitioner och beslutsfattande faktorer. Dessutom drogs slutsatsen att mjölkproduktion indirekt är en av de faktorer som främst påverkar djurägarnas beslut angående betesstrategierna. Djurägarna har också en omfattande kontroll över den mängd mjölk som används som livsmedel och ett högre intresse för mjölkproduktion än förväntat. Andra slutsatser är att kvinnornas ambition med mjölkproduktionen är att maximera den mängd mjölk som används som livsmedel och att mjölkningsstrategierna varierar mellan kvinnorna. De säsongsmässiga effekterna på mjölkproduktionen och djurägarnas betesstrategier under torrperioden motsvarar litteraturen. Medan kvinnornas mjölkningsstrategier under torrperioden kretsar kring kalven. Avslutningsvis så har massajernas kvigor i studieområdet en högre ålder vid första kalvningen och korna har längre kalvningsintervall och laktationer, än vad som bedöms vara fördelaktigt för högsta möjliga mjölkavkastning i litteraturen.

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1 INTRODUCTION

The Maasai pastoralists live on vast savannah rangelands in the Rift Valley region in Kenya and Tanzania (Talle, 1990). The population is estimated to roughly one million people (Maasai Association, 2013), with two thirds residing in Kenya and the remaining part in Tanzania (Talle, 1990). The Maasai is a patriarch society where cattle and age dominate the social structures thus; the most important differences between men are based on age (Gneezy et al., 2008). The male population is arranged in hierarchical age-groups and they advance through rituals, e.g. circumcision (Talle, 1990). Wealth, on the other hand, is mainly expressed in cattle (Gneezy et al., 2008). However, cattle are not only a sign of wealth but keeping livestock is also what makes the Maasai people into Maasai (Talle, 1990); it is a vital part of their identity (J. Njonjo Kamango, field research coordinator, SORALO, pers. comm., 4 Nov, 2012).

In Kenya the Maasai have based their livelihoods on dairy production (Grandin, 1988; Kettel, 1992), rather than on meat production (Kettel, 1992). A pastoral livestock system based on dairy production can support 2.5 times more people per hectare, in terms of energy, proteins and market value, than a system based on meat production (Kerven, 1987; Grandin, 1988). For instance, the Maasai of Olkarkar, Kenya, obtain 14.8 kg of milk and 11.1 kg of animal live weight per hectare per year (Grandin, 1988). Hence, milk is the most significant animal product and the single most important foodstuff for the Maasai pastoralists (Dahl & Hjort, 1976; Nicholson, 1984; Grandin, 1988; Talle, 1990). Over 60 % of their calorie intake is based on milk and milk products (Grandin, 1988). Therefore, the cattle production goal is to maintain a sufficient milk supply for human consumption throughout the year (Nicholson, 1984; Grandin, 1988; de Leeuw et al., 1991).

Kettel (1992), states that the pastoral dairy production has two vital characteristics; breeding and milking. The purpose of breeding is to maintain the herd size and this is traditionally the men's responsibility, as well as the overall management of the herd. The chores of management include, among other things, the distribution of animals, slaughter, castration and herding towards water and pastures. On the other hand, according to Kettel (1992), milking is the duty of women and aims to keep a domestic group of cows to provide the household with a supply of milk. Depending on this partition of chores between herd owners and women, they also possess different management routines, ambitions and strategies regarding the milk production. In the literature review of this study it is evident that both the herding strategies of herd owners and the milking strategies of women might affect the milk production and the milk off-take in various ways. Yet, among the Maasai there is little communication between the herd owners and the women. For instance, few of the herd owners have knowledge of what the women's milk production goals are and how they decide the amount of milk off-take.

As late as in 1884, Nicholson wrote that animal scientists only recently started to record animal performance and milk production of pastoral herds. This is also confirmed by Grandin (1988) and she stresses that further focus should be directed to the dairy part of pastoralism. Even though these articles were written more than twenty years ago, the message still applies. None of the cited studies concerning herding strategies mentions the herd owners interests in milk production, even though it is a vital part of their livelihood and diet. Additionally, none of the articles mentions the level of control that the herd owners might have over the milk off-take. The role of the woman is mentioned shortly in a number of articles and books (e.g. Barrett & Larkin, 1974; Dahl & Hjort, 1976; Talle,

1990; de Leeuw et al., 1991) nonetheless, only one article thoroughly investigates the milking strategies of Maasai women (see Grandin, 1988). However, Grandin (1988) only investigates the milking strategies of the Maasai women in Olkarkar, Kenya, and it is not certain that all Maasai women practise the same strategies and have the same production goals. To understand the different production goals, different strategies and decision-making processes within the Maasai household and thus, the impact that it might have on their cattle production, more research is needed.

1.1 Objectives

The objective of this case study was to investigate what goals and strategies the Maasai herd owners and women in the semi-arid areas Olkiramatian and Shompole, close to Lake Magadi, Kenya, had regarding the milk production. The aim was to examine the herd owners' interests in milk production and the possible control that they might have over it, as well as thoroughly investigate the women's milking strategies. An important part was also to study upon which factors their respective decision making were based. The study should shed light on the following questions:

1. What are the herd owners' ambitions with cattle milk production?
2. What are the herd owners' herding strategies and on which factors is their decision-making based?
3. What are the women's ambitions with cattle milk production?
4. What are the women's milking strategies and on which factors is their decision-making based?
5. How do the Maasai manage the dry season and what impact does season have on the milk production of their cattle?
6. What are the influences of average age at first calving, calving intervals and length of lactation period on the productivity of the cows?

Additionally, the possible effects of herding strategies, milking strategies, season and timing of calving and lactation on the milk production hence, the milk off-take was investigated.

2 LITERATURE REVIEW

Kenya is located in eastern Africa and is divided into five different ecological zones; humid, sub-humid, semi-arid, arid and hyper arid (FAO, 2005a). Approximately 83 % of the country's surface consists of semi-arid and arid land, which includes savannah rangelands and shrub lands. In 2010 the human population in Kenya was estimated to 40.9 million people (SIDA, 2012) and about ten million, less than 25 %, live in semi-arid and arid areas (Karume, 2004). Conversely, the livestock population is concentrated to these areas (FAO, 2005b), as they host approximately 70 % of Kenya's livestock population (Karume, 2004). Since rain-fed crop agriculture is impractical in semi-arid and arid lands, the importance of livestock is heightened (FAO, 2005a). According to FAO (2005a), indigenous species of *Bos Indicus*, e.g. East African Zebu, is indispensable in semi-arid areas, mostly because of their adaptive characteristics. Main animal products are milk, blood, meat, manure and draught power. FAO (2005a) also stresses that livestock is an important part in the social and cultural lives of the farmers, as well as ensuring a certain economic stability. In the arid and semi-arid areas of Kenya 95 % of the family income and 90 % of the employed people depend on livestock (FAO, 2005b). Unfortunately, these areas also count for about 65 % of the country's poverty and have a low access to infrastructure and basic social services.

2.1 Pastoralism

There are five main Kenyan livestock production systems; mixed crop-livestock production, pastoralism, ranching, landless, and land saving production (FAO, 2005a). In the arid and semi-arid areas of the world, where rangelands are used for extensive grazing, pastoralism is one of the most important production systems (FAO, 2001). A way to define pastoralism according to Sandford (1983), is that the herd owners depend on livestock for 50 % or more of their income and that natural forage constitute most of the fodder available to the animals. Furthermore, most pastoralists and their families have no other economic activities besides caring for their animals. Livestock enables the pastoralists to convert the low yields of solar energy in grass into animal products such as milk, which are more economical and highly more accessible to man (Dyson-Hudson & Dyson-Hudson, 1980; Sandford, 1983; Kettel 1992).

Pastoralism is considered the most appropriate production system in dry areas and the reason is mobility of livestock (Adriansen & Nielsen, 2002; Ayantunde et al., 2011). Ayantunde et al. (2011) states that herd mobility are critical in pastoral production systems because it enables the optimal utilization of water and forage resources. In addition, movement also benefits from preventing environmental degradation, since the herders may adjust the stocking rate according to the available resources. The excessive variability of precipitation between and within years in semi-arid and arid areas is one dominant factor that determines the pastoralists' use of land (Sandford, 1983). An area that produces sufficient grazing one year may produce almost nothing the following year. Thus, the productivity of pastures depends on precipitation and the productivity of livestock depends on pastures, as well as herd mobility (Ayantunde et al., 2011). However, the pastoralists are normally forced to focus more on livestock survival than a high production (de Leeuw et al., 1995; Allsop et al., 2007), probably because of the harsh climate conditions.

2.2 Maasai pastoralists

In Kenya there are three types of land tenure; private land, public land owned by the government but used by the public and finally, communally owned group ranch land (J. Njonjo Kamango, field research coordinator, SORALO, pers. comm., 4 Nov, 2012). The Maasai in Kenya resides on communal rangelands (Butt et al., 2009) and to keep agricultural communities from possessing exclusive land use rights, group ranches were established in 1968 (Kimani & Pickard, 1998; Wangui, 2008). Group ranches are sections of land cooperatively owned by the heads of the residing families (Kimani & Pickard, 1998) and every member within that community has a right to land use (J. Njonjo Kamango, field research coordinator, SORALO, pers. comm., 4 Nov, 2012). Normally, men own their herds individually but herd them collectively (Kimani & Pickard, 1998). A vital part of the Maasai ability to adapt is their territorial mobility, i.e. moving animals and people between seasonal settlements (Talle, 1990). They maintain semi-permanent settlements during the wet season, but during the dry season they can also form temporary settlements closer to pastures (Butt et al., 2009; J. Njonjo Kamango, field research coordinator, SORALO, pers. comm., 4 Nov, 2012).

2.2.1 Group ranches: *Olkiramatian and Shompole*

The following information was recounted by J. Njonjo Kamango (field research coordinator, SORALO, pers. comm., 4 Nov, 2012). The two locations for this study, Olkiramatian and Shompole, were both group ranches. The Maasai population in Olkiramatian was about 4000 people and within Shompole about 6000 people. Both locations were also divided into three portions; the agricultural area Nguruman where community members had a right to grow crops e.g. mango, the conservancy area, and the third and largest part was the livestock keeping range which stretched from the river Ewuaso-ng'iro until the soda lake Magadi. The livestock keeping range functioned as the wet season grazing area and also contained the permanent settlements of the Maasai. Conversely, the conservancy and the agricultural area were used for dry season grazing and the temporary settlements were found within the conservancy. The Maasai in this area could live up to six month in their temporal dry season settlements, roughly between September-Mars, depending on the precipitation.

A committee controlled the activities within the group ranch areas and functioned as an umbrella organization with several sub-committees. The largest sub-committees were the conservancy, agricultural and grass bank committees. The grass bank committee controlled the grazing in the area, i.e. every month of the year had a separate piece of land that was allowed to graze. This ensured that there was grass left to graze when the dry season started. The grass bank committee also controlled the watering points of the area.

2.2.2 Maasai household

Each of the Maasai settlements consists of several independent polygamous or extended families (Talle, 1990; J. Njonjo Kamango, field research coordinator, SORALO, pers. comm., 4 Nov, 2012). Within settlements each married woman has her own house where she resides with her children (Talle, 1990). All married Maasai woman also have the right to obtain a number of her husband's cows (Dyson-Hudson & Dyson-Hudson, 1980; Grandin, 1988), and the milk that they produce is hers to allocate according to her needs (Grandin, 1988). Most milk and milk products are consumed in the household, but it is also

common to sell the surplus or to give it to underprivileged people in the community (Grandin, 1988; J. Njonjo Kamango, field research coordinator, SORALO, pers. comm., 4 Nov, 2012). The woman's cows and their off-springs will later serve as the key inheritance of her sons (Grandin, 1988). Since the Maasai live in extended families, several sons can become responsible for the maintenance of the settlement and the livestock when the father retires hence, a cattle herd could have more than one herd owner (J. Njonjo Kamango, field research coordinator, SORALO, pers. comm., 4 Nov, 2012). The herd owner makes all the important decisions concerning the herd, e.g. regarding grazing, watering, and selling of animals (Dyson-Hudson & Dyson-Hudson, 1980). Hence, there is an unequal access to resources between the sexes. However, the men cannot sell, loan out, or give away the women's milking-stock (Kettel, 1992). Women are also responsible for selling excess milk (Grandin, 1988; Wangui, 2008) and the income accrues solely to the women (Grandin, 1988).

2.3 Daily herd management routines

De Boer and Prins (1989), Bayer (1990) and Butt (2010) describe the herd owners' daily herd management routine in Burkina Faso, Nigeria and Kenya in a highly similar way. Around 06.00-06.30 and 08.00 are the cattle allowed to graze and ruminate near the settlement. Between 08.00 and 14.30-15.00 the herdsman herd the animals towards the target grazing area, and the cattle are allowed to graze. This is the time when the herd is farthest away from the settlement. After 15.00 the herd starts to walk back and arrives at the settlement between 18.00 and 19.00. Normally they do not arrive later because of the risk of predator attacks. Thus, a herding day lasts more than 10 hours during the dry season and walking, grazing and watering constitute more than 95 % of the day (Bayer, 1990). The amount of time the cattle spend resting or ruminating is low during the dry season.

Normally, the Maasai women milk the cows twice a day, in the morning before the cattle depart from the household and in the evening when they return (Nicholson, 1984; De Boer & Prins, 1989; Talle, 1990; Butt, 2010). But a close daily health inspection of both cow and calf is also an essential part of the Maasai management routines (Grandin, 1988). Grandin (1988) stresses that it will give the women a good overview of the milk production and the milk off-take can be adjusted accordingly. For instance, if either the cow or the calf seems unhealthy or weak, both milking frequency and amount of milk taken will be reduced. After milking the calves are separated from the cows, both during the day when the cows are out grazing and during the night (Grandin, 1988). It happens that larger calves jump over the enclosures at night and spend the rest of the night with their mothers. In such cases morning milking is not possible.

2.4 Goal and strategies of the herd owner

Western and Finch (1986) concluded that in noncash economies and in arid environments traditional pastoral management strategies are the most effective approach. Even so the decision making of the herdsman is a complicated process (De Boer & Prins, 1989). The decision where to graze the cattle is influenced by many factors and it can be difficult to find an ideal decision that results in the highest profit. However, Allsopp et al. (2007) stated that the pastoralists are innovative and they do their best to adapt the herding practices to their constraints. Other studies have found that the herd owners' emphasis is on keeping as many animals alive as possible to increase the herd size (Western & Finch,

1986; Allsopp et al., 2007), but animal welfare and herd productivity also seem to be important goals (Western & Finch, 1986).

2.4.1 Factors affecting the herding strategies

De Boer and Prins (1989), Allsopp et al. (2007) and Butt (2010) determines in various studies that herd owners decide on a target grazing location every morning before the herds depart from the settlement and the route changes daily. In addition, several other studies found that the herd owners' decision is based on numerous criteria:

- The seasonal dependent productivity and availability of different grazing areas (Hendricks et al., 2004; Allsopp et al., 2007; Samuels et al., 2007);
- The nutritional value of the vegetation (Sieff, 1997; Allsopp et al., 2007; Butt, 2010);
- Water availability (Sieff, 1997; Coppolillo, 2000; Hendricks et al., 2004; Allsopp et al., 2007; Samuels et al., 2007; Butt, 2010);
- The condition of livestock (Sieff, 1997; Hendricks et al., 2004);
- The safety of the animals as regards to predators, toxic plants, harsh weather or rough terrain (Allsopp et al., 2007; Butt, 2010);
- The presence of other herdsmen and cropland (Allsopp et al., 2007);
- The presence of other settlements (Coppolillo, 2000).

According to Allsopp et al. (2007), the pastoralists in the arid South African rangeland choose their grazing route depending on the criteria above, while the grazing area is selected according to the presence of toxic plants. The authors report that if the animals do not seem particularly hungry in the morning the herders might choose an area with intermediate forage quality and low presence of toxic plants. However, if the animals do appear hungry the herders will herd them to an area with high presence of preferred grazing plants. These areas are normally rare. Allsopp et al. (2007) also writes if the animals are well fed and watered in the target grazing area the herders might also move the cattle to an area of high-quality forage, despite a high presence of toxic plants, for an afternoon meal. Since the animals are neither hungry nor thirsty, they carefully select what plants they ingest and are at a lower risk of eating poisonous species. In the study the authors concluded that animals' preferences and behavior are key points in the herd owners' choice of grazing route and grazing areas.

2.4.2 Maasai herding strategies

However, other pastoralists adapt different strategies. Butt (2010) conducted interviews with Maasai in Talek, Kenya, and learned that these herd owners often rely on a strategy called "tracking" during the dry seasons. When practicing "tracking", the herd owners decide on a target grazing location in the morning and then later during the day they can change their decision. Butt (2010) reports that the decision to change grazing location normally is based on information obtained by herders from other settlements, often regarding locations with high-quality forage and water or areas with predators or other dangerous wildlife such as elephants. The bonds between herders from different settlements are strong and this is an important key to the tracking strategy. Butt (2010) also found that when the target grazing location is changed the cattle often need to spend more time walking instead of grazing, due to an increase in walking distance. The herd distance traveled in the study was between 5.8-10.2 km each day during wet season and 8.7-12.8 km during the dry season.

Western and Finch (1986) writes that the Maasai in Amboseli, Kenya, practise two other herding strategies during the dry seasons. Some of the herd owners decline to only water their animals on alternate days, which enable them to travel to more distant and less grazed pastures. Normally, the settlements of these herd owners are about 8-12 km from water and the cattle walk approximately 16 km each day. Other herd owners, whose settlements are situated in swamps, locate about three km from the available water point and their cattle walk about eight km daily. Coppolillo (2000) concluded that distance to water is the strongest predictor of how the herding strategies are established in the dry season and most herds never travel further than the water points.

2.4.3 Effects of herding strategies on milk yield

Both pregnancy and lactation is energetically costly for the cows and to compensate for the losses of energy, their feed intake need to increase (Knight, 2001). De Boer and Prins (1989) states, that the feed intake of cattle is directly linked with their condition and hence, with the desired production. Conversely, it can be difficult for the herd owners to find sufficient forage to sustain the milk production of the cows, especially during the dry season. Almost exclusively the cows have to utilize their body reserves to meet the production throughout the entire dry season (Prins & Beekman, 1989). Although, moving cattle around might be the best action against drought to find forage and sustain milk production (Hatch & Stafford Smith, 1997), the herding radius still affect the milk yield negatively (Coppolillo, 2000). Coppolillo (2000) found that lactating cows herded far from the settlement produce one third of the milk produced by cows grazing closer to the settlement.

De Boer and Prins (1989) noted that the distance travelled by the herd was relatively extensive during the first part of the morning, as well as the last part of the afternoon. They could also see that the feed intake of the cattle was higher during days when the animals travelled a shorter distance, probably due to the increased grazing time. Therefore, De Boer and Prins (1989) concluded that the herds daily travel time had a large influence on the total feed intake. Traveling induce a serious loss of time and energy for the cattle (Sieff, 1997; Hendricks et al., 2005) thus, traveling farther will not give the herd a nutritional benefit (Coppolillo, 2000). Walking towards water also occupy precious time when the livestock could walk towards grazing areas instead (Sieff, 1997; Coppolillo, 2000). This corresponds to the conclusions of De Boer and Prins (1989); there is an upper limit to how much time the cows can graze, since most cattle need to return to the settlement every night to be milked. Hence, all the decisions made by the herd owners during the day will affect the amount of grazing time and thus, the milk production of the herds.

2.5 Goal and strategies of the women

Besides herding strategies there are also several other factors that determine the potential supply of milk available to the Maasai, e.g.:

- The season, e.g. the dry season can severely reduce milk yield (Dahl & Hjort, 1976; Nicholson, 1984);
- The size of the herd (de Leeuw et al., 1991);
- The proportion of lactating cows in the herd (Dahl & Hjort, 1976; de Leeuw et al., 1991);

- The length of the lactation (Galukande et al., 1962, de Leeuw et al., 1991);
- The health and nutritional status of the cow (Barrett & Larkin, 1974);
- The milk production potential of every cow (Dahl & Hjort, 1976; de Leeuw et al., 1991);
- How much the calf is allowed to suckle (de Leeuw et al., 1991).

However, the actual milk off-take is determined by a flexible milking strategy (Grandin, 1988), see Fig. 1. The two main components of a milking strategy are the amount of milk being extracted during a milking session and the milking frequency (de Leeuw et al., 1991). This will determine how much milk the women can derive for self-interest (milk off-take) and how many teats the calf is allowed to suckle.

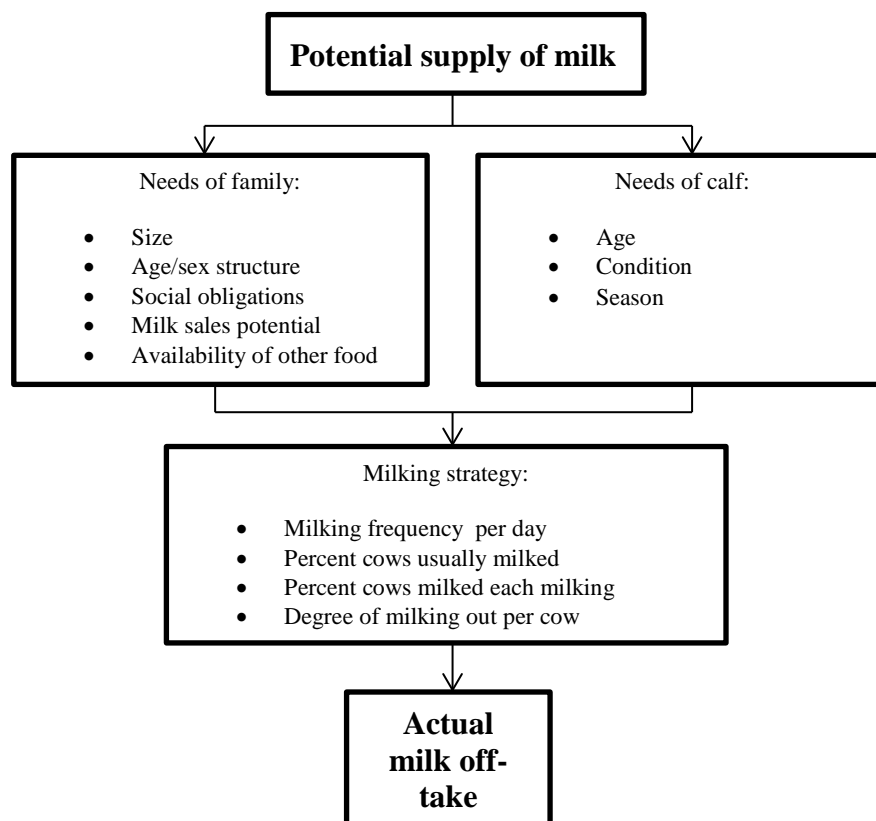


Figure 1. Factors that determine the actual milk off-take in a household (from Grandin, 1988).

2.5.1 Milking strategies of women

Another study discovered that survival of the calf is the essential goal for the Maasai and affect the milking strategies and the amount of milk off-take (Grandin, 1988). Additionally, Grandin (1988) also found that there are three other important factors determining milk off-take: the amount needed to sustain the family, the availability of other foodstuff, and the possibilities of milk sales. According to the Maasai there is also a competition between the needs of the calf and the needs of the children hence, the milk given to the children is lost to the calf (Dyson-Hudson & Dyson-Hudson, 1980; Nicholson, 1984; Grandin, 1988; Talle, 1990). Thus, the Maasai milking strategies are based on the concept of “milking calves”. Grandin (1988) recount that the calf’s need for milk varies

with age and the newborn calf is allowed all the colostrum during the first few days of life. Milking can begin when the calf has grown stronger and more robust. Grandin (1988) also states that the milking frequency and the amount of milk off-take can increase further when the calf is old enough to eat forage and drink water. If the calf has a frequent access to water the sooner it can rely solely on forage for growth and maintenance, instead of milk. It is common for the Maasai women to milk two teats in each cow and leave two teats for the calf to suckle to the end of the lactation period (Barrett & Larkin, 1974; Dahl & Hjort, 1976; Talle, 1990). However, three teats can be milked if the need of the family is increased (Grandin, 1988; de Leeuw et al., 1991).

The milking strategies of the Maasai are similar to milking strategies of other pastoralists. Dahl and Hjort (1976) writes about the Dinka people in Sudan. Dinka calves receive all the milk from the cow during the first two weeks of lactation. Later, when the calves are older than two weeks they will receive 50 % of the milk yield. The amount of milk is then gradually reduced until they only are allowed 25 %. Dahl and Hjort (1976) claims that control over the calf's milk intake is achieved by letting the calf suckle at the beginning and end of milking. This is almost consistent with the ways of the Maasai women. Grandin's (1988) study describes that Maasai calves are permitted to suckle during and directly after milking. The fact that the calf is allowed to suckle in conjunction with milking is favourable because it stimulates milk let down in the cow (Barrett & Larkin, 1974). Without the calf it might not be possible to derive any milk from the teats, since indigenous zebu breeds, see Fig. 2, have strong maternal instincts and prefer to hold back milk for the calf.



Figure 2. The three most common cattle breeds in the study area, in order from left: Maasai zebu (photo: Professor Clemens Wollny, Dagris), Kenyan Boran (photo: Giles Prettejohn, Livestock Manager, Ol Pejeta Conservancy, Kenya) and Kenyan Sahiwal (from Khurana Dairy Farm, 2013).

2.5.2 Other components of the milking strategy

The following passage derives from Grandin (1988). Her study found that other important components of a milking strategy are the degree of milk out and the number of cows milked. The milk off-take available to the household depends on the amount of milk extracted from each cow, which is a function of both the number of teats being milked and the level of milk-out. The amount of milk derived from the teats varies. A rich woman may move on to milk another cow when the flow of milk starts to decrease and leave the rest for the calf, whereas a poorer woman will try to milk the teats completely empty. Also, it is not certain that the women will milk all the lactating cows in the herds. Some cows are not milked at all, or only during parts of the lactation, due to low potential, mastitis or aggressive behaviour. In addition, young calves need less milk and are easier to handle and women preferably milk their dams.

Grandin (1988) also found that there is a decrease in the percentage of milked cows according to the wealth of the household. For instance, a rich woman might only milk about 40 % of her lactating cows, while a poor woman will milk all cows. Since a rich household generally have a higher number of heads, they can obtain a sufficient level of milk off-take and still leave more milk to the calf. Furthermore, a rich woman can stop milking sooner than a poor woman. This might have the positive advantages of an increased growth rate of the calf, since it is allowed more milk. In turn, an increased growth rate might lead to a decreased age at first calving, a higher weight gain of the dam and finally, earlier conception.

2.6 Age at first calving

In pastoral production systems the total milk production depends on several factors, e.g. genetics, management, physiology and environment (Grandin, 1988). Pastoral animals have a lower weight at weaning, slower growth, reach maturity later, and have a lower mature body weight compared to their exotic counterparts (Barrett & Larkin, 1974; Cossins, 1985), mostly due to the competition of milk (Cossins, 1985). The low weights at weaning will slow down the entire reproductive process (Cossins, 1985). For instance, the age at first calving is also higher in pastoral herds. Among Borana pastoralists was the heifers' age at first calving about 45-47 months, while the N'Dama cattle in Ghana had an average age of 32-37 months (Tuah & Nyamaa Danso 1985). In comparison, in Sweden the dairy breeds give birth to their first calf at the average age of 29 months and the beef breeds at the average age of 28 months (SJV, 2013a).

2.7 Calving intervals and lactation length

Milk production is a result of calving and it is desirable that the calving interval is twelve months to achieve an efficient milk production (Barrett & Larkin, 1974). Therefore, the dry off period should be 6-8 weeks to benefit a lactation of ten months. Barrett and Larkin (1974) states that it will give the cow the maximum milk yield in her lifetime, providing that management and forage quality are sufficient. The Maasai do not control breeding hence, the cattle reproduction is mostly influenced by rainfall and the resulting increase in forage (de Leeuw et al., 1991). Thus, poor nutrition is said to be the most common reason for infrequency in calving, especially in semi-arid and arid areas (Dahl & Hjort, 1976). In Kenya a normal calving interval can be up to 465 days and longer (Barrett & Larkin, 1974). Additionally, the Maasai normally practise natural weaning hence; there is an extreme variation in lactation length (Nicholson, 1984). Barrett and Larkin (1974) stress that the birth of a new calf, after a reasonable time period, would favour the long-term milk yield. Few cows yield enough milk to recompense their keep in the end of a prolonged lactation. Normally, a lactation lasts for about 7-9 months in dry areas (Dahl & Hjort, 1976). Furthermore, the authors point out that it is not certain the cows produce more milk than the need of their calves.

3 MATERIAL AND METHODS

The study was a case study of the Maasai in Olkiramatian and Shompole, conducted in collaboration with South Rift Association of Land Owners (SORALO) and Lale'enok Research Centre in Magadi. The organization SORALO was established in a daughter project within the African Conservation Centre (J. Njonjo Kamango, field research coordinator, SORALO, pers. comm., 4 Nov, 2012), and worked on grass root level to bring land owners from 15 group ranches together within the Kajiado and Narok districts (ACC, 2013). The goals of SORALO were e.g. to promote tourism, support sustainable utilization of land, and create conservation areas.

3.1 Study area

The study was conducted in southern Kenya close to the Tanzanian border, south of the Kenyan rift valley (SORALO, 2012a), see Fig. 3. The study area included the group ranches Olkiramatian and Shompole, situated in the Kajiado district within the Rift valley Province (J. Njonjo Kamango, field research coordinator, SORALO, pers. comm., 4 Nov, 2012), see Fig. 4. The climate was arid to semiarid (SORALO, 2012a) and the vegetation ranged from savannah, wood land, and shrub land, to swamps (J. Njonjo Kamango, field research coordinator, SORALO, pers. comm., 4 Nov, 2012). The study area had a bimodal rainfall pattern; the long rains occurred between March-May and the short rains between October-December (Ministry of state for development of Northern Kenya and other arid lands, 2012). The annual rainfall was strongly influenced by the altitude (Ministry of state for development of Northern Kenya and other arid lands, 2012) and Olkiramatian and Shompole were located on an average height of 650 meters, i.e. the average annual precipitation was 600 mm (J. Njonjo Kamango, field research coordinator, SORALO, pers. comm., 4 Nov, 2012). J. Njonjo Kamango (field research coordinator, SORALO, pers. comm., 4 Nov, 2012) also recounted that available water points, beside the river Ewuaso-ng'iro, included temporal water pans that collected water during the rains and were used during both wet and dry seasons, and open pipelines served by the Magadi soda company. The pipelines were mostly used during the dry season when the water pans were dried up.

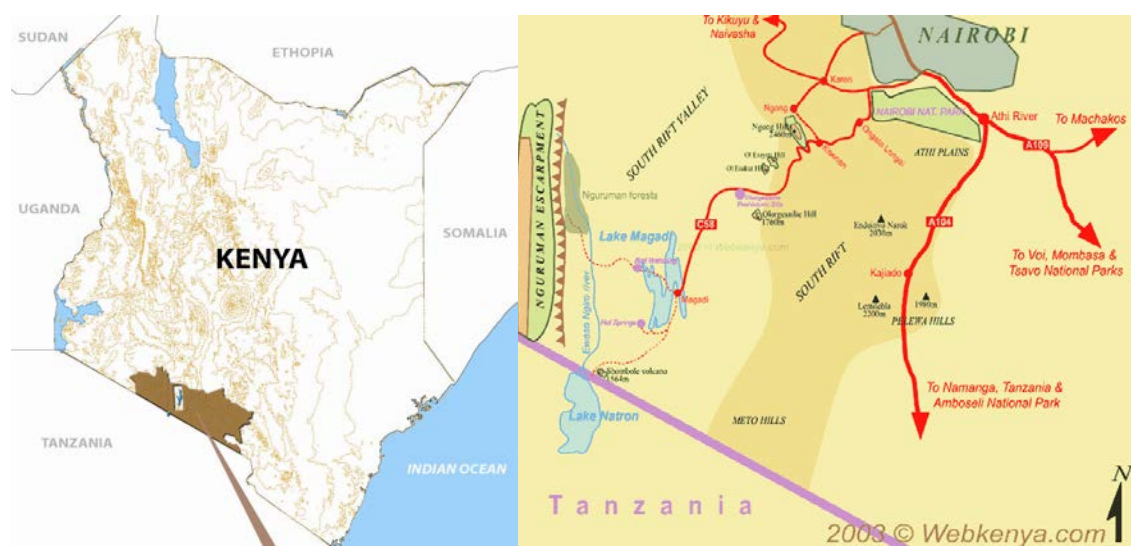


Figure 3. Left map: location of Kajiado district in Kenya (shaded area) (from SORALO, 2012a). Right map: locations of the soda lake Magadi, the river Ewuaso-ng'iro and the agricultural area Nguruman to the left on the map (from Webkenya, 2013).

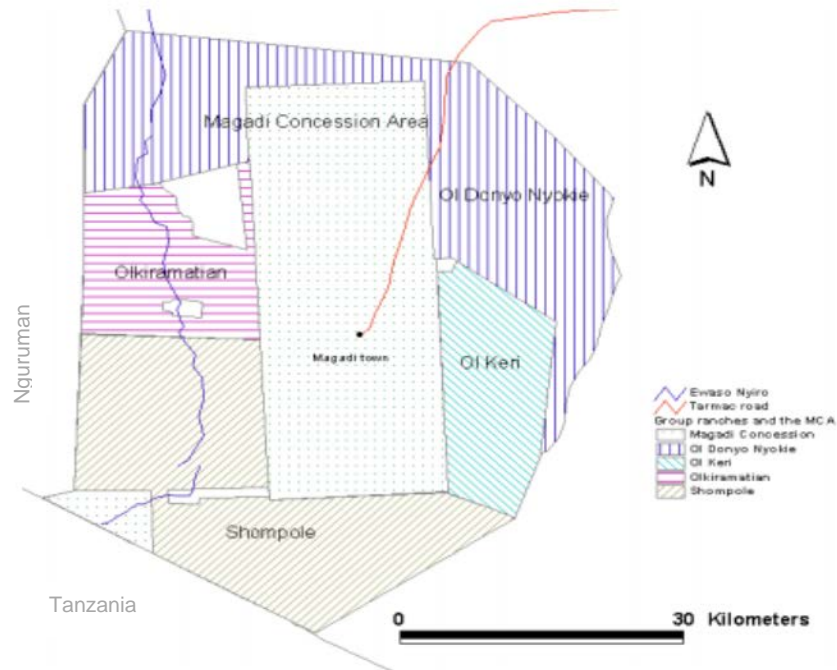


Figure 4. Locations of the group ranches Olkiramatian and Shompole (from Sacco & Flintan, 2012). Shompole is located next to the Tanzanian border and the river Ewaso-ng'iro flows through Olkiramatian.

3.2 Data collection

Data were obtained through semi-structured interviews with both herd owners and women during October-December 2012, which is the season of the short rains. The results of the interviews were also to be used by the SORALO researchers at Lale'enok, to enhance the understanding of the Maasai in their research programs.

3.2.1 Interview forms

After a two weeks period of adapting to the area and learning about specific local issues, two interview forms were created by the author in collaboration with researchers from SORALO. One researcher was originally Maasai and from the study area hence, he could determine if the questions corresponded to the Maasai way of thinking. The questions were then translated into the Maasai speaking language Ma by one of the male Maasai working at Lale'enok Research Centre. In addition, he also functioned as both translator and driver in this study. The translation into Ma had dual purposes; few Maasai spoke English and also the need to certify that the questions were comprehensible in both languages.

Next a pilot study was conducted to validate the questions, and to determine if the interviews could be carried out in the intended way. The pilot study also provided information of the lengths of the interviews, which enabled an assessment of the necessary time frame. Each interview lasted roughly 20-30 minutes. Three independent herd owners and three women in charge of milking were randomly chosen and interviewed. None of the interviews in the pilot study were later used in the study. Following the pilot study, the answers were looked over and if some questions did not give a sufficient answer, the questions were corrected. The complete interview questions are presented in Appendices 1 and 2.

3.2.2 Interviews

In this study semi-structured interviews were used. In semi-structured interviews the same questions were asked to all respondents, but the questions had opportunity for different responses (Kvalitativ metod, 2013). Thus, the respondents had an equal chance to express their views on the same issues.

During twelve days, 22 herd owners and 32 of these herd owners' women were interviewed. All the households interviewed in this study were chosen because they were currently collaborating with SORALO within another research project. In the SORALO study 25 herd owners participated, based on that they lived in close proximity to one of SORALOs research assistants. The aim was to interview all 25 herd owners, but three could not be reached within the time period of this study for various reasons. Another aim was to interview two women in charge of milking in each of the herd owner's household. However, in one household no woman was accessible and in ten households only one woman was available. Since the interviewed households already participated in a study and collaborated with a research assistant they were more accessible, both in terms of scheduling the interviews and to find their locations.

Since some households were located in remote areas, the interviews were scheduled according to the locations of the households, i.e. all households in the same area were interviewed during the same day. Hence, one day six herd owners and their women could be interviewed, whereas another day only one household could be reached. A terrain motorbike was used for transportation because of rough terrain, and the same translator was used during the entire study to ensure that the questions were asked in the same way in all interviews.

3.3 Analysis

Each particular answer was coded and typed into Excel 2010 (Microsoft Corp., Redmond, WA, USA). For some questions, especially regarding the milking strategies, have highly similar answers been merged. Only answers to interview questions judged to shed light on the study questions are presented in the Results section. Remaining answers are summarized in Appendices 3, 4 and 5. Number of responses, relative frequency, and means when applicable, were calculated for all questions. Descriptive statistics, mainly cross tabulations, were performed in Minitab 16 statistical software (Minitab Inc., State College, PA, USA) for selected questions. The cross tabulations were applied on one or several questions simultaneously. By "eyeballing" the resulting tables the ambition was to reveal relationships between questions, i.e. if the proportion of respondents that gave the same answer to one question also gave the same answer to another question.

The questions related to the study objectives as follows:

- *Basic information about the households and the herds.* Herd owner questions 3 and 10-12, and woman question 3 were chosen to give an overview of the circumstances in the studied households, regarding ages of herd owners and women but also herd size, number of females and cattle breeds.
- *What are the herd owners' ambitions with cattle milk production?* Herd owner questions 14-18 were chosen. The herd owners' management goals were considered important because they illustrate the importance of milk production to the herd owners. In addition, it contributes with a background to their decision

making and herding strategies. The herd owners interests and control over the milk off-take emphasise their views of the importance of milk production. These questions combined describe the herd owners interests and direct impact on milk production.

- *What are the herd owners' herding strategies and on which factors is their decision-making based?* Herd owner questions 21-22 and 24-28 were chosen. The questions provided information about the preferred grazing and watering locations, watering frequency, and length of the herding day and hence, the preferences of the herd owners can be distinguished.
- *What are the women's ambitions with cattle milk production?* Woman questions 14 and 16-19 were selected. The questions regarding their goals with milk off-take, milk-out of the teats, if the derived milk was sufficient and how they utilised the off-take, are a vital part in understanding the women's ambitions and profits regarding milk production.
- *What are the women's milking strategies and on which factors is their decision-making based?* Woman questions 7, 8, 10, 11, 15 and 20 were selected. When compared to literature, these questions revealed the milking strategies of the women and also included factors affecting their strategies.
- *How do the Maasai manage the dry season and what impact does season have on the milk production of their cattle?* Herd owner question 23 and woman questions 21 and 22 were chosen. The questions show how the seasons affected the milk yield of the cows according to the respondents. In addition, how herd owners and women responded to the changes in season and adapted their respective strategies accordingly. This was important for the understanding of seasonal effects on milk off-take.
- *What are the influences of average age at first calving, calving intervals and length of lactation period on the productivity of the cows?* Woman questions 9, 12 and 13 were selected, because they show the effects of seasons, herding strategies and milking strategies on the physiology of both heifer and cow, which in the long term might affect the milk yield and hence, the milk off-take.

4 RESULTS

Summaries of answers to the questions are available in Appendices 3, 4 and 5.

4.1 Basic information

The mean age of the herd owners in this study was 46 years, ranging from 18 to 73 years (herd owner question 3) and the mean age of the women was 40 years, ranging from 20 to 74 years (woman question 3). The mean herd size were 47 heads, ten being the lowest number of heads in a herd and 160 heads being the highest (herd owner question 10). Simultaneously, the mean number of female cattle in the herds was 36 heads, ranging from 5 to 120 heads (herd owner question 11). Fourteen of the studied herds (64 %) consisted of Boran cattle (herd owner question 12). One herd (5 %) consisted of Sahiwal and the remaining seven herds (32 %) of crossbreeds. The most common breeds to cross were Boran and Maasai zebu.

4.2 Herd owners' ambitions with milk production

4.2.1 Herd management goals

Twenty-one herd owners (96 %) wanted to increase the herd size, which made it the most common long term management goal in the study (herd owner question 14). Next, 17 (77 %) herd owners also wanted to crossbreed to achieve a higher milk production, either with the breeds Sahiwal, Frieser or Maasai zebu. In addition, the most common short term management goals were: the herd owners wanted the animals to graze on good quality pastures every day and spray the cattle against vectors (herd owner question 15). Both answers were given by 20 herd owners (91 %) each. Secondly, twelve (55 %) herd owners wanted to keep the cattle healthy. The only notably difference in the answers appeared in the short term management goals; one female herd owner wanted her cattle to produce enough milk.

In the study 20 herd owners (91 %) answered both “increase herd size” and “graze on good quality pastures”, and 14 (64 %) herd owners answered both “crossbreed for a higher milk production” and “spray cattle against vectors”. In addition, 18 (82 %) herd owners answered “increase herd size” and “spray cattle against vectors”, and finally, 16 (73 %) answered both “crossbreed for a higher milk production” and “graze on good quality pastures”. These were the most common combination of answers.

4.2.2 Interests in milk production

Regarding the herd owners interests in milk production: eleven (50 %) herd owners believed that low milk off-take could indicate sick animals, and another eleven (50 %) that milk off-take could indicate the quality of pastures (herd owner question 16). Ten of the eleven herd owners answering that low milk off-take could indicate sick animals, also answered that it might indicate quality of pastures. Thirdly, eight (36 %) herd owners considered milk production interesting because it allowed them to identify and breed on breeds with a high milk production. However, seven (32 %) had no interest in milk production since it was the women's business. Only one herd owner (5 %) had an interest

in the actual milk production, by keeping a breed he knew would produce enough milk to sustain his family.

4.2.3 Control over milk off-take

Concerning the control over milk off-take (herd owner question 17), with ten responses (46 %) the most common answer was that the herd owners had control. They could tell the women how to milk according to season, health of the calf, and health and production of the cow. In addition, six herd owners (27 %) had some level of control only when the calf was very young and four (18 %) had no control over the milk off-take. Only the two female herd owners (9 %) claimed to have all control of the milk off-take, because they also did the milking.

Both the herd owners that claimed to be in control of milk off-take during the entire lactation (46 %) and those that had some control only when the calf was young (27 %), were able to give the women instructions on how to milk the stock. For instance, if the production of a cow was low or if a calf was unhealthy they could tell the women to milk the cow less, or if it was a high yielding cow they could tell the women to increase the milk-out. The herd owners that had control over the milk off-take when the calf was very young could remain in control until the calf reached an age of four months.

Notably, all herd owners that claimed to have no interest in milk production still had control over milk off-take. Otherwise, no apparent connection between the herd owner questions 16 and 17 could be found.

4.2.4 Benefit milk production by changing herding strategy

Of the 22 herd owners interviewed 21 (95 %) believed that they could not improve the milk production by changing the current herding strategies (herd owner question 18). Of these 21 herd owners 20 considered milk as a secondary product. However, they believed they were already maximising the milk production by practicing a herding strategy that favoured health and fattening of the cattle. Four of these 20 herd owners also answered that they, in addition to fat and healthy cows, also tried to maximise the milk production. Finally, the last one of the 21 herd owners already tried to maximise the milk production to sustain his family. The single herd owner (5 %) that would have to change his current herding strategy to achieve a higher milk production, focused solely on fattening of his cows.

4.3 Herding strategies and decision-making factors of herd owners

4.3.1 Grazing

The three main reasons for herd owners to graze their cattle in a specific area (herd owner question 21) were:

1. Good quality forage (eight responses, 36 %);
2. No predators (nine responses, 41 %);
3. Open area, it was safer and had fewer disturbances (five responses, 23 %).

The three main reasons for herd owners not to graze their cattle in a specific area, even if it had high quality forage (herd owner question 22) were:

1. Predators and tsetse flies (both received eight responses, 36 % each);
2. Predators (seven responses, 32 %);
3. Other herds grazing, because of less grass and space, and were not comfortable for the cows (six responses, 29 %, note that only 21 herd owners gave a third reason).

No connection could be distinguished between the answers of the two questions.

4.3.2 Watering

Regarding how the herd owners decided where to water the herds, common reasons to consider were because the water point was close to the settlement or close to pastures, with six (27 %) and five (23 %) responses respective (herd owner question 27). Still, 15 (68 %) herd owners did not have a specific water point, because they were currently located in areas with good access to water e.g. streams, dams or the swamp Olorishi. Hence, for the same reasons 15 (68 %) herd owners had no specific number of times to water the herds each day (herd owner question 28). The cattle could drink unhindered. Next, five (23 %) herd owners watered the cattle two times per day and they had several reasons e.g.; the cattle grazed better if watered, the water point was close to the settlement, there was water all around, and because forage was close to the settlement.

Naturally, a connection between herd owners that did not have a specific water point and herd owners that did not have a specific number of watering times could be distinguished in the study. No other connections between herd owner questions 27 and 28 could be seen.

4.3.3 Decisions regarding grazing arrangements

Eighteen herd owners (82 %) made the arrangements for next days' grazing in the evening when the herd returned to the settlement (herd owner question 24). These herd owners looked at the abdomens of the cows to distinguish if they looked full and if not, they changed the intended grazing location for the following day. Conversely, the remaining four herd owners (18 %) made the arrangements in the morning before the herds departed from the settlement. Some herd owners looked at the dung to establish the quality of previous days' forage. They considered both the size and consistency; if the dung was dry the forage was not good, but if the dung was soft the forage was good. In addition, some herd owners also considered the milk yield in the morning.

4.3.4 Decisions regarding herd departure and return

In the study area the most common hours for the herds to depart from the settlement were 09.00-10.00 (herd owner question 25). In the study ten (46 %) of the herd owners' herds left at these hours: six herds because it was not far to walk to pastures, five because the settlement was located near thick bushes and gave predators time to withdraw, and five because tsetse flies were less active in sunlight. Secondly, eight herds (36 %) left at 06.00-07.00: five herds because it was not far to walk to pastures and three because it was far to walk to pastures. Finally, four herds (18 %) left at 08.00-08.30 because it was not far to walk to pastures.

Sixteen herds (72 %) returned to the settlement at 17.00-17.30 (herd owner question 26). The reasons were e.g.: nine herds returned at these hours so the care takers had time to identify sick cows and begin treatment, nine herds so the herder had time to count all cows and look for missing ones, eight because it was not far to walk home, and five because they needed to be home before predators became active. In addition, five herds (23 %) returned at 18.00: three herds because they needed to be home before predators became active, three so they could stay on the pastures as long as possible and finally, two herds because it was not far to walk home.

No connection could be distinguished between time of departure and time of return. However, eight herd owners stated "it is not far to walk to pastures" as the reason for both their specific departure and return hours.

4.4 Women's ambitions with milk production

All 32 women interviewed in this study (100 %) replied that their goal was to maximize the milk off-take available to the household (woman question 14). Simultaneously, all women (100 %) maximised the milk-out of the available teats (woman question 16). However, a few women also mentioned that the level of milk-out depended on the health and growth of the calf. Next, all milk derived from the milking-stock was used for home consumption within the household (woman question 17). Although, 15 women (47 %) from ten different households also stated that they normally sold the surplus milk. In addition, all four women from Nguruman, the agricultural area, sold surplus milk. No milk was given away.

Twenty-two women (69 %) answered that the milk off-take was not sufficient for their needs and they wished to acquire more milk (woman question 18). The remaining ten women (31 %) answered that the milk off-take was sufficient and they did not need more milk. Fourteen of the 15 women that normally sold surplus milk, answered that the milk off-take was not enough for their needs.

The mean litres of milk the women replied that they needed each day were 6.6 litres per day, ranging from 2 to 20 litres (woman question 19). However, seven women (25 %) wanted 5 litres per day and seven women (25 %) wanted 10 litres per day hence, these amounts were the most desired. Note, however, only 28 women were asked this question.

4.5 Milking strategies and decision-making factors of women

In the study all women (100 %) separated dam and calf during the night (woman question 20). Simultaneously, all but one woman (97 %) milked their stock twice per day, once in the morning before the herd departed from the household and once in the evening when they returned (woman question 8). The remaining woman (3 %) lived in Nguruman and milked her cows thrice per day, in addition to mornings and evenings she also milked at 10.00. In only four households was the number of milked cows lower than the number of lactating cows (woman question 7). The following reasons were mentioned:

- The teats were infected, e.g. from a tick bite;
- The cow did not produce enough milk to sustain her calf and being milked;
- The calf is a male they want for breeding hence, they do not milk the dam.

The women in this study stated several factors determining the milk off-take (woman question 15). The most important reasons were: the milk production of the cow and the health situation of the calf, with 29 (91 %) and 25 (78 %) responses respective. Only two women (6 %) answered that it also depended on if they had visitors in the household. Finally, three women each answered (3 % respective): the milk off-take depended on if the children needed more milk, if they did not have enough of other foodstuff e.g. vegetables, and the size of the calf.

The milking strategies of women can be viewed in Table 2, Appendix 5 (woman question 10). There was no consistent milking strategy among the women in this study. Nonetheless, 29 women (91 %) stressed that the milking strategy depended on the health of the calf, and 25 women (78 %) that it depended on the milk production of the cow (woman question 11). These factors decided if they were to deviate from their normal milking strategy. Most women milked fewer teats if the calf was unhealthy or if the cow produced less milk. For instance, some women did not milk the dam if the calf was unhealthy and some only milked one teat and left three for the calf. If the cow was healthy and could eat grass and drink water to produce enough milk, the women could increase the number of milked teats e.g. milk three teats and leave one for the calf. Most women increased the number of teats when the calf was old enough to eat grass and drink water on its own.

Five of the ten women that considered the milk off-take to be sufficient practiced a milking strategy where the first milking period, before the number of teats changed, was when the calf was 0-1 week old. In addition, four also practised a milking strategy where the first milking period was when the calf was 0-1 month old.

4.6 How the Maasai manage the dry season and the seasonal impacts on milk production

During a severe dry season 19 (86 %) herd owners stated that they could move to another settlement closer to sufficient pastures (herd owner question 23). For instance, Nguruman, Kajiado, Nairobi and even Tanzania were mentioned as possible locations where the herd owners might move to find forage. However, a majority could not mention a location since the availability of grass will determine the move. Next, ten (46 %) herd owners answered that they could buy hay and stay at the current settlement, and six (27 %) answered that they could sell animals, save the money and buy new animals during wet season. Finally, three (13 %) herd owners could feed the cattle with branches of leaves from the Cordia tree.

Thirteen women (41 %) discovered a difference in milk yield and changed their milking strategies according to these differences (woman question 21 and 22). The differences in milk strategies between seasons can be viewed in Table 8, Appendix 5. However, 15 women (47 %) discovered a difference in milk yield but did not change their milking strategies. Finally, four women (12 %) did not discover a difference in milk yield between the seasons. These four women lived in three households in Nguruman. One woman stated that it depended on that cows in this area had access to high quality forage all year and therefore, there were no changes in milk yield. All the other 28 women (88 %) that discovered a difference replied that during wet season there was plenty of fresh forage hence, cows produced more milk. While during dry season it was dry and less forage consequently, cows also produced less milk.

4.7 Average age at first calving, calving interval and length of the lactation period

In the study four women (13 %) answered that the heifers' average age at first calving was three years, 26 women (81 %) answered four years, and two women (6 %) answered five years (woman question 13). Twenty-one (66 %) women stated that average age at first calving depended on that it was the average amount of time for a heifer to grow to the right birthing size. While nine women (28 %) answered that it depended on the quality of forage, e.g. good quality forage make the heifer grow faster and thus, come in heat faster. Finally, three women (9 %) said that it was the normal age to give birth; else the heifer is too young.

All but three women (91 %) answered that the average calving interval was two years, 24 months (woman question 12). The remaining three women (9 %) replied that it was 16 months. In the study 23 women (72 %) answered that the heifer was four years at first calving and the calving interval was 24 months hence, this was the most common combination of answers.

The mean value of the average lactation length during wet season was 11 months and during dry season 9 months (woman question 9).

5 DISCUSSION

For the Maasai pastoralists in the semi-arid areas Olkiramatian and Shompole, close to Lake Magadi in southern Kenya, livestock is a key asset and their livelihood is directly linked to the productivity of their animals (ACC, 2012). Hence, it is important to understand what ambitions and goals the Maasai in this area have regarding cattle milk production, and also on what factors their decision-making is based, e.g. to improve the productivity in the future. In this section each study question are discussed separately, in addition to general discussions.

5.1 Study methods

According to the Swedish National Agency for Higher Education (2013) a case study is a method of investigation. It is a detailed study of a single case, or a few typical cases, used to nuance, deepen and develop concepts and theories. Hence, the number of households in the sample population could be too large for this study to be considered a case study. However, this study might be viewed as a case study of the Maasai population in Olkiramatian and Shompole, rather than a case study of the Maasai household. The ambitions and goals of the sample households were thoroughly investigated and the answers nuanced and extensive. Additionally, the semi-structured interviews were a good approach and worked out well in this study. By asking the same questions to all respondents, especially combined with using the same translator, the interviews were structured and the possibilities of receiving relevant answers increased. Simultaneously, without e.g. answering alternatives, both herd owners and women had the opportunity to share their individual knowledge and experiences. However, the amount of collected data was massive and one difficulty was to differentiate the relevant questions and answers and write a cohesive thesis. Therefore, though the study was qualitative a more quantitative way of presenting the data where used, e.g. showing the relative frequency for each answer, in order to achieve more structure and ease of understanding.

5.1.1 Sources of error

Since the author did not speak Ma it is one of the major sources of error in this study. Although the same translator was used during all interviews information most certain got lost in translation, as English was neither the translators' first language nor the authors. For instance, answers tended to be quite contradictive, e.g. among the short term management goals only one herd owner stated that she wanted the cattle to produce enough milk. This is contradictive to the results in the long term management goal, where a majority of herd owners wanted to crossbreed to achieve a higher milk production. In addition, the single herd owner that solely focused his herding strategy on fattening of his cows also claimed to have no control over milk off-take. However, he then stated that his interest in milk production was to identify breeds that have a high milk production. Hence, some answers do not seem as thoroughly grounded; yet it is possible that the complete meaning was lost in translation. For instance, perhaps the herd owner wanted a higher milk yield to favour the growth of his calves and thus, the long term meat production. Because of the language issue it is difficult to know for certain that responses given actually answered the question the author intended to ask. However, the author did not perceived that the respondents fabricated answers to be able to answer a question. The herd owners were normally asked questions regarding their herding strategies within the SORALO research project and it is possible that some answers were given automatically and no longer were accurate. On the

other hand, the women were not accustomed to being interviewed and some appeared shy. However, all answers seemed to make sense in the context. Finally, to speak freely with the Maasai would have given a larger flexibility within the interviews.

With a larger number of interviews a more accurate result would probably have been achieved. Perhaps it would have been possible to better distinguish relations between answers or e.g. differences between ages. However, since the Maasai live in remote areas and scattered over great area, it was difficult to access as many as needed considering the time frame of this study. Finally, this study did not have access to data, other than those collected through the interviews, e.g. regarding milk measurements, calf growth, distance travelled and GPS-data. Through the literature study and the interviews, many aspects of this research area could be covered however, it would be beneficial to complement with measurements to discover the actual impact on animal productivity and milk off-take. This study can only rely on the perceptions and answers of the Maasai to draw conclusions.

5.2 What are the herd owners' ambitions with cattle milk production?

5.2.1 Long term and short term management goals

The most common long term management goal was to increase the herd size. Western and Finch (1986) and Allsopp et al. (2007), states that herd owners' emphasis on increasing the herd size. This corresponds to Roderick et al. (1998). They write that pastoralists have implemented strategies, such as increasing herd size, to minimize the risks related to a rangeland based production. However, it is crucial to maintain a balance between the number of heads and the health of livestock. The herd owners need to take into consideration the trade-off between sustaining both animal condition and herd size (Allsopp et al., 2007). Further, seventeen herd owners wanted to crossbreed to achieve a higher milk production, either with the breeds Sahiwal, Frieser or Maasai zebu. In the study area 64 % of the herds consisted of Boran cattle and normally, Boran breeds are strictly for meat production (SORALO, 2012b). Conversely, the main use of Kenyan Maasai and Sahiwal are both milk and meat (Dagris, 2012; SORALO, 2012b) hence, by crossbreeding higher milk production can be achieved. None of the herd owners in this study mentioned choice of residence, which according to Grandin (1988) is one of the most important long-term management decisions.

Among the short term management goals are two goals more common than others: the herd owners wanted the cattle to graze on good quality pastures every day and spray the cattle against vectors, e.g. ticks and tsetse flies. Dyson-Hudson and Dyson-Hudson (1980) states by discovering the best available pastures, herd owners can minimise animal losses and cope with environmental threats such as droughts. In addition, vectors and vector-borne diseases severely affect health and productivity of the livestock. According to Ellis (1987) Australian workers have found that when infested with more than 50 ticks, beef cattle show a loss of 0.65 kg per year and dairy cattle a loss of 180 litres of milk per year. However, different breeds withstand different amounts of ticks (Ellis, 1987) and indigenous zebu breeds, for instance Sahiwal, are more tick-resistant (SORALO, 2012b). The tsetse-borne disease Trypanosomiasis is also a serious problem, especially in Africa (Ellis, 1987). For instance, the disease can cause sickness and mortality among livestock, which indirect constraints the cattle production. This is related to the second most common short term management goal, which was to keep the cattle healthy. The most common

combinations of answers between the questions also indicate that the health of the cattle was a primary management goal.

5.2.2 *Interests in milk production*

Only one herd owner had an interest in the actual milk production, since he kept a breed he knew would produce enough milk to sustain his family. Nonetheless, eight herd owners considered milk production interesting because it allowed them to identify breeds with a high milk production. This enabled them to breed on specific breeds to achieve higher milk yields and indirectly, it could be considered as an interest in the actual milk production. However, most herd owners only saw milk production as a mean to identify unhealthy animals and the quality of pastures, e.g. by attending the milking sessions and monitor milk yields. Simultaneously, a majority of herd owners did not believe they could improve milk production by changing the current herding strategies. They also considered milk to be a secondary product. However, the herd owners favoured a strategy that would maintain fat and healthy cattle and they stated that healthy cows yield higher amounts of milk. A few herd owners also tried to maximise milk production. Thus, even though milk is considered a secondary product the herd owners show a higher interest in milk production than expected.

5.2.3 *Control over milk off-take*

Regarding if herd owners had control over the milk off-take, the most common reply was that they had control. They could tell the women how to milk according to season, health of the calf, and health and production of the cow. Simultaneously, six herd owners had some level of control, but only when the calf was newborn until it reached an age of four months. According to the Maasai, when the calf is four months old it can sustain itself completely on forage and water. These herd owners could give the women instructions on how to milk the stock. For instance, they could tell the women to milk the cow less, maybe only one teat or not to milk at all, if the milk production was low or if the calf was unhealthy. In addition, they could let the calf stay with its mother during the night, if it did not yet eat forage or drink water. The herd owners could also tell the women to increase the milk-out of a high yielding cow to avoid overfeeding of the calf, which could lead to diarrhea. These findings correspond to Grandin (1988). She writes that both woman and herd owner closely monitor the situation of the calf. If the woman appears to milk too much, the herd owner may reprimand her for endangering the calf. Grandin (1988) also writes that Maasai believes the calf can get diarrhea if it consumes too much milk hence, the women have to milk even wild dams. A large intake of milk powder can occasionally cause diarrhea in calves (Phillips, 2010). However, it is not likely that calves suffer from diarrhea because of a large milk intake, since the two major forms of diarrhea are viral or bacterial (Phillips, 2010). The infection is probably brought to them by other cows.

Only the two female herd owners claimed to have all the control of the milk off-take because they also did the milking. Widowed Maasai women can acquire power and prestige as the owner of a cattle herd, especially if they have sons (Gneezy et al., 2008). Notably, the four herd owners that claimed to have no interest in milk production still had control over the milk off-take. Hence, herd owners seem to have a major influence on the milk off-take.

5.2.4 Study question summary

The conclusions are that herd owners' main focus is to maintain a proper overall management of the herd. They aim for healthy, extensive herds rather than a high milk yield. These ambitions correspond to literature. However, a majority still wanted to crossbreed for a higher milk production. In addition, milk was considered a secondary product but was still one of the factors that primarily affected the decisions regarding herding strategies since, herd owners used milk yield to obtain information regarding the general condition of the herds. The herd owners also showed a higher interest in milk production than expected, e.g. by wanting to breed on high yielding cattle breeds and stressing that fat and healthy cows yield more milk. Hence, indirectly milk plays an important part in proper management of the herd. The herd owners also had a more extensive control over milk off-take than expected. Perhaps it did not come across clearly in the answers because the herd owners had not considered the actual impact of milk production or it is not the obvious answer since, traditionally milk is the women's responsibility.

5.3 What are the herd owners' herding strategies and on which factors is their decision-making based?

5.3.1 Grazing

Good quality forage, no predators and an open area are the three main reasons why herd owners choose to graze the cattle in a specific area. In addition, the three main reasons for herd owners not to graze the cattle in a specific area with high quality forage are: predators and tsetse flies, predators and other herds grazing. Other herds grazing were considered negative because of less grass, less space, and it is not comfortable for the cows. These reasons affecting the herding strategies of herd owners are common among literature. Butt et al. (2009) stress that management strategies need to adapt to forage availability. It is crucial since the greatest variations in milk yield depend on the cows' nutritional status, both before and during lactation (Barrett & Larkin, 1974). Next, economical losses due to predation of livestock can be particularly damaging in countries like Kenya, especially on communal rangelands (Maclennan et al., 2009). The impacts of tsetse flies have previously been discussed. Regarding other herds grazing Samuels et al. (2007) discovered that herd owners made an effort not to overlap their home range with other herds. The benefits of avoiding other herds are: prevents spreading of diseases, prevents animals from mixing and competing for the same natural resources. Coppolillo (2000) writes that herds need to travel farther to find sufficient forage if surrounded by other settlements.

No connection could be distinguished between the answers of the two questions, which otherwise could have been presumed to be closely joint.

5.3.2 Watering

The study was conducted during the period of the short rains hence; a majority of herd owners did not have a specific water point or a specific number of times per day when they watered the livestock. They were currently located in areas with good access to water e.g. streams, dams or the swamp Olorishi, and the cattle could drink unrestricted. Naturally, a connection between the two answers could be distinguished. Other common reasons the herd owners considered when choosing a specific water point were: if the water point was

close to the settlement or close to the pastures. These answers correspond to previous studies. For instance, Hendricks et al. (2005) found that pastoral settlements in Richtersveld National Park, South Africa, on average are located 2.4 km from the nearest water point. They also found that large areas of the national park are avoided due to lack of water.

In Olkiramatian and Shompole five herd owners watered their cattle two times a day and they stated several reasons e.g.: the water point was close to the settlement, there was water all around, and the settlement was near forage. According to Grandin (1988) are both the watering frequency and the production of the cow dependent on the distance to the water point. Walking claims both energy and time from cattle (Hendricks et al., 2005) and as the distance increase, energy expenditure, reduced grazing time and less water intake will depress milk yields (Grandin, 1988). For instance, Grandin's (1988) research among the Maasai in Olkarkar, Kenya, shows that a settlement located 2 km from the water point, instead of 7 km, had a 260 ml higher mean milk off-take per cow and day. In the study area there were currently no difficulties accessing water thus, the current circumstances appear favourable for pastoral milk production.

5.3.3 Decisions regarding grazing arrangements

The majority of herd owners in this study made the next days' grazing arrangements in the evening when the herds returned. The remaining four herd owners made the arrangements in the morning before the herds departed for grazing. The most common factor to consider for all herd owners was the abdomen of the cows. For instance, if the cows appear full they will not change the previous days grazing location. In addition to the abdomen, herd owners that made their decision in the morning also distinguished the quality of previous days' forage by looking at milk yield and dung, both size and consistency. Kavana et al. (2005) confirms that if the rumen bulges it is believed that the animals have grazed on good quality pastures. On the other hand, if the cows seem weak or emaciated the herd owner will change the grazing location. However, the bulge of the rumen is not a reliable factor. Ruminants depend upon the rumen microorganism to convert and supply nutrients and when the cow starves or forage has low nutritional value, the microorganisms die or digest the feed insufficiently (Pearson, 1969). For instance, mule deer have been found dead with the rumina full of feed (deCalesta et al., 1974). Though Kavana et al. (2005) settles that milk production is high when animals graze on good quality pastures. Hence, milk yields might be a more secure mean of determining forage quality.

5.3.4 Decisions regarding herd departure and return

In the study area the most common hours for herds to depart from the settlement were 09.00-10.00 and to return 17.00-17.30. The herd owners had several reasons and one of the most common answers were that it was not far to walk to pastures. Next, the second most common departure times was at 06.00-07.00; five herds left because it was not far to walk to pastures and three because it was far to walk to pastures. The second most common time to return to the settlement was 18.00. No relation could be distinguished between the time of departure and the time of return within the study. However, different studies agree with each departure and return hour, indicating that it is a rather individual decision. For instance, Bayer (1990) writes that herds left before 08.00 during the dry season and after 11.00 during the wet season nevertheless, they constantly returned around 18.00. In addition, Butt et al. (2009) recount that herds left at 07.00-09.00 and returned around

18.00-20.00. According to Bayer (1990) the length of the herding day depends on the departure time from the settlements. In the current study the departure times depended primarily on distance to pastures, along with sub factors such as predators, tsetse flies and chores to be done when the herds returned.

Unfortunately, there is no GPS-data available in this study to determine the average walking distance of the herds. However, Adriansen & Nielsen (2002) measured that during wet season the daily distance travelled by pastoral herds were 7 km and during dry season 16 km. In addition, Hendricks et al. (2005) found that the walking distance ranged between 2.86 and 11.40 km. Distance to pasture can according to several sources affect the milk yield negatively. Coulon et al. (1998) and Jung et al. (2002) found that a prolonged walk towards pastures reduce both milk yield and live weight, because of higher energy expenditure due to walking and reduced time on pastures. Both studies found that cows do not compensate by increasing the feed intake. However, Bayer (1990) disagrees and states that cattle in fact do intensify their feed intake and hence, a reduced time on pasture is not likely to limit animal productivity. Di Marco and Aello (1998) writes that the energy saved by walking less distance and the improvement of animal productivity, rather is a result of better pasture management. Nevertheless, the walk to pastures might still affect cattle negatively, e.g. by exposure to heat. When exposed to critical temperatures, approximately from + 26°C, cattle invoke physiological mechanisms to preserve a core body temperature of 38.2°C which reduce both milk yield and growth rates (Phillips, 2010).

5.3.5 Study question summary

When deciding on a grazing location the herd owners consider access and quantity of forage, as well as the safety and welfare of the animals, which correspond to literature. The strategies of herd owners with a restricted access to water also relates to literature. In addition, currently the majority of herds in the study did not walk far to reach pastures. Hence, the milk yield might not be affected negatively by the distance to either water or pastures. Herd departure and return hours corresponded roughly to literature, indicating that it is an individual decision. However, the author is surprised that some herds left late in the midmorning, even though it corresponds to literature. Otherwise, it could be assumed that herd owners would take advantage of all available hours on pasture. However, some herds could not leave earlier because of predators and tsetse flies. The arrangements for next days' grazing are based on the wellbeing of the cattle thus; the juncture of the decision probably does not affect the milk yield. The herd owners are normally attentive to the health of the herds.

Only answers that were the least prioritized could differ between individual herd owners, e.g. reasons for herd departure and return.

5.4 What are the women's ambitions with cattle milk production?

All 32 interviewed women replied that their goal was to maximize the milk off-take available to the household. All women also maximised the milk-out of the teats. This contradicts the findings of Nicholson (1984), Grandin (1988) and de Leeuw et al. (1991). Nicholson (1984) writes that pastoralists in general are reluctant to milk-out the teats of their milking-stock completely, and de Leeuw et al. (1991) that the derived amounts vary. While Grandin (1988) found that among Maasai women in Olkarkar, Kenya, it is common to stop milking after a few minutes and leave the remaining milk to the calf. The level of

milk-out may also be affected by the skill of the woman in the act of milking; a less skilled woman might derive less milk.

Grandin (1988) also establish that women in Olkarkar, on average seem to aim towards a daily milk off-take of 1-1.5 litres. The storage capacity restricts the maximum target off-take in the area. None of the women in this study mentioned such an aim or restriction. However, some women stated that the daily milk-out depended on health and growth of the calf. A healthy, properly growing calf implicates that they can empty the chosen teats available for human consumption entirely. Next, the mean litres of milk the women in Olkiramatian and Shompole stated to need each day were 6.6 litres per day. Five and ten litres a day being the most commonly desired amount. The enormous differences in the desired milk off-take between the two areas of Maasai, could depend on that the women of Olkarkar stated the amount of milk off-take they reasonable could aim to receive every day. While women in this study answered the amount they wished to achieve every day in order to meet their household needs. In addition, Grandin (1988) writes that the target goal could vary with seasons e.g. a lower milk off-take goal in the dry season.

5.4.1 Milk usage within the household

In the study all milk derived from the stock was used for home consumption within the household, which corresponds to literature e.g. Grandin (1988). Additionally, 15 women from ten different households stated that they also sold the surplus milk. According to Grandin (1988), the primary goal of the Maasai pastoralists is milk for home consumption, but also that milk sales might be as important. In the study area the price for one litre of milk fluctuates between 40-60 Kenya Shillings, which according to Forex (2013) currency converter equals 3.17-4.75 SEK. In comparison, the Swedish conventional dairy farmers acquired approximately 3 SEK per litre milk during 2012 (SJV, 2013b). Hence, the selling of milk could make a significant difference in the everyday life of the Maasai household. Milk can also be traded against other foodstuff with equal value. In the studied households no milk were given away, contradicting the findings of Grandin (1988).

A majority of the interviewed women answered that the daily milk off-take was not sufficient for their needs and they wished to acquire more milk. This is consistent with the results discussed above, regarding the target goal of daily milk off-take. A noteworthy result is that 14 women, out of the 15 that sold surplus milk, claimed that the daily milk off-take was not enough. A possible explanation could be that since they desire to sell milk, in addition to home consumption, they require more milk everyday compared to the other households.

5.4.2 Study question summary

The women's ambition with cattle milk production is to maximise the milk off-take available to the household, e.g. by maximizing the milk-out. This does not correspond to literature. However, the milk off-take was restricted by the health and growth of the calf and was not enough to cover the needs of the women in this study. The milk off-take was mainly used for home consumption, which corresponds to literature. The only reason for selling milk, according to the author, is not because of a large milk surplus but the possibilities of gaining cash or trading foodstuff.

5.5 What are the women's milking strategies and on which factors is their decision-making based?

According to Grandin (1988) the Maasai separate the dam and the calf during the night and correspondingly, all women in this study did the same to enable morning milking. Next, all but one woman milked their stock twice per day. This also corresponds to Grandin (1988). However, she also noticed that wealthier households preferred to milk once per day, but this phenomenon was not seen in this study. One woman in Nguruman milked thrice per day, but according to Barrett and Larkin (1974) there is rarely an advantage. In only four households was the number of milked cows lower than the number of lactating cows. The reasons for not milking a cow mostly depended on illness or low production hence; it did not correspond to Grandin (1988). In her study richer women only milked 40 % of the stock. The women in this study appeared to milk all the available cows to maximise milk off-take.

5.5.1 Factors affecting milking strategy and milk off-take

The factors affecting the milking strategies were identical. A majority of women stressed that the milking strategies depend on health of the calf and milk production of the cow. Most women milked fewer teats if the calf was unhealthy or if the cow produced less milk. Conversely, if the cow was healthy and could eat grass and drink water to produce enough milk, the women could increase the number of milked teats. The same factors were also the most influencing when determining the milk off-take. Since the calf has no access to feed supplements or milk substitutes, milk off-take and calf intake need to be carefully balanced (Nicholson, 1984). Grandin (1988) recount that for every kg live weight gain the calf need nine litres of milk however, the benefits are still major. Besides survival and value of the weight itself, a sufficient weight gain might lead to a higher rate of maturity and that heifers go into heat faster. The calves are also essential for milk off-take, since their stimuli are indispensable for milk let down (Nicholson, 1984; Phillips, 2010). In addition, a suckling calf is able to extract residual milk (Phillips, 2010). The increase in milk yield persists even when the calf stops suckling hence; the long term production potential of the dam increase.

In addition, Grandin (1988) writes that the sustainment of the family is an important factor affecting the milk off-take. However, only one woman answered that the milk off-take depends on the children's need and one woman answered that it depends on if the family have enough of other foodstuff. This indicates that the survival of the calf is a main goal of the Maasai women, relating to Grandin (1988).

5.5.2 Milking strategies

The milking strategies in this study differed from woman to woman, e.g. the strategies varied in number of milked teats and age of the calf when the number of milked teats increased. Consequently, the most common milking strategy was only practiced by four women. According to Grandin (1988) the Maasai calf is allowed all the colostrum during the first days. However, it did not occur among the Maasai women in this study. A majority of women milked 1-2 teats more or less completely already from birth, depending on health of the calf and production of the cow. This first stage of milking could last for one week up to three months. Usually, women then milked two teats completely until the end of lactation. A number of women could also milk three teats when the calf reached the

age of four months. Both Dahl and Hjort (1976) and Grandin (1988) found that the milked teats could increase to three when the calf grew older. Nicholson (1984) recount that during the first four months the milk off-take is roughly 30 % of the total milk yield in pastoral herds, but may increase in relation to the calf and the development of a functional rumen. The newborn calf sustains solely on milk and the rumen, reticulum and omasum are underdeveloped compared to the abomasum (Svensk Mjök, 2003). When the calf is 2-3 weeks old it can begin to eat forage and the forage particles start a fermentation process when entering the rumen thus, initiating rumen development (Sjaastad et al., 2003). In Sweden the calves can be completely weaned at an age of 6-8 weeks, assuming feeding was optimal during the first months of life (Svensk Mjök, 2003). For the Maasai it can be difficult to achieve optimal feeding however; the number of milked teats could probably be increased sooner than four months.

An interesting finding was that among the ten women that considered the milk off-take to be sufficient for their needs; five women practiced a milking strategy where the first milking period (before changing the number of milked teats) was when the calf was 0-1 week old. In addition, four women practiced a milking strategy where the first milking period was 0-1 month. Unfortunately, without milk measurements it is impossible to confirm that these two strategies are the most profitable ones. Since milking strategies have a direct impact on the daily milk off-take, small differences may have a major impact e.g. age of calf when increasing the milked teats. For instance, a woman in Nguruman milked three teats when the calf was 0-2 weeks old, two teats until the calf was two months old, and then three teats until the end of lactation. While two women only milked one teat during the first three months and then three teats until the end of lactation. Assumed that both calf and cow are healthy, the woman in Nguruman should receive a higher amount of milk off-take during the lactation period. However, there is a possibility that the other women valued a higher weight gain of the calf, but still all women claimed to try and maximise the milk off-take.

5.5.3 Study question summary

In this section it is also evident that the women's ambition was to maximise milk off-take, e.g. by separating dam and calf during the night and milk all lactating cows available. In addition, another main goal appears to be the survival of the calf and that corresponds to literature. The survival of the calf influences all aspects of the milking strategies but also contributes benefits, such as facilitate milk let down. This also relates to literature. Thus, the factors affecting the decision-making were identical, but the actual milking strategies differed between each woman. The variety of strategies did not correspond to literature, since only one Maasai strategy was found. All factors within the milking strategy have a direct impact on the milk off-take in the household, and the variations in milk off-take might depend on small differences in the milking strategies.

5.6 How do the Maasai manage the dry season and what impact does season have on the milk production of their cattle?

5.6.1 Drought strategies of herd owners

A majority of the herd owners answered that their strategy for managing droughts was to relocate to another settlement closer to pastures. Nguruman, Kajiado, Nairobi and even Tanzania, was mentioned as possible locations where the herd owners might move to find

forage. Apart from the herd owners already living in temporal dry season settlements, all herd owners currently living in permanent settlements stated that they primarily would move to find better pastures. As mentioned earlier, territorial mobility is a vital part of the Maasai adaptability (Talle, 1990). Butt et al. (2009) concludes that Maasai relocating to dry season settlements reduce stress, daily walking distance and daily time spent walking. Probably because the herd owners already have searched the area for patches with forage and can herd the cattle directly to and from pastures. Conversely, Butt et al. (2009) also found that herds from permanent settlements have to walk further during dry seasons thus, increasing the stress on both herdsman and cattle. Hence, it is reasonable to assume that the distance to pastures is a motivation for herd owners in Olkiramatian and Shompole to relocate to a dry season settlement, i.e. following the pastures.

Normally, pastures are the only feed allowed the cattle, but since forage is available in Nguruman during the entire year it is possible to buy hay during the dry season. Therefore, ten herd owners answered that they could buy hay and stay at the same settlement. However, without the proximity to an agricultural area it is doubtful this drought strategy could be implemented. The strategy of selling half the herd, practiced by six herd owners, is reasonable. With fewer animals it is easier to find sufficient forage to sustain the entire herd. Finally, three herd owners, all living close to the swamp, answered that they could cut down branches of *Cordia* trees and feed the leaves to the cattle. Bayer (1990) found that pastoralist in Nigeria also cut down branches of trees to increase the forage available to the cattle. This might compensate for less access to pastures and decrease negative effects on animal productivity.

5.6.2 Milk yield

In this study 28 women discovered a difference in milk yield between the dry season and the wet season. Each woman replied that it depends on the availability of forage. During the wet season there is plenty of fresh forage hence, the cows produce more milk. While during the dry season it is dry and less forage and consequently, the cows produce less milk. This is consistent with literature. Nicholson (1984) writes that dry seasons severely reduce milk yields, due to low nutritional levels and restricted access to water. It is common that milk production is not possible during the entire length of that harsh season (Dahl & Hjort, 1976; Prins & Beekman, 1989). While the wet season and the following of new grass can give rise to a rapid increase in milk yield almost in every stage of the lactation (Nicholson, 1984). Hence, milk production is a function of the different seasons instead of different lactation stages. For Maasai zebus milked twice a day de Leeuw et al. (1991) recount that the average milk off-take of was 1.09 litres per cow and day during wet season and 0.79 litres during dry season. Thus, the annual mean off-take was 0.94 litres per cow and day.

However, four women living in the three households in Nguruman did not discover a difference in milk yield between seasons. One explanation was that cows in the agricultural area always have access to high quality forage and thus, there is no change in milk yield during dry seasons. According to literature it might depend on that Nguruman lies on an altitude. The precipitation in mountains is enhanced compared to lower lying areas, due to higher elevations (Mölg et al., 2009). Therefore, mountains may create a local climate different from the neighboring plains. Samuels et al. (2007) found a similar situation among the pastoralists in Namaqualand, South Africa. The herdsman in this area normally choose a route that will take their livestock to higher lying areas in the mountains. Both the

quality and quantity of forage are better in the mountains, which make higher lying areas a key resource for grazing during droughts.

5.6.3 Changes in milking strategies

Surprisingly, a majority of women in this study claimed they did not change the milking strategy even though the milk yields altered. However, as discussed in the passage above, the milk yields of the cows are almost certain to decrease during dry seasons and affect both milk off-take and milk available to the calf. Since nearly all women stressed that the milking strategies depended on health of the calf and milk production of the cow, most women are likely to change their milking strategies according to these circumstances all the same.

The production of the cow and health of the calf are also the main factors determining the dry season milking strategies. Several women answered that the strategy does not change regarding the older calves, but younger calves are allowed more milk. For instance, the women milk only 1-2 teats and leave 2-3 teats to the calf. While others answered that they increase the number of teats available to all calves, e.g. 2-3 teats. The later strategy appears to be independent of the ages of the calves nonetheless; some women could leave all four teats to a young calf. As previously discussed, it is clear that women in Olkiramatian and Shompole prioritise the survival of the calves, even during droughts. By allowing the calf to suckle an increased number of teats and considering the reduced milk yields of the dams, the amount of milk off-take should be severely reduced.

5.6.4 Study question summary

Since all herds cannot graze in Nguruman, dry seasons have a negative impact on the milk production in a majority of the herds in the study area. This relates to literature. Consequently, both herd owners and women implements different strategies to cope with dry seasons. Corresponding to literature, the herd owners' strategies revolve around finding enough forage to sustain the grown animals, e.g. by following the pastures. Meanwhile, the women's concern is the survival of the calves. However, since almost all women experienced a reduced milk yield it does not seem possible to completely compensate for losses due to the seasons. The milk off-take is reduced to favour the survival of the calf.

5.7 What are the influences of average age at first calving, calving intervals and length of lactation period on the productivity of the cows?

Both herding and milking strategies might have long term effects on the productivity of livestock, e.g. regarding physical aspects such as average age at first calving, calving intervals and length of lactation. For instance, Nicholson (1984) found that a high milk off-take result in a slower calf growth, later puberty and higher age at first calving. A majority of women in the study answered that the heifers' average age at first calving was four years. This corresponds to Roderick et al. (1998); they also found that the average age is four years for Maasai herds in Olkiramatian. In comparison to countries with intensive production, e.g. Sweden, it is nearly twice the age. A majority of women stated that four years is the average amount of time for a heifer to grow to the right birthing size, and nine women answered that it depends on forage quality. Simultaneously, Barrett and Larkin

(1974) writes that at conception the size and weight of the heifer must be sufficient so she may carry a calf without injuries. Thus, an early calving can have permanent negative effects. On the other hand, Barrett and Larkin (1974) also concludes that the total length of time when the cow is productive depends on age at first calving. Hence, the productivity of the Maasai herds is decreased due to the higher age at first calving.

A majority of women answered that the average calving interval was two years, 730 days. While Roderick et al. (1998) found that it was 1.7 years, 609 days, for Maasai herds in Olkiramatian. Barrett and Larkin (1974) and Dahl and Hjort (1976), stresses that inadequate nutrition is the main reason for infrequency in calving. Barrett and Larkin (1974) also states that a calving every twelve months acquires the maximum milk yields from a cow. In addition, length of the lactation period affects the total milk yield significantly (Galukande et al., 1962; de Leeuw et al., 1991). Galukande et al. (1962) concludes that 53-66 % of the total variation in milk yield depends on this factor. According to women in this study the mean lactation period during the wet season was 11 months and 9 months during the dry season. These lactation periods are generally longer compared to literature. Nicholson (1984) states, the typical lactation length for Maasai cattle are 5 months but 7-9 months are the average. Maasai practise natural weaning (Nicholson, 1984) hence, the cows dries themselves off when they do not yield enough to be milked. This is not profitable for the next lactation, since abruptly is the best way of drying off. Finally, as previously discussed the nutritional status of the cows also affect the lactation length.

5.7.1 Study question summary

When compared to literature the Maasai heifers in the study area have a higher age at first calving and the cows have longer calving intervals and lactation periods, than perceived to be beneficial for the maximum milk yield possible. Both herding and milking strategies severely affects these three aspects and hence, the long term productivity of the herd. If these aspects could be improved, the milk off-take available to the Maasai in this area probably would be increased.

5.8 Differences between answers

In general, the herd owners' herding strategies and main ambitions were highly similar in this study. In addition, the answers and ambitions of the women were almost identical, beside the variation in milking strategies. Hence, the conclusion can be drawn that the overall ambitions and strategies were similar for all respondents in the study area.

However, the less prioritised answers could vary, e.g. the reasons affecting herd departure and return and the women's milking strategies differed greatly. Baker and Hoffman (2006) found that the pastoralists in Paulshoek, South Africa, did not practise a common herding strategy. They suggest that even though herd owners utilise the same environmental resources, the individual situations will vary very significantly. Economical resources, social resources, and personal and environmental constraints will greatly affect the daily herding decisions. Which strategy the herd owners then chose to implement depends on the options available, evaluations of costs and benefits and also personal situations, e.g. physical health (Dyson-Hudson & Dyson-Hudson, 1980). There is no reason why the situation should not be the same for the Maasai in Olkiramatian and Shompole, especially since they practise

different levels of territorial mobility. This could be a reason for some of the variations in answers among both herd owners and women.

5.9 Practical implementations

For communities in arid and semi-arid areas pastoralism is considered the appropriate cultural, social, and economical strategy, since it conserves ecosystem services, secures livelihoods, promotes wildlife conservation and honours cultural values (CCADP, 2013). For instance, in areas where pastoralists have been supported by policies, ecosystem and biodiversity has enhanced (CBD, 2010). In addition, pastoral production significantly contributes to export earnings and national economy. However, the value of pastoralism have often been challenged (CBD, 2010) and the economic viability and agronomic potential are directly linked to natural resources and hence, sustainable management of these resources (CAADP, 2013). Pastoralists can be a key in achieving sustainable land management, e.g. since livestock convert low quality forage into economically important products and livestock also recycling nutrients which enhance system productivity. Thus, research is needed to discover the mechanism behind pastoralism production, e.g. decision-making factors, goals, ambitions, and different constraints. Knowledge is needed to overcome obstacles, enhance productivity, maintain sustainability, and prevents wildlife conflicts. The increased human population reduces available land for both pastoralists and wildlife; hence, over-stocking and conflicts are an increased problem.

The results regarding milking strategies in this study are going to be used by SORALO to standardise the measurement of milk off-take in one of their research programs. SORALO utilise milk off-take to indicate how the herd owners grazing decisions during the previous days affect milk yields and productivity of the cows. However, the milking strategies differed greatly and the results from this study only partially corresponded to the literature. In addition, only a few sources were available regarding Maasai milking strategies thus, more research is especially needed in this area. For instance, to discover which milking strategy that is the most profitable strategy, both milk off-take and calf growth need to be measured and compared.

6 CONCLUSIONS

In this study the herd owners' main ambitions, herding strategies and decision-making factors are consistent with each other and also confirm the information obtained in other studies. Another conclusion is that milk production indirectly is one of the factors that primarily affect the decisions regarding herding strategies. The herd owners also have an extensive control over milk off-take and a higher interest in milk production than expected.

In this study the women's main goal, frequency of milking, and decision-making factors are consistent with each other and also confirm the information obtained in other studies. However, the women's main ambition with cattle milk production is to maximise the milk off-take available to the household, but still the milk off-take is not sufficient for a majority of women in the study area. Another finding is that the milking strategies differ with each woman.

The seasonal impact on milk production and the herd owners' dry season herding strategies corresponds to literature. While, women's dry season strategies revolve around the calves. Compared to literature the Maasai heifers in the study area also have a higher age at first calving and the cows have longer calving intervals and lactation periods, than perceived to be beneficial for the maximum milk yield possible.

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APPENDIX 1

Interview questions to herd owners

Basic information

1. Date
2. Name of herd owner
3. Age of herd owner
4. Sex of herd owner
5. Temporal/permanent settlement
6. Number of herd owners
7. Number of wives
8. Number of children
9. Total number of people in the settlement
10. Number of cattle in the herd
11. Number of females in the herd
12. Breeds in herd

Introductory questions

13. When did you move to this settlement (month) and why?
14. What are the long term management goals for your herd?
15. What are the short term management goals for your herd (weekly/daily)?
16. What are your interests in milk production?
17. Do you have any control over how much milk the women are taking from your cows?
18. Do you believe that you could increase the milk off-take if you change the herding strategy from how you normally herd?

Main questions

19. Who herds your herd (hired or family member)?
20. Do you as herd owner sometimes herd your cattle?
21. What are the three main reasons for choosing a specific area to graze your herd?
22. What are the three main reasons why you avoid grazing your herd in a specific area, even if the forage is of good quality?
23. If the rain fails what will your drought strategy be regarding herding and grazing your herd?
24. At what time do you plan for the next day's grazing arrangements and why?
25. What time do your herd leave in the morning and why?
26. What time do your herd return in the evening and why?
27. How do you decide where you water your herd?
28. How many times during the day and at what times do you water your herd and why?
29. To get to a certain grazing area or water point do you follow the same route or do you change? Why?
30. Under what circumstances can the herder change the herd owners' strategy during the day?

APPENDIX 2

Interview questions to women

Basic information

1. Date
2. Name of woman
3. Age of woman
4. Number of lactating cows in the herd
5. Number of calves in the herd
6. Number of cows being milked in the herd
7. If the number of milked cows are less than the total number of lactating cows, why?

Introductory questions

8. How many times during the day are the cows being milked?
9. How long is the average lactation period?
10. What is the milking strategy during lactation?
11. How do you determine the amount of teats available to the calf?
12. How long is the average calving interval?
13. What is the average age at first calving and why?

Main questions

14. What is the goal with the milk off-take?
15. Which factors determines what amount of milk that you derive from the cows?
16. Do you milk the chosen teats completely empty or do you leave milk?
17. How is the milk being used?
18. Does it happen that you need more milk than the cows produce?
19. How many litres of milk do you need every day?
20. Do you separate the dam and the calf during the night for the morning milking?
21. Do you discover a difference in milk yield between the dry and the wet season and how?
22. Does your milking strategy change because of the changes in milk yield between the seasons?

APPENDIX 3

Basic information obtained from both herd owners and women

Table 1. Situation in the 22 settlements; answers to herd owner questions 3-9 and woman question 3.

Household	Sex of herd owner	Age of herd owner (years)	No. of herd owners per herd	No. of wives	No. of women interviewed	Ages of women interviewed (years)	No. of children	Total no. of people in settlement	Temporal or permanent settlement
1	Male	52	4	2	2	48, 74	24	47	T
2	Male	53	1	3	2	24, 47	18	27	T
3	Male	32	1	2	2	28, 31	8	32	P
4	Male	55	1	2	2	42, 48	17	30	P
5	Male	26	1	2	2	22, 24	3	15	P
6	Male	33	2	3	2	28, 32	8	14	T
7	Male	73	1	5	1	48	38	48	P
8	Male	63	1	1	1	43	8	25	P
9	Male	34	1	2	2	20, 30	5	24	P
10	Male	48	1	3	1	34	16	36	T
11	Female	58	1	Widow	1 ¹	58 ¹	5	5	P
12	Male	54	1	2			26	36	T
13	Male	18	1	0	1 ²	43	0	12	P
14	Male	25	1	0	1 ²	49	0	10	P
15	Male	28	1	1	2 ²	20, 56	3	12	P
16	Male	62	2	3	1	24	38	17	T
17	Male	65	1	3	2	52, 58	22	40	T
18	Male	48	1	3	2	32, 42	16	25	T
19	Male	53	1	4	2	47, 52	14	24	T
20	Female	68	1	Widow	1 ¹	68 ¹	4	7	T
21	Male	30	1	2	1	24	6	28	T
22	Male	28	1	1	1	24	0	6	T
Mean		45.7		2.2		39.8	12.7	23.6	

¹The herd owner is a widowed woman hence; she was interviewed both as herd owner and as woman in charge of milking.

²If possible was the interview conducted with the herd owners' mother when the owner was not married or only had one wife.

Table 2. Description of the herds of the studied household; answers to herd owner questions 10-12 and woman questions 4-6.

House- Hold	Herd size		No. of lactating cows	No. of calves	No. of milked cows	Cattle breed
	(No. of heads in household ¹)	No. of female cattle				
1	123	80	20	20	15	Boran
2	26	14	5	5	4	Crossbreed
3	36	21	12	12	12	Crossbreed
4	20	10	7	7	7	Crossbreed
5	35	24	9	9	9	Boran
6	160	120	40	40	40	Boran
7	15	11	5	5	5	Crossbreed
8	14	11	5	5	5	Boran
9	19	14	3	3	3	Boran
10	70	50	20	20	20	Crossbreed
11	20	15	5	5	5	Boran
12	52	41				Boran
13	24	17	6	6	6	Boran
14	11	7	3	3	3	Boran
15	10	5	3	3	3	Boran
16	120	100	30	30	30	Crossbreed
17	100	85	20	20	20	Boran
18	30	26	8	8	8	Boran
19	68	58	18	18	14	Sahiwal
20	37	34	5	5	4	Boran
21	12	11	3	3	3	Crossbreed
22	40	38	3	3	3	Boran
Mean	47.4	36.0	11.7	11.7	11.1	

¹The number of heads that the herd owner was responsible for, sometimes the cattle of the herd owners' brothers could be included. In addition, all households had a number of goats, sheep, and donkeys.

Table 3. Reasons why four households did not milk all lactating cows, according to woman question 7.

Household	Reason for not milking a lactating cow
1	The cow does not produce enough milk to sustain her calf and being milked
2	The teats are infected by a tick bite
19	The herd owner wants a male calf for breeding hence, they do not milk the mother
20	The cow does not produce enough milk to sustain her calf and being milked

APPENDIX 4

Answers obtained from herd owners

One herd owner may have given several answers; each bar shows the proportion of herd owners that gave that specific answer.

Table 1. Reasons why the herd owners chose to move to the current settlement, according to herd owner question 13.

Reasons for moving	Number of responses	Relative frequency (%)
No grass left around previous settlement	8	36
Changed the position of previous settlement	8	36
Following better pastures	3	13
No water left around previous settlement	3	13
To access their own field for growing crops	1	5

*41 % of the herd owners moved to the current settlement more than two years ago, the rest moved during Jun, Aug, Sep, Nov and Dec 2012.

Table 2. Long term and short term management goals of the herd owners, according to herd owner questions 14 and 15.

Herding strategy area	Answer	Number of responses	Relative frequency (%)
Long term management goals (question 14)	Increase the herd size	21	96
	Crossbreed to achieve a higher milk production, either with the breeds Sahiwal, Frieser or Maasai zebu	17	77
	Crossbreed for larger size/ more meat, exclusively the Boran breed	14	64
	Crossbreed for a higher resistance to both climate and vectors, exclusively the Maasai zebu	3	13
	Remain with the same breed	3	13
	Crossbreed to achieve a higher selling price	2	9
	Keep a manageable herd size and suitable breeds for droughts	1	5
Short term management goals (question 15)	Graze the cattle on good quality pastures	20	91
	Spray the cattle against vectors	20	91
	Keep the cattle healthy	12	55
	Have sufficient medicine to treat unhealthy cows	3	13
	Fattening the cattle	3	13
	Provide adequate water	1	5
	Avoid predators and vectors	1	5
	Make the cattle produce enough milk	1	5
	Sell animals to acquire money for saving	1	5
Have a good herder	1	5	

Table 3. Herd owners' interests and utilisation of milk production, according to herd owner question 16.

Answer	Number of responses	Relative frequency (%)
Low milk off-take can indicate unhealthy animals	11	50
Milk off-take can indicate the quality of pastures	11	50
Identify breeds for breeding that produce enough milk	8	36
No interest, it is the women's business	7	32
Own a breed that produce enough milk to sustain the family	1	5

Table 4. Level of control the herd owners had over the amount of milk off-take that the women milk, according to herd owner question 17.

Answer	Number of responses	Relative frequency (%)
Has control. The herd owner can instruct the women how to milk according to season, health of the calf and production/health of the cow	10	46
Has control when the calf is very young	6	27
Has no control	4	18
Has all the control	2	9
If the calf is a bull that the herd owner want for breeding he can instruct the women not to milk the dam	1	5

Table 5. If the herd owners believed they could benefit the milk production by changing their current herding strategy, according to herd owner question 18.

Herding strategy area	Answer	Number of responses	Relative frequency (%)
Benefit milk production by changing herding strategy	No	21 ¹	95 ¹
	Yes	1 ²	5 ²

¹Of these herd owners 95 % considered milk a secondary product however, they believed that they were already maximising the milk production by herding for healthy and fat cattle. Next, 24 % of these herd owners also answered that they tried to maximise the milk production.

² The herd owner focused solely on fattening his cattle.

Table 6. Identity of the person herding the herd owners' cattle and during what circumstances the herder might change the herd owners' strategy during the day, according to herd owner questions 19, 20 and 30.

Herding strategy area	Answer	Number of responses	Relative frequency (%)
The person herding the cattle (question 19)	Family member, almost exclusively sons	14	64
	Hired herder	6	27
	The herd owner himself	2	9
If the herd owner herd his cattle (question 20)	Herds the cattle at least sometimes per month	17	77
	Do not herd the cattle	5	23
During these circumstances might the herder change the herd owners' strategy during the day (question 30)	Allowed to change the strategy when needed, e.g. the presence of predators, the cows walk in a different direction, or if the cows are not grazing comfortably	12	54
	During no circumstances	9	41
	Only if the forage is of low quality	1	5

Table 7. Herd owners' three main reasons for grazing and not grazing in an area, according to herd owner questions 21 and 22.

Herding strategy area	Answer	Number of responses	Relative frequency (%)
Three main reasons for grazing the cattle in an area (question 21)	Good quality forage as the most important reason	8	36
	No predators as the second most important reason	9	41
	Open area as the third most important reason, because it is safer and have less disturbances	5	23
Three main reasons for not grazing the cattle in an area with good quality forage (question 22)	Both predators and tsetse flies as the most important reason, had equal number of responses	8 ¹	36 ¹
	Predators as the second most important reason	7	32
	Other herds grazing as the third most important reason, because of less grass and space and it is not comfortable for the cows	6 ²	29 ²

¹Both answers (predators and tsetse flies) each achieved eight responses.

²Only 21 herd owners gave a third reason hence; the relative frequency was calculated for 21 herd owners.

Table 8. Drought strategies of the herd owners, according to herd owner question 23.

Answer	Number of responses	Relative frequency (%)
Move to another settlement closer to sufficient pastures. Some herd owners could name a location but most of them not, since the grass will determine the move	19	86
Buy hay and remain at the same settlement	10	46
Sell animals, save the money and buy new animals during the wet season	6	27
Feed the cows with branches of leaves from the Cordia tree	3	13
Divide the herd into smaller groups thus, the cows can graze smaller patches of grass	1	5
Search for pastures close to the current settlement	1	5
Have a fenced field in store for dry season grazing	1	5
Sell half the herd, buy hay to the remaining cattle and buy new animals during the wet season	1	5

Table 9. When the herd owners made the arrangements for next day's grazing and in addition, the hours when the herds left and returned to the settlement, according to herd owner questions 24-26.

Herding strategy area	Answer	Number of responses	Relative frequency (%)
When the herd owners made the arrangements for next days' grazing and why (question 24)	The grazing arrangements were made in the evening and they considered the abdomens of the cows, i.e. if the cows appeared full	18 ¹	82 ¹
	The grazing arrangements were made in the morning and they considered the abdomens of the cows, i.e. if the cows appeared full	4 ²	18 ²
The time when the herds left in the morning (question 25)	09.00-10.00	10 ³	46 ³
	06.00-07.00	8 ⁴	36 ⁴
	08.00-08.30	4 ⁵	18 ⁵
The time when the herds returned in the evening (question 26)	17.00-17.30	16 ⁶	72 ⁶
	18.00	5 ⁷	23 ⁷
	19.00	1 ⁸	5 ⁸

¹Of these herd owners 6 % also looked at the mood of the cows i.e. if the cows appeared satisfied, and 6 % of these herd owners also looked at the behaviour of the cows e.g. if not satisfied they might try to graze inside the settlement.

²Of these herd owners 75 % looked at the dung to distinguish the quality of previous days' forage. They considered both size and if it was dry (the forage was not good) or soft (the forage was good). Next, 50 % of these herd owners also looked at the milk yield in the morning.

³Of these herd owners 60 % left at this time because it was not far to walk to pastures, 50 % because the settlement was located near thick bushes and gave predators time to withdraw and finally, 50 % because the tsetse flies are less active in sunlight.

⁴Of these herd owners 63 % left at this time because it was not far to walk to pastures, and 38 % because it was far to walk to pastures.

⁵All of these herd owners left at this time because it was not far to walk to pastures.

⁶Of these herd owners 56 % returned at this time so they had time to identify unhealthy cows and begin treatment, 56 % so that the herder had time to count all cows and look for missing ones, 50 % because it was not far to walk home, 31 % because they needed to be home before the predators became active, 31 % because they needed to be home before the tsetse flies became active and finally, 25 % because the cows were full.

⁷Of these herd owners 60 % returned at this time because they needed to be home before the predators became active, 60 % so that they could stay at the pastures as long as possible, and 40 % because it was not far to walk home.

⁸All of these herd owners returned their herds at this time because it was far to walk home from pastures.

Table 10. Why the herd owners chose a specific water point and the number of times they watered the cattle, according to herd owner questions 27 and 28.

Herding strategy area	Answers	Number of responses	Relative frequency (%)
How the herd owners chose water point (question 27)	No specific water point, because water was all around and the cattle could drink unrestricted, e.g. in dams or the swamp	15	68
	The water point was close to the settlement	6	27
	The water point was close to the pastures	5	23
	The water point was the only one available in the area	2	9
The number of times the herd owners watered their herds per day (question 28)	No specific number of times because water was all around and the cattle could drink unrestricted	15	68
	Watered the animals two times per day because: cattle graze better if they drink, the water was close to home, there was water all around, they watered in the morning when they crossed the river and then again when they crossed back and finally, because forage was close to the settlement	5	23
	Watered the cattle three times per day, because there was water all around and the cattle could drink unrestricted	1	5
	Watered the animals one time per day, because the pastures were green and the cattle did not need to drink as much because of the water in the vegetation	1	5

Table 11. If the herd owners needed to follow a specific route to reach a certain grazing or watering location and why, according to herd owner question 29.

Answer	Number of responses	Relative frequency (%)
No routes or crossing points because they lived in an open area	10	46
Had some focal crossing points e.g. because of thick bushes and the river Ewuaso-ng'iro	9 ¹	41 ¹
Needed to follow the available roads because they lived in the agricultural area Nguruman, e.g. the risk of trespassing or grazing other people's crops was high	3	13

¹Of these herd owners 89 % said that it depended on the location of the intended grazing and watering area, and 11 % of these herd owners had a crossing point because it was close to the settlement.

APPENDIX 5

Answers obtained from women

One woman may have given several answers; each bar shows the proportion of women that gave that specific answer.

Table 1. Average lactation period in months during both wet and dry season according to each woman in the households, the results of woman question 9.

Household	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	22
Woman 1																					
Wet	12	12	9	12	6	12	12	9	12	12	12	12	12	8	12	12	12	12	12	12	12
Dry	14	8	7	9	9	12	9	6	9	12	8	12	12	8	8	8	9	8	8	9	9
Woman 2																					
Wet	12	9	9	12	12	12			12					8		12	12	12			
Dry	14	12	9	9	9	9			9					8		8	8	8			

*The mean lactation period was 11 months during the wet season and 9 months during the dry season.

Table 2. Milking strategies of the women, according to woman question 10.

Answer	Number of responses	Relative frequency (%)
0-1 month old calf: she milks one teat completely, depending on the production of the cow. 1 month–4 months old calf: she milks two teats completely. 4 months old calf: she milks three teats completely until the end of lactation	4	13
0-1 week old calf: she milks 1-2 teats completely if the cow produces enough milk, or she milks two teats but not completely. 1 week–1 month old calf: she milks 1-2 teats completely or not, depending on the production of the cow. 1 month old calf: she milks two teats completely. Two women said that they started to milk three teats completely after two and four months respective, until the end of lactation	3	9
0-3 weeks old calf: she milks one teat completely (one woman milked one teat three times per week). 3 weeks–2 months old calf: she milks two teats but not completely. 2 months old calf: she milks two teats completely until the end of lactation	3	9
0-1 month old calf: she milks one teat completely (sometimes one woman could leave a little milk in the teat for the calf in the morning). 1 month old calf: she milks two teats completely until the end of lactation. At this age the calf is old enough to sustain itself on forage and water	3	9
0-1 week old calf: she milks 0-2 teats depending on the production of the cow. 1 week–4 months old calf: she milks 1-2 teats depending on production of the cow. 4 months old calf: she milks three teats completely until the end of lactation. The calf can sustain on grass at this age	2	6
0-2 weeks old calf: she milks 1-2 teats completely or not (one woman from Nguruman milked one teat in the morning and two teats in the evening, to ensure that the calf can sustain itself during the day. The Maasai believe that the calf's digestion is higher during the day). 2 weeks old calf: she milks two teats completely until the end of lactation	2	6
0-2 weeks old calf: she milks one teat completely. 2 weeks–3 months old calf: she milks two teats completely (one woman milked one teat completely and the other woman did not). 3 months old calf: she milks three teats completely until the end of lactation	2	6

0-2 months old calf: one woman milks one teat completely and the other milks two teats but not completely (during dry season she does not milk the cow at all when the calf is at this age). 2 months old calf: she milks two teats completely until the end of lactation	2	6
0-3 months old calf: she milks one teat completely. 3 months old calf: she milks three teats completely until the end of lactation	2	6
0-1 week old calf: she milks 0-2 teats but not completely, depending on production of the cow (low production and she leaves all the teats for the calf). 1 week–2 months old calf: she milks two teats, but not completely since the calf do not eat forage. 2 months old calf: she milks two teats completely until the end of lactation, depending on the health of the calf (if not healthy she will not empty the teats completely)	1	3
0-1 week old calf: she milks 1-2 teats depending on production of the cow (high production and she milks two teats). 1 week–3 months old calf: she milks two teats completely. 3 months old calf: she milks three teats completely until the end of lactation	1	3
0-4 days old calf: she does not milk the cow. 5 days–1 month old calf: she milks one teat completely. 1 month old calf: she milks two teats completely until the end of lactation (sometimes three if the production of the cow is high)	1	3
0-2 weeks old calf: she milks two teats completely, if milk production is high and if she does not give all teats to the calf. 2 weeks–4 months old calf: she milks two teats completely. 4 months old calf: she milks three teats completely until the end of lactation	1	3
0-2 weeks old calf: she milks three teats completely (in Nguruman milk production is high and can be unhealthy for young calves). 2 weeks–2 months old calf: she milks two teats but not completely. 2 months old calf: she milks three teats completely until the end of lactation	1	3
0-3 weeks old calf: she milks two teats but not completely (if the production of the cow is low the calf is allowed all the teats). 3 weeks–3 months old calf: she milks two teats completely. 3 months old calf: she milks three teats completely until the end of lactation	1	3
0-1 month old calf: she does not milk the cow at all, but pet her so she will not become aggressive. 1 month–3 months old calf: she milks two teats but not completely. 3 months old calf: she milks three teats completely until the end of lactation	1	3
0-1 month old calf: she does not milk the cow at all. 1 month–4 months old calf: she milks one teat completely. 4 months old calf: she milks two teats completely until the end of lactation	1	3
0-1.5 months old calf: she does not milk the cow at all but touches the teats so she will not be aggressive. 1.5 months old calf: she milks two teats completely until the end of lactation. The calf is old enough to sustain itself on forage and water	1	3

Table 3. Remaining introductory questions regarding number of milking sessions per day, factors affecting the number of teats allowed to the calf, average calving interval and average age at first calving, according to woman questions 8, 11, 12, and 13.

Questions	Answer	Number of responses	Relative frequency (%)
Number of milking sessions per day (question 8)	Milk twice per day	31	97
	Milk thrice per day	1	3
Factors affecting the milking strategy (question 11)	Health of calf	29	91
	Milk production of cow	25	78
	Calf is old enough to sustain itself on grass and water	1	3
Average calving interval (question 12)	24 months interval	29	91
	16 months interval	3	9
Average age at first calving (question 13)	4 years	26	81
	3 years	4	13
	5 years	2	6

Table 4. Factors affecting the heifers' average age at first calving, according to woman question 13.

Answer	Number of responses	Relative frequency (%)
The average amount of time required for a heifer to grow to the right birthing size	21	66
Depends on the quality of forage, e.g. good quality forage allow the heifer to grow faster and thus, come in heat faster	9	28
The normal age to give birth; the heifer is too young before this age	3	9
Depends on the climate, e.g. in hot climates the heifer come in heat faster compared to in colder highlands	1	3

Table 5. Women's goals with the milk production and parts of the milking strategies, according woman questions 14, 16-20.

Question	Answer	Number of responses	Relative frequency (%)
Women's goal with milk production (question 14)	Maximise milk off-take	32	100
If the women maximise the milk-out of the available teats (question 16)	Maximise milk-out	32	100
How the milk off-take is used (question 17)	Home consumption within the household	32	100
	Sell surplus milk	15	47
If the women sometimes need more milk than the cows produce (question 18)	Milk off-take is not sufficient for their needs and they need more milk	22	69
	Milk off-take is sufficient for their needs	10	31
How many litres of milk the women require each day (question 19) ¹	5 litres of milk	7	25
	10 litres of milk	7	25
	4 litres of milk	5	18
	6 litres of milk	4	14
	3 litres of milk	2	7
	2 litres of milk	1	4
	7 litres of milk	1	4
	20 litres of milk	1	4
If the women separated the calf and the dam during the night to favour morning milking (question 20)	Yes	32	100

¹Only 28 women were asked this question hence; the relative frequency was calculated for 28 women.

Table 6. Factors determining the amount of milk off-take, according to woman question 15.

Answer	Number of responses	Relative frequency (%)
It depends on the milk production of the cow	29	91
It depends on the health situation of the calf	25	78
It depends on if they have visitors (extra people) in the household	2	6
It depends on the children's need of milk	1	3
It depends on if they have enough of other foodstuff, e.g. vegetables	1	3
It depends on the size of the calf	1	3

Table 7. Remaining main questions regarding if the women discovered a difference in milk yield between the wet and the dry season and if they changed their milking strategies in relation to these differences, according to woman questions 21 and 22.

Question	Answer	Number of responses	Relative frequency (%)
Discover a difference in milk yield between the seasons (question 21)	Yes	28	88
	No	4	12
How and why the milk yield differed (question 21) ¹	During the wet season there is plenty of fresh forage hence, the cows produce more milk. While during the dry season it is dry and less forage and consequently, the cows produce less milk	28	97
	No difference, since in Nguruman the cows have access to high quality forage all year	1	3
Changing the milking strategy according to these differences (question 22)	Yes	13	41
	No	19	59

¹Among the four women that answered that they did not discover a difference in milk yield, only one gave an explanation and hence, the relative frequency was calculated for 29 women.

Table 8. Changes in women's milking strategies in relation to the seasons, according to woman question 22.

Change in milking strategy	Number of responses	Relative frequency (%)
No change in milking strategy, even if the milk yield altered	19	59
Dry season: for older calves the milking strategy does not change. For the young calves the strategy changes to allow them more milk, e.g. the woman milk only 1-2 teats and give 2-3 teats to the calf. One woman could leave all four teats to the calf, because during the dry season the cows produce less milk and young calves do not eat enough forage to sustain themselves	6	19
Wet season: the cows produce more milk and hence; the woman can apply her usual milking strategy or milk 2-3 teats and leave 1-2 teats to the calf. Dry season: she milks 1-2 teats and leaves 2-3 teats to the calf (a decreased number of teats are being milked. If it is a really small calf some women leave all four teats to the calf)	6	19
Wet season: it depends on the size of the calf. She milks all four teats but not completely if it is a big calf. Dry season: she give all teats the calf	1	3

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