AN ANALYSIS OF CAMEL CALF GROWTH AND SURVIVAL UNDER PASTORAL CAMEL PRODUCTION SYSTEMS IN SAMBURU

BY

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Thesis submitted to the University of Nairobi in partial fulfilment of the requirement of the Masters of Science degree in Livestock Production Systems

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May 2010
Declaration

I declare that this thesis is my original work and has not been presented for a degree in any other University.

Mungai Ihuthia ...

This thesis has been submitted for examination with our approval as University supervisors.

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Department of Animal Production

2. Prof. M.M. Wanyoike, PhD ...

Department of Animal Production
Dedication

To my dear wife Hannah Nyambura for her great encouragement and moral support and to our daughters, Teresia Nyakanyi, Esther Wakonyo and Precious Soki who had to bear with my absence from home while pursuing the studies.
Acknowledgement

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<th>Description</th>
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<tbody>
<tr>
<td>ADG</td>
<td>Average Daily Weight Gain</td>
</tr>
<tr>
<td>ALPRO</td>
<td>Asal Based Livestock and Livelihood Support Project</td>
</tr>
<tr>
<td>AL</td>
<td>Arid and Semi Arid Lands</td>
</tr>
<tr>
<td>CBS</td>
<td>Central Bureau of Statistics</td>
</tr>
<tr>
<td>DP</td>
<td>Director of Livestock Production</td>
</tr>
<tr>
<td>DLPPO</td>
<td>District Livestock Production Officer</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agricultural Organization</td>
</tr>
<tr>
<td>GOK</td>
<td>Government of Kenya</td>
</tr>
<tr>
<td>KARI</td>
<td>Kenya Agricultural Research Institute</td>
</tr>
<tr>
<td>KCA</td>
<td>Kenya Camel Association</td>
</tr>
<tr>
<td>KCF</td>
<td>Kenya Camel Forum</td>
</tr>
<tr>
<td>MLDD</td>
<td>Ministry of Livestock Development</td>
</tr>
<tr>
<td>MLDD SP</td>
<td>Ministry of Livestock Development Strategic Plan</td>
</tr>
<tr>
<td>NALEP</td>
<td>National Agriculture and Livestock Extension Programme</td>
</tr>
<tr>
<td>TLU</td>
<td>Tropical Livestock Unit</td>
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</table>
Abstract

Survey was conducted to document traditional camel and camel calf management practices in Opiroi, Barsaloi and Kawop locations. The data was collected using a structured questionnaire. Linear measurements and actual live weight of the camel calves were taken so as to estimate correlations that could be used in determining calf weight. It was observed that the communities in the study area kept camels, cattle and small stock to optimize range resource use. Male animals constituted a high proportion for different livestock kept at 73% for camels, 65% cattle, 75% for goats and 72% for sheep. The respondents reported no specific breeding programme for the camels. Breeding of closely related camels was reported by 52.15% to 60.15% of the poor and rich wealth categories of respondents suggesting inbreeding. Abnormalities may be related to inbreeding were reported. Feed availability was reported by 76.6% of respondents to vary with season, with the wet season providing more feed than the dry one. The oral feed scarcity was reported to cause camels to feed on poisonous plants. A common, but non-toxic plant, *Capparis tomentosa*, was reported to form a significant component of the animals’ diet during the dry season. A need to explore its usefulness as feed and find ways of mitigating its poisonous effects was identified. Herding of camels to pasture was constrained by pasture scarcity forcing restricted grazing of calves. Calf nutrition was further aggravated by competition with humans for the milk; a situation made more difficult where a market for milk existed. Either because of tradition or due to scarcity of animal health and extension services, the respondents were dependent on ethno-veterinary practitioners. Camel calves had an ADG of 212 g/day up to weaning at 8 months. The male calves had a higher ADG (281 g/day)
the females (168 g/day). The vegetation condition at birth, significantly (P<0.05) affected camel calf growth and survival. The mortality rates of camel calves remained unacceptably high an average of 50% and were higher for male calves at 56% than female calves at 43%. The mortality could be due to such reported practices reported as colostrum denial, milk access ation, malpresentation during birth and mismothering. The correlation of predicted weights the actual live weights was high (r = 0.963) for the general regression equation derived from three linear body measurements of abdominal girth, heart girth and shoulder height bined. Abdominal girth coefficient of determination R² was high (91.4%) than heart girth (6) and shoulder height (17.2%), making it the best single weight predictor. The findings mined intervention points for improving camel calf growth and survival.
CHAPTER ONE

General Introduction

Camels overcome the challenges of water, feed shortage and high temperatures characteristic of
\textit{aridity} by their anatomical, behavioural and physiological adaptations (Payne, 1990; Wilson,
1993; Field, 1993; Field, 2005). These adaptations are useful only when the calves born survive
grow to maturity. Calf survival is very important for it ensures herd progression and in the
term, benefits of camel ability to survive in arid condition are realized. Without offspring
we would be no perpetuation of life and more so of such an important animal which have
adapted to harsh conditions of arid and semi-arid lands (ASALs). Camel calf rearing is a
challenge to the pastoralists in northern Kenya and is reflected in high calf mortality rates
(Wilson, 1984; Kuria, 2004). When the calf mortality is more than 15\%, it is time to intervene
(Payne, 1990, Ndungu \textit{et al.}, 2001). Calf survival is crucial for certainty of future of pastoralists’
role source of livelihood. Milk is the main product from the camels, a source of food not only
the calves but also for pastoralists’ households. So to the weak and most vulnerable groups of
people; the women, children and the elderly who cannot follow cattle to the grazing satellite
\textit{barras} (Wilson, 1984; Payne, 1990; Evans, 1995). The death of the calf affects the volume of
milk produced by the dam (Simpkin, 1998).

The high calf mortality in pastoral camel rearing system is among the major challenges
pastoralists kept highlighting in different camel fora. The pastoralist experiences 37\% to 73\%
mortality rates in female and male camel calves, respectively (Schwartz and Walsh, 1992). The
problem is further compounded by the fact that camels are spreading to the southern range lands
which are much more humid than the traditional camel home range (Schwartz, 1992; Field,
2005), where calf mortality is expected to be even higher. The causes of this calf mortality were
ght to be due to health and nutrition (Schwartz and Walsh, 1992). From a participatory epidemiology study on camel calves of the Samburus and Rendilles semi nomadic pastoral livestock production systems, it was concluded that health alone could not be expected to improve on growth rate of the camel calves if other measures were not integrated in the intervention packages (Nanja et al., 2003).

Hence, improving survival and high growth rate of camel calves would guarantee increase of the camel herd, a resource for the pastoral livelihood. Therefore, this study analyzed and documented the pastoral camel production system, investigated the factors responsible for growth and survival of camel calves, and generated a simple to use equation for estimating camel calf live weight. This assessment of traditional camel calf management will form basis of possible improvement in pastoral camel calf rearing and provide valuable repository of traditional knowledge that is important for management of camel calves.

References:


CHAPTER TWO

Literature Review

Samburu district

Samburu district lies on 0°4' and 2°31'N, 36°20' and 38°10'E neighbouring Turkana in the west, Baringo in the southwest, Marsabit in the northwest, Isiolo in the east and Laikipia in south. Samburu district has a surface area of 21,000 km²; it is administratively divided into 6 divisions and 39 locations. Human population is estimated at 175,350 of whom 80% live in the areas (CBS, 2002). Livestock rearing is the mainstay of the livelihoods in the district; most bitants are Samburus and Turkanas who are essentially pastoralists. Eight percent (8%) of district is considered as high rainfall area receiving over 875mm p.a. and is used in limited production and forestry. The rainfall is erratic at times coming in storms and mostly equate for crop farming. The rest of the district is considered rangelands, best utilized for extensive livestock production or wildlife exploitation (Shaabani and Walther, 1992).

Classification and Geographic distribution of camels in the World

Camels belong to order Artiodactyla, sub-order Tylopa and family Camelidae. Camel species of genera camelids (old world camels) found in the world are; Camelus dromedarius (one humped) and Camelus bactrianus (two humped). C. dromerius is found in the hot deserts and C. brianus in the cold deserts of Asia. The other genera of Illamoids (new world camels) consists of species: Guanaco (Lama guanaco), Vicuna (Vicuna vicuna), which are wild; and Llama glama), and Alpaca (Lama pacos) which are domesticated (Wilson, 1984; Kuria, 2004; Deh and Dawa, 2004; Larson and Judith, 2004). The lamoids are found in the cold heights of
Latin America (Wardeh and Dawa, 2004). Camels found their way to Kenya from Somalia and domestication in Southern Arabia between 1 and 4 B.C. (Bulliet, 1975; Wilson, 1984; Kuria 2004).

2.3 Camel population and breeds in Kenya

There are three breeds in Kenya; Turkana, Rendille/Gabbra, Somali, based on the tribes who keep them. However, genotypic and phenotypic differences exist among them (Simpkin, 1998; Simpkin, 1998; Hülsebusch et al., 2002; Kuria 2004). Phenotypic differences especially the body measurements were clear for all camel breeds (Hülsebusch et al., 2002). Hanotte and Mburu (2002) separated the Kenyan camels into two groups, the Rendille and the Gabra on one group and the Somali and Turkana on the other though number of markers were few. Further analyses separated the camels into two groups; Somali and Gabra – Rendille – Turkana (Mburu et al., 2003) The Somali type is further classified into four namely Hoor, Siifdaar, Gelab and Eydimmo based on milk production, lactation length, age to attain sexual maturity, hardness and weight gain (Hussein, 1993; Adams and Kaufmann, 2002). Rendille distinguish four different types among the Rendille camels; Dabach, Godan, Coitte and Aithimaso (Adams and Kaufmann, 2002) and bases their classification on milk yield, fitness during rainy and dry season and season tolerance. Gabbra too have four different types namely Qorti, Mirgissa, Baku and A and bases their classification on performance, morphology and adaptations (Adams and Kaufmann, 2002).

Kenya has an estimated camel population of 2,200,000 (KNBS, 2010) which constitutes 10% of domestic herbivore biomass (MoLD, 2008). Camels formed 5.5% of total TLU in Samburu district (MoLD, 2008). Camels are spreading to the southern range area formerly outside
Problems related to camel rearing are likely to increase posing greater challenge to the industry.

2.4 Camel production in Samburu

The camels are mainly kept in low land comprising 92% of the total area of Samburu district (Shaabani and Walther, 1992). The camels are fed mainly on natural vegetation and especially shrubs and forbs of semi arid and arid regions. The area lies in agro- ecological zones (AEZ') to VI. The Turkanas and the Samburus nomadic pastoralist exploit these grazing areas which are most suited for keeping livestock. The vegetations have adapted into utilizing the scarce moisture and are in form which is not palatable to most livestock except the camel and may be goats and wildlife which have adapted to aridity (Shaabani and Walther, 1992: Herlocker, 1992).

The most common strategy by pastoralists to cope with drought is herd mobility which aims at making use of spatially different vegetation type and productivity in variant places (Galvin et al., 2001; Mworia & Kinyamario, 2008). The access to different vegetation species and productivity ensures maintenance of livestock population stability and body condition (Ellis & Swift, 1987) and maximizes use on available feed resource in the range.

2.5 Adaptation of the camel and its potential as a source of food for pastoralists

Due to its drought resistance qualities the camel has high potential as a source of food for communities in ASAL which, in many situations, would be effectively utilised for livestock keeping. The adaptation to the adverse weather conditions (Payne, 1990; Wilson, 1984; Field et al., 2005) enables the camels to provide milk for families in the pastoral areas especially during dry/drought periods. Camels are rarely slaughtered except on ceremonies. In comparison with
other livestock, the potential of camels is mostly under-estimated due to lack of information on meat and milk production. A major reason for this is that most camel products never reach the market but are consumed within the producer community, and where these are traded, they are exchanged in kind instead of cash (Schwartz and Walsh, 1992). The camel will stay longer without water and have a variety of shrubs and acacia trees to feed on unlike cattle which graze and have to be watered every third or fourth day (Grandin et al., 1991; Tolera and Ab), 2007). When the grass is depleted the grazers, that is cattle and sheep suffer shortage of feed and have to migrate in search for pasture unlike the browsers, (that is camels and goats), which feed on deep rooted browse species that remain green longer into the dry season.

2.6 Camel calf mortality and colostrum

High camel calf mortality has been associated with denial of access to colostrum after birth (Wilson, 1998). A study done on a Kenyan ranch showed that low colostrum intake in the first 24 hour of life and not low immunoglobulin G (IgG) concentration presumably causes early mortality (Kamber et al., 2001). The average IgG concentration in the camel colostrum is higher than that recorded in the literature for cattle and horses (Kamber et al., 2001). Within 24 hour of birth the stomach of the calf can absorb the whole molecule of the antibodies protein without digesting it (Kamber, 1995). Beyond this period the intestinal lining of the newly born becomes increasingly impermeable to the immunoglobulin. Most of the absorption takes place within the first 12 hour and by 24 hour the intestinal closure is almost complete. It was observed by Kamber et al., (2001) that the IgG concentration reaches maximum level in serum of the camel calves within 24 hours after birth.
The camel calf do acquire its passive immunity from colostrum. Passive immunity gives temporary protection by transfer of immune substances from a resistant dam. It is critical the calf should suckle the milk as soon as possible after birth to boost its immune system and take the advantage of the high nutrient content of the colostrum which is very rich in protein, energy, minerals and vitamins. Camel calves as is true for other mammals are born without antibodies and active immunoglobulin synthesis starts from two weeks of life, reaching a protective level at two to three months of age (Kaufmann, 2003).

One of the most important vitamins found in colostrums is ascorbic acid (vitamin C) and it is established by Al- Sultan (2008) that injection of Ascorbic acid effectively increases lysosomal concentration in colostrum deprived camel calves. This suggests that the vitamin C may enhance the immune effect on camel neonates. Dietary supplementation of ascorbate increases plasma immunoglobulin and stimulates cellular and humoral immunity in a variety of species.

The current study endeavours to understand the pastoralists’ (Samburus and Turkana) perception of these facts about colostrum and how and why their camel management practices may or may not incorporate them. A comparative study in perception of causes of camel calf losses between the pastoralists of Marsabit and scientists by Kaufmann (2003) revealed that Rendilles, Gabbras and Somalis restricted colostrum due to diarrhoea. This was scientifically sound where there is uncontrolled intake of colostrum. The excess protein was not absorbed in the gut thus causing diarrhoea. In view of the scientifically proven importance of access to colostrum by neonates, the extreme reaction by the pastoralists of prohibiting colostrum was unsound.
2.7 Camel milk

From the FAO data (2007), of the estimated 566.9 million tonnes of milk produced in the world, 85% is cow milk. The camel milk occupies a small proportion of 0.2% far behind buffalo or even the goats and ewes. Of this 55% is taken by calves (Faye, 2004). Individual camel milk yield is not well documented in Africa but it ranges from 1000 to 3300 litres per lactation (Simper et al., 1998, Faye, 2004). In Asia the milk production is 650 – 6000 litres per lactation (Khan and Iqbal 2001). Though camel milk production is low compared to cows globally, at household subsistence level it is very important in the environment where the camel is reared. In a past production system, considering the available resources, camel milk production exceeds that of other livestock. In Ethiopia, the Afar farmers rearing cattle and camels simultaneously get an average a daily yield of 1 to 1.5 litres of milk from Afar Zebu against 4 to 5 litres with Dan camels (Richard & Gerard, 1985). Schwartz & Walsh (1992) reported the productivity of camels as 1250 Kg of TLU/year which was higher than that of goats at 300 to 500 Kg and of zebu cattle at 550 Kg/ TLU lactating female per year in the horn of Africa.

Camel milk just like other animals is an important feed for the calf before weaning. It determines the growth rate and vigour for the baby calf. The milk contains the important feed components such as proteins, sugars, minerals and vitamins. The camel milk is rich in vitamin C. Tables 2.1 and 2.2 showing the camel milk composition compared with the cow milk. Generally, the proportion of vitamin C is much higher in the milk of cow and camel than the other vitamins that may explains the role of ascorbic acid in immunity of animals. The mineral content of camel milk is generally low compared to cow milk as is displayed by Table 2.3 below.
### Table 2.1: Composition of camel and cow milk (%)

<table>
<thead>
<tr>
<th></th>
<th>Dry matter</th>
<th>Lactose</th>
<th>Fat</th>
<th>Protein</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camel</td>
<td>12.63</td>
<td>4.62</td>
<td>3.70</td>
<td>3.45</td>
<td>0.74</td>
</tr>
<tr>
<td>Cows</td>
<td>12.80</td>
<td>4.80</td>
<td>3.70</td>
<td>3.50</td>
<td>0.80</td>
</tr>
</tbody>
</table>

*Source: Ramet (2001)*

### Table 2.2: Vitamin composition of camel and cow milk (micrograms / 100g)

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Camel milk</th>
<th>Cow milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pantothenic acid</td>
<td>88.00</td>
<td>350.00</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>15.00</td>
<td>45.00</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>2370</td>
<td>2000</td>
</tr>
<tr>
<td>Thiamin</td>
<td>33</td>
<td>45</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>41</td>
<td>150</td>
</tr>
<tr>
<td>Vitamin B6</td>
<td>52</td>
<td>35</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>0.15</td>
<td>0.30</td>
</tr>
<tr>
<td>Niacin</td>
<td>461</td>
<td>93</td>
</tr>
<tr>
<td>Folic acid</td>
<td>0.41</td>
<td>5.9</td>
</tr>
</tbody>
</table>

*Source: Ramet (2001)*

### Table 2.3: Mineral composition of camel and cow milk (mg/100g)

<table>
<thead>
<tr>
<th>Average</th>
<th>Ca</th>
<th>P</th>
<th>Ma</th>
<th>K</th>
<th>Mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camel</td>
<td>116</td>
<td>67</td>
<td>33</td>
<td>99</td>
<td>11</td>
</tr>
<tr>
<td>Cow</td>
<td>125</td>
<td>96</td>
<td>58</td>
<td>140</td>
<td>12</td>
</tr>
</tbody>
</table>

*Source: Ramet (2001)*
2.8 Calf management

Different communities differ in their management of the calf and that has implications to growth and survival of the calf. Camels dam at parturition require very little assistance if any is only necessary in case of difficult birth (Kamber, 1995). However the calf that is born requires immediate attention to ensure it survives. A careful stockman ensures mucus is cleared from the nose and the mouth and breath is initiated. The calf should get ample amount of colostrum for passive immunity transfer to reduce mortality (Mc Giure *et al.*, 1975; Rea *et al.*, 1996). Camel calves unlike other herbivores are weak to stand immediately after birth and should be assisted so that they can suckle and form a bond with the dam. The young have an active part in forming and maintaining the bond with their mothers (Murphey and Ruiz-Miranda, 1998). Different pastoral communities have marks for identification of their animals and under other pastoral communities Samburuses marks the camel calves about a week after birth.

Provision of adequate amount of milk is important for calf growth. Field (1979) reported growth rates of 378 g/day to 655 g/day where camel calves got up to 75% of the dam’s milk production in the dry and wet seasons respectively. In the same environment but under Rendille management where the calf faces enormous competition for the milk, growth rates of 222 g/day and 255g/day in dry and wet seasons were obtained respectively. The competition for the camel milk worsens in dry periods when complementation from other types of livestock is reduced nil. Based on bovine calf, for the animal to grow normally, should be fed milk 8% to 10% of body weight (MCMU, undated). Probably the same proportion of feeding milk to the camel may apply. Camel keeping areas have predators and calves are the most vulnerable enclosures become handy to ensure the survival of calves.
2.8.1 Weaning

The calf weaning age depends on environmental and genetic factors (Lasley, 1987). It can depend on health status of the calf and production aims. When the objective is to increase herd, camel calves may be weaned early to allow early conception of the dam or may be delayed to prolong the lactation. The environmental aspects include the nutrition of the embryo in uterus and after birth through the milk production of the dam (Lasley, 1987; Willis, 1998; Noor, 1999). A calf weaning age in normal circumstances is 6 to 12 months (Noor, 1999). Among Somali, a calf weaning age is 8 to 18 months (Farah et al, 2004) and it ranges from 8 to 12 months among the Samburu. The weaning age is important for determining economic efficiency of a production system (Lasley, 1987; Willis, 1998). The weaning weight determines reproduction efficiency of the herd. Thus an efficient system is expected to have high growth rate of calves implying calves will mature quickly and be weaned at an early age.

2.9 Camel feeding, supplementation and watering

Camel supplementation in many situations entails only provision of sodium chloride (NaCl). Often this involves taking the camels periodically to the sites with natural salt licks. Supplementation with other feeds apart from natural pastures is not a common practice in pastoral production systems. However, feed supplementation is known to increase camel productivity. An on farm experiment in Erer valley of Eastern Ethiopia studied the effect of supplementation to lactating dromedary camels on milk production (Derege and Uden, 2004). There was a significant increase in milk production with protein and energy supplementation both dry and wet seasons. Feeds in arid areas are very seasonal and in the drought cycle there is always a time of scarcity. Supplementation may improve production but the availability and cost might be prohibitive. In Djibouti the peri-urban camel dairy herd has been successful.
supplemented. A study in Tunisia showed that supplementary feeding of dromedaries under range condition during late pregnancy and post-partum period improved productive reproductive parameters (Hammadi et al., 2001). Just like other types of livestock, camels have to be watered periodically. However due to its adaptive characteristics, the camels require frequent watering than cattle (Wilson, 1998; Field, 1993). Young camel calves are often separated from their mothers during the day to control suckling in Samburu (Simpkin, 1998). The watering frequency is affected by factors such as feed succulence, ambient temperature and water availability (Evans, 1995).

2.10 Calf health

The calf is most susceptible to diseases at early stages of life because of low immunity. The handling and housing is crucial at this time because of predisposing factors (Hartung 1999). Prevention of the calf diseases is important to cut the cost of production and increase survival rate of calves ensuring the progression of the camel generations. The gestation period of camels which is about 387 days is longer than all the livestock kept by the pastoralist, calving interval long averaging 24 months for pastoral herds in Kenya and so calf death is such a great loss to pastoralist or stock farmer (Wilson, 1998). This partly explains why growth of the national camel herd is slow compared with that of other stock.

2.11 Calf growth and camel productivity

Growth rates depend on management and milk availability to the calf. Reduced milk competition allows the calf to access more milk and the growth rate is expected to increase. The age at maturity would relatively be reduced. The productivity of camels in range is reduced by 1
growth rate, long gestation period, a long calving interval and low survival rate of camel calves.

According to Field (1979) Gabbra and Rendille calves in Marsabit district of Northern Kenya gained 222 g/day in the dry period of the year and showed little improvement in the wet season to 255 g/day. In the same area but under experimental condition, gains were as high as 655 g/day. Faye (2004) reported that in traditional systems the daily growth rate of the camel up to one year is 190-310 g. In more intensive production system this can be 440-580 g/day and in Australia a maximum of 1100 g was reported (Faye, 2008). Other factors influencing growth are environment and general climatic and vegetational conditions, during the period of growth (Wilson, 1984). Female camels mature earlier than males and attain sexual maturity at the age of 3 years but are not bred until at 4 to 5 years of age (Evans and Powys, 1979; Simpkin and Guturo 1995; Tefera and Gebreah, 2001; Kuria, 2004). The males start showing breeding activity at the age of 5 to 6 years (Kuria, 2004) but are fully sexually active at 6-9 years and may continue to serve up to 14 to 15 years (Tefera and Gebreah 2001). Camels are seasonal breeders but in warm regions this is triggered by nutritional status and tends to mate during rainy season (Yagil and Etzion, 1980). Consequently the calves are born in the rainy season when feed is plenty enhancing their survival and growth. Simpkin and Guturo (1995) reported an abortion rate of 26% and a calving rate of 21% in Kenya, lower than 50% calving rate in Ethiopia (Tefera and Gebreah, 2001).

Most of the camels in Kenya are kept in the pastoral systems where accurate record keeping is almost non-existent. However, the camel is reported to maintain a longer lactation period than cattle (Kuria, 2004). In Dromedaries the lactation period varies from 9 to 18 months, with peaks...
production on the seventh month (Yagil, 2000). A lactation of one year was recorded in northern Kenya with a milk yield of 1897 Kg (Field, 1979).

The camel meat contributes about 0.4 % of world meat production (FAO, 2007). This is indeed a small proportion with little impact in the world. However, camel meat has some cultural values. Traditionally camel meat consumption is not common in a subsistence pastoral system except for ceremonies such as Mugiet (initiation of a Samburu to eldership). The carcass is large and needs to be shared among many households. Male calves are sacrificed to recover milk that would have been taken by the calf and are slaughtered in such ceremonies. Fat male camels may also be slaughtered to provide meat in times of severe droughts among the Rendille (Kuria, 2004). The dressing weight is about 59% (Schwartz and Walsh, 1992) and the carcass weight can reach up to 300 or more for adult camel. The meat production is lower than from other ruminants; 14 Kg/TLU/year against 14 Kg for cattle and 35 for small ruminants (Faye, 2004). This is attributable to slow growth rate.

References:


http://www.isocard.org/e-


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settlement (manyatta) based milk camel herds among the Rendille community


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Mburu D.N., Ochieng J.W., Kuria S.G., Jiaulin H., Kaufmann B., Rege J.E.O. and Hanotte

McGuire T.C., Poppie M.J. and Banks K.L., 1975. Hypo-gamma-globunemia predisposing

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CHAPTER THREE

3.0 GENERAL CAMEL PRODUCTION PRACTICES IN SAMBURU

3.1 Introduction

Camel rearing in the northern rangelands of Kenya is challenged by poor feed availability, poor reproductive performance and high calf mortality (Schwartz and Walsh, 1992). Feed quantity and quality fluctuate with season thus affecting the camel nutrition and body condition, which in turn influences camel productivity. The effect of feed fluctuation extends to milk production which has a bearing on the calf and human nutrition largely based on milk. Reproduction factors such as long gestation period, calving interval and age at first parity affect the rate of camel growth. Although maturity in camels is naturally attained later than for other livestock kept by pastoralists, it is aggravated by feed availability, forage quality, salt supplementation and labour (Kuria, 2004). The pastoralists may not be aware of subclinical effect related to feed quality, mineral salt deficiency (Kuria, 2004). Northern Kenya pastoralists except the Samburus have traditionally kept camels over many generations but the national camel population has remained fairly constant. It is generally accepted that the pastoralists have accumulated wealth and knowledge in range camel management. However, the knowledge is neither adequately documented, nor evaluated to determine its usefulness. The researcher in this study interviewed pastoral camel herdsmen of Samburu district, in Northern Kenya and documented traditional management practices with a view of identifying gaps and challenges in camel production.

3.2 Materials and Methods

3.2.1 The study area

Opiroi, Barsaloi and Kawop locations within the larger Samburu district were the focus of the survey. Opiroi is located on the Eastern side of Kirisia hills and is 1500 m.a.s.l, the media
annual rainfall is 500 to 600 mm; Barsaloi is on the riverline of Barsaloi lagga and is 1500 m.a.s.l with median annual rainfall of 450 to 500 mm while Kawop is in Albatra plains and is 1200 to 1500 m.a.s.l. with median rainfall of 400 to 450 mm. The three locations were purposefully chosen because they are among the camel rearing area within the ALLPRO working sites. The sites are the pilot areas for the ALLPRO where Participatory Integrated Community Developments (PICD) methods to identify and prioritize community needs has been conducted. Some micro-projects are being implemented in the sites. Households were selected from clustered random samples of manyattas. Each location had a number of manyattas which comprises a number of households. Selected households within a manyatta to be considered required had one or more camels with calves. The household heads were interviewed. The first two locations are inhabited by the Samburus and the other by Turkanas.

3.2.2 The respondents

The thirty respondents interviewed comprised 28 men and 2 women who were house heads and knew their camel herds well and had other information pertinent to the household. Women headed households were widows. When administering the interview a translator fluent in Samburu or Turkana was used in the three study areas. A feedback workshop was also done to cross-check the information obtained during the survey after the analysis. The interviews were done during the dry season.

3.2.3 The survey instrument and the data collected

A structured questionnaire was developed, pre-tested and used to capture data on household demographics, herd structure, camel calf management and breeding, livestock feeds, feeding...
practices and constraints, extension and health services, reproductive performance and marketing of livestock products (see Appendix). Responses were sought from persons who owned camels even though they kept other livestock.

The data collected consisted of the following:

1. Pastoral camel rearing practices: Livestock herd structures, dam management practices, herd size, camel keeping experience, housing of calves, environmental control.

2. Range condition in general recorded as observed at that particular interview moment,

3. Breeding system: Criteria for selection of breeding camel dams and sires, awareness of consequences of inbreeding and measures taken if any, to avoid inbreeding.

4. Disease control recorded: The ranking and perceived importance of camel diseases, causes, the scope and extent of utilizing the local knowledge on disease treatment according to animal health services.

5. Feeding of the camels: Pastoralists feeding of the camel, the level of competition for milk, milking styles.

3.2.4 Analysis of the data

Data analysis involved the use of non parametric tools. Initially, explorative analysis was carried out to establish categories of camel keepers for further analysis. Categories to classify respondents were generated from the herd structure using the Tropical Livestock Unit (TLU) (Jahnke, 1982). The aim was to standardize the livestock owned by pastoralists and then form bases for the categories of the respondents in the three locations of the study area. Respondent proportions, counts or frequencies to specific management practices was generated based on
established. The resultant data comparing categories was tabulated and presented in proportions or frequency histograms.

Results and Discussion

Camel management

Camel rearing is not practised in isolation but is integrated with other types of livestock within a general production system. Pastoralists are known to keep different types of livestock as means of diversification and spreading risks. In view of this wealth status, livestock distribution here and other management practices are analysed.

1.1 Wealth status, livestock distribution and herd structure

Pastoralists in the three locations namely Opiroi, Barsaloi and Kawop kept varying numbers of livestock. The numbers were transformed into Tropical Livestock units to weight the livestock (Jahnke, 1982). Then respondents were categorized into three clusters based on TLU; the rich (>76 TLU), intermediate (21 – 75 TLU) and poor (<20 TLU). Respondents interviewed in Opiroi, Barsaloi and Kawop locations had a total of 335.1 TLU, 270.6 TLU, and 261.4 TLU, respectively. The distribution of the respondents among the wealth categories is shown in Figures 3.1a and b. In Kawop location, in total, the proportion of the rich and intermediate livestock owners kept about the same numbers of livestock (115 and 114 TLU). However, the poor livestock owners of Kawop averaged 10.5 TLU and those of Opiroi kept an average of 17 TLU; while the medium owner category of Kawop owned more than those of Opiroi at 36 and 32.8, respectively. Apparently these were random distributions because of the small sample size. Probably it is for the same reason that the Opiroi had 71 TLU a number above the 61 kept by the Kawop rich. There were no respondents in
Figure 3.1a: Wealth status distribution described by TLUs owned by respondents

Figure 3.1b: The proportion of respondents' wealth status distribution per location.
the poor category from Barsaloi location. The location’s rich kept an average of 83.5 TLU e
and the intermediate ones kept an average of 34.5 TLU.

Fig. 3.2 shows proportion of different livestock kept by respondents. The respondents reported
their livestock proportions for cattle, camels, goats and sheep being 44%, 41%, 11% and 28% TLU respectively. Camels and cattle made up a high combined proportion of 85% while small ruminants made up the rest with goats being almost twice as many as the sheep. It is probable that this distribution enables best-bet pastoral ecosystem vegetation utilization. Edgerton and Swift (1988) pointed out that the range provides variety of grazing levels for different livestock species. It is also evident that domestic or wildlife herbivores living together subsist on different levels and plant species of grazing or browse (Teferi et al., 2008). Camels which are predominantly browsers make use of encroaching bush thus opening the range for grazers and intermediates (Migongo-Bake and Hansen, 1987). Also grazing one livestock species can influence the sward structure and botanical composition benefiting other grazing stock species. This is also observed in nature where camelids (giraffes), equines (zebra), bovidae (wildebeest), caprae (impala) and ovines (gazelles) graze or browse in the same range (Mc Naughton, 1977; Soder et al., 2007). Although pastoralist lifestyle has undergone a great change over the fifty years, if the suggestion of Brown (1971) that most African pastoral families (equivalent to 6.5 adults) subsist on a diet of 75% milk and 25% meat; and that a family required 27 to 31 TLU to survive; then the poor category respondents’ family size (7±4 people), in the study area, can not solely depend on livestock for subsistence. Camel herds on average consisted of 76% breeding females and 27% males across all the locations in the study area (Table 3.1). Of these 40% were breeding females and 4% breeding bulls, the rest were immature camels and calves. Goat and
Figure 3.2: Proportion of species composition as reported by respondents

![Bar chart showing the proportion of different species composition.]

Table 3.1: Proportion of sex of livestock kept by pastoralists in Samburu

<table>
<thead>
<tr>
<th>Species</th>
<th>Males %</th>
<th>Females %</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAMELS</td>
<td>27</td>
<td>73</td>
</tr>
<tr>
<td>CATTLE</td>
<td>35</td>
<td>65</td>
</tr>
<tr>
<td>GOATS</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>SHEEP</td>
<td>28</td>
<td>72</td>
</tr>
</tbody>
</table>
sheep flock sex ratios were 65% and 35%; 72% and 28% for males and females respectively. Elmi (1989) reported similar herd structure in a Somali camel herd and noted that majority males were castrates. However, Samburus and Turkanas seldom practice camel castration as a breeding management strategy. More of males were apparently kept than is normally accepted because they acted as a food security measure for the family through exchange with cereals. Proportionately, more females were kept to provide milk, the main product from the system (Jahnke, 1982).

3.3.1.2 Source, selection, age and parity of breeding animals

Thirty seven percent (37%) and 23% of the wealthy and poor respondents respectively, bought breeding bulls from the market or exchanged/barter trade (Table 3.2). The pastoralists did not appear to have a clear breeding programme as portrayed by their acquisition of breeding bulls. Most respondents either borrowed a bull or bought one from the market. Failure to see the need to rear own replacement bulls may be translated to mean lack of a breeding programme. Camels that are taken to market are mostly culls for reasons known only by the seller. Customs dictates that a pastoralists only sells the worst performing animals not suitable for breeding. This in effect impacts negatively on the general herd growth and translates to low level of production. In addition, no records exist for most animals bought from the market, as the traders may not have or tell, the whole history of the animal.

Most of the respondents listed similar criteria for selection of breeding bull namely; lack of defects, fertility and lack of sexually transmitted diseases, good temperament, and lack of reproductive disorder. According to Elmi (1989) Somalis selects the sires and dams based on
Table 3.2: Proportion of respondents reporting breeding management practices in Samburu

<table>
<thead>
<tr>
<th>Category</th>
<th>Proportion of respondents (%) practicing inbreeding observing abnormalities (n=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Practicing Inbreeding</td>
</tr>
<tr>
<td>Inbreeding practice</td>
<td></td>
</tr>
<tr>
<td>Very rich</td>
<td>83</td>
</tr>
<tr>
<td>Rich</td>
<td>40</td>
</tr>
<tr>
<td>Poor</td>
<td>63</td>
</tr>
<tr>
<td>Very poor</td>
<td>40</td>
</tr>
<tr>
<td>Source of replacement of stock</td>
<td>Rear own stock</td>
</tr>
<tr>
<td>Poor pastoralists</td>
<td>20</td>
</tr>
<tr>
<td>Wealthy pastoralists</td>
<td>20</td>
</tr>
</tbody>
</table>
productivity and temperament. The information is derived from memory or observation of the herd.

Inbreeding was practiced by all categories of respondents (see Table 3.2 above). The pastoralists allowed closely related camels to mate resulting in inbreeding. The range of respondents proportion reporting inbreeding was quite high in all the categories; 40% to 63% and 40% to 83% for the poor and the wealth categories, respectively. Abnormalities such as deformed legs, short ears, cryptorchidism and infertility had been observed and were reported during interviews. The generation interval in camels which is already long because of their long gestation period- 300 to 400 days (Yasin & Wahid, 1957; Evans & Powys, 1979; Payne, 1987; Simpkin & Guturo, 1995; Wilson, 1998; Kuria, 2004) can be further lengthened if sub-fertility occurs in either bulls or cows. In such situations genes for abnormalities take long before they are discovered. If decisions have to be made, then they are delayed resulting in an economic loss to the pastoralists.

Camels’ first parity was about four years old implying that the first service was at three years age as reported by 87% of the respondents. Bissa et al., (1998) study on Bikenari breed showed growth continues beyond 4 years even if lactating so long as they were adequately fed. Fifty percent (50%) of respondents reported calving interval of 2 years; 30% reported calving intervals of 3 years and 17% intervals of over 3 years. Calving interval of more than three years generally slows the growth of the camel herd and this partly explains the stunted growth of the national herd. The calving intervals reported concur with those in literature (Evans & powys, 1979; Wilson, 1998; Tefera & Gebreah, 2001; Kuria, 2004).
3.3.2 Camel feeds and feeding practices

Camels derive their feed from natural shrubs, trees and other forbs available in the range. The study area had varying densities of Acacia trees; \textit{Acacia tortilis}, \textit{Acacia mellifera}, \textit{Acacia senegal}, \textit{Acacia brevispica} (thornless acacia) and other shrubs e.g. \textit{Salvadora persica}, \textit{Cor}\textit{spp.} etc. Comparatively, there is more feed for the camels than other livestock and thus the higher proportion of camels in the study area. According to Schwartz, (1992) camels have adaptive features related to feeding behaviour and nutritional physiology. Camels are able to select browse of best qualities between seasons and can increase the retention time of poor quality feeds for the microbes to break the fibrous materials. Further camels can recycle and use body urea for microbial protein synthesis much more efficiently than other ruminants. However, there are seasonal fluctuations of feeds, a characteristic of range lands and influences the body condition of camels. There are challenges related to camel feeding described below.

3.3.2.1 Constraints to feeding

Feed shortage was considered by 33.3\% of respondents as a serious problem opposed to 23.1\% who thought not a serious problem. The remaining 43.3\% viewed feed availability as an average problem (Table 3.3). In spite of variety in the range, feed availability fluctuations minimize camels feed choices causing them to turn to poisonous plants (\textit{Capparis tomentosa}) as was evident in the study area (Fig. 3.3). Plant poisoning is cited as one of the problem in the study area. \textit{Capparis tomentosa} Lam. family Capparaceae is a climbing shrub or small tree up to 10 m (Elffers \textit{et al.}, 1964) which can be reached by camels and their calves. The plant is known to have many uses such as human disease medicine and food as is indicated in the literature (Birgitta and Caroline, 2000; Sama and Ajaioba, 2006; Akoto \textit{et al.}, 2008) but pastoralists are
Figure 3.3: A picture of a camel foraging *Capparis tomentosa* at Opiroi

Table 3.3: Ranked constraints of camel feeding

<table>
<thead>
<tr>
<th>Constraint/ Rank</th>
<th>Proportion of respondents (%)</th>
<th>n=30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>23.3</td>
<td></td>
</tr>
<tr>
<td>Shortage of basal feeds</td>
<td>33.3</td>
<td></td>
</tr>
<tr>
<td>Always a problem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Only a problem</td>
<td>36.7</td>
<td></td>
</tr>
<tr>
<td>Insecurity</td>
<td></td>
<td>23.3</td>
</tr>
<tr>
<td>Mobility</td>
<td></td>
<td>3.3</td>
</tr>
<tr>
<td>Poisonous plants</td>
<td></td>
<td>3.3</td>
</tr>
</tbody>
</table>
categorical of its poisonous properties to camels. The picture in Fig. 3.3 shows a camel feed
on this poisonous plant at Opiroi. The plant is always green and is commonly found along
riverine where camels feed from during the dry spells. The plant fruits and flowers, as repor
ted by respondents are known to cause paralysis in camels (Schwartz, 1992). The antidote is
known though the pastoralists administer concoction of ground charcoal and fat of lamb to
affected camels. The shrub can be reached by the camel calves which are more vulnerable than
the adults. The plant is not easy to eradicate but pastoralists attempt cutting (Fig. 3.4). However,
it vigorously re-grows. In addition 23% of respondents viewed labour as a constraint to feed
while 36.7% not a constraint as such. A herder is required to take care of animals in the field
they feed. Young calves are left in enclosures the whole day as no one is available to herd them
(see Fig. 3.5). School enrolment still remains very low among the pastoralists for this reas
According to Esilaba (2005) the illiteracy level in Samburu is quite high (80%). However there
are other reasons of keeping camel calves in the enclosures such as restricting the camel calf
suckle in order to avail milk to the family, age or size requiring protection from the predator.
Labour needs override these others. The proportion of respondents considering insecurity a
constraint to feed availability was 23.3%. Animals’ forage radius and mobility was reduced by
insecurity impacting negatively on productivity, calf growth and the environment.

3.3.2.2 Watering and salt supplementation to camels

The proportion of respondents reporting watering interval for the camels being week
fortnightly or over two weeks were 83%, 14% and 3% respectively. Most watering points were
reported to be 2 to 30 Km away. The communities near the water points could afford to water
frequently thus explaining the high watering frequency reported. Watering interval of one mon
Figure 3.4: A picture of a dry *Capparis tomentosa* after being cut

Figure 3.5: A picture of camel calves enclosed in the whole day at Opiroi
reported by 2% was only applicable where camels had access to green vegetation with high water content for example along riverine areas in a dry season or during wet periods. Eighty-four percent (84%) of respondents took their camels to salt licks monthly and 16% after two months (Table 3.4). The distance to salt licks was 20 to 60Km away and that may explain the lapse between visits. Very young camel calves could not walk such long distances for saltlick due to their vulnerability and yet are at a critical stage for salt requirements. Mineral salt is crucial for bone development and other physiological functions. Lack of essential mineral can lead to poor growth, weak bones which can break easily, diarrhoea, anaemia, infertility, poor reproduction (NAP, 2000; Radostits et al., 2000). Insecurity and seasonal flooding prone zones such as Sugulla valley limited access to salt licks.

The Opiroi communities used Barsaloi lagga (sandy riverbed) both for watering and salt lick. The Lupus communities at Barsaloi location used Suyian lagga to water and avail salt to their camels. They claim it has superior quality of salt than Barsaloi lagga. Both laggas have visible sports of salt deposit and halophyte (Salvadora persica) growing along the riverine. Though pastoralists occasionally take their camels for the natural salt lick, the effect of salt quality was not easily determined. Problems related to mineral deficiencies are not easily conceptualized by camel keepers unless at advanced stages (Kuria, 2004). There is need to do study on mineral supplements in Samburu for inference can only be made based on Marsabit district report (Kuria et al., 2004). The quality of salt supplementation might differ based on the geological factors and vegetation available. Forage mineral concentration also varies considerably and is dependent on many factors including species, soil mineral concentration, climatic conditions and season of the year (Kuria et al., 2004).
Table 3.4: Proportion of respondents reporting watering and salt lick frequency for camels in Samburu

<table>
<thead>
<tr>
<th>Watering and saltlick frequency</th>
<th>watering</th>
<th>saltlick</th>
</tr>
</thead>
<tbody>
<tr>
<td>One week</td>
<td>82</td>
<td>0</td>
</tr>
<tr>
<td>Fortnightly</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>One month</td>
<td>2</td>
<td>84</td>
</tr>
<tr>
<td>Two month</td>
<td>0</td>
<td>16</td>
</tr>
</tbody>
</table>
It was noted in Samburu that pastoralists with the intention of supplementing their camels with common table salt (see pictures in Fig 3.6 & 3.7). Table salt (NaCl) which is meant for human consumption might be deficient in other essential elements required by the camels. The requirement for camels varies with season (Faye et al., 1991) due to seasonal variations in vegetation quality (Elmi, 1989; Wardeh, 2004; Kuria et al., 2004). Therefore supplementation for camels is necessary.

However, the reasons for not supplementing camels with the right type of mineral salt are numerous, namely, limited extension services to camel keepers, low purchasing power due to prevailing poverty and availability due to long distances to the shopping centres where agro shops are located. Mineral salt is known to improve livestock fertility, reduce incidences of retained afterbirth and increases milk production, increase weight gain, improves on body development and growth (NAP, 2000). According to Kuria (2004) mineral supplementation in dams increased the growth rate of Rendille camel calves by 60.1% and 38.1% attributed to increased amount and quality of milk available to the calves.
Figure 3.6: A picture of a herder showing common table salt in the trough at Opiroi

Figure 3.7: A picture of common table salt in a trough at Opiroi meant for camels
3.3.3 Marketing of camel milk

The respondents reported selling the camel milk. Fifty seven (57) percent of respondents sold camel milk mostly to the local market (Fig. 3.8) and a small proportion to their neighbours. Majority of milk vendors are from Kawop location probably because of their proximity to Baragoi shopping centre and the high poverty levels (Table 3.5). Eighty eight (88%) of the respondents selling milk came from Kawop location where 53% were poor households. Twenty two percent of respondents selling milk came from Opiroi where the ratio of the poor and the wealthy respondents was the same. No sale of milk was reported at Barsaloi not because they did not want to but because of distance to the shopping centres and lack of customers. About 45% of milk was sold though variation existed from one household to the other depending on the number of persons in the family. The price of camel milk ranged from Ksh20 to Ksh30 per litre.

Marketing of camel milk, though a source of income to the household aggravated the constraint of milk availability to the calf. This scenario worsened during dry season, negatively affecting the growth and survival of young calves solely depending on milk. During the rainy season milk production increased and there was complementation from other stocks which return from satellite manyattas. When milk is in excess, preservation technologies such as milk condensation may be applied to improve the shelf life of the product and improve food security at the household level. According to Simpkin (1993) and Farah et al., (1995), when 250 g of sugar added to a litter of milk and boiled until only 0.5 kg or 500ml remains, the shelf life of milk increased to over six months. This condensed milk can be used by the pastoralists during the dry period.
Figure 3.8: Proportion of respondents selling camel milk

![Pie chart showing proportion of respondents selling camel milk and proportion of respondents not selling milk.]

Proportion of respondents not selling milk: 43%
Proportion of respondents selling milk: 57%

Table 3.5: Respondents reporting marketing of camel milk as per locations (%)

<table>
<thead>
<tr>
<th>Categories</th>
<th>Opiroi location (%)</th>
<th>Barsaloi location (%)</th>
<th>Kawop location (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very rich</td>
<td>0</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td>Rich</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Poor</td>
<td>6</td>
<td>0</td>
<td>29</td>
</tr>
<tr>
<td>Very poor</td>
<td>0</td>
<td>0</td>
<td>24</td>
</tr>
</tbody>
</table>
3.3.4 Access to extension, health services and frequency of service provision

Access to extension and health services is very important in livestock industry. However almost all the respondents did not receive any advisory extension services. Ninety seven percent (97%) of respondents interviewed did not at all get advisory services from extension workers, 35% of respondents were attended to once in a month and the message passed by the few workers to the pastoralists on livestock health. Eighty seven percent (87%) of the respondents did not seek extension services because they were not aware of such services. This clearly showed that there was a knowledge gap. The extension service providers were not able to effectively reach out the cattle owners and neither did the pastoralists seek the information and worse still they did not know whether such services exist. The respondents reported that the main animal health providers were Agrovet shops (56.7%), Ethnoveterinary (20%) and unqualified private vendors (6.7%).

Respondents who sought the government services were minimal (3.3%) in Table 3.6. The frequency of service provision is displayed in Table 3.6. Ninety eight percent (98%) respondents attended to their livestock whenever there was a health problem in the herd. Alternatively they turned to community based animal health workers (16.7%) or ethnoveterinarians (16.7%) or Agrovet shops (36%). Private veterinary services were not available at the local level but most Agrovet shops owners or employee had veterinary background and in the process of selling drugs would offer some extension services on how to use the drugs.

Government services were less frequently used because they were not available except in emergency or outbreaks. The Government institutions were far away with limited extension staff and Pastoral areas had a seriously shortage of extension field workers. The areas were very extensive and sparsely populated and had poor infrastructures leading to poor networking.
### Table 3.6: Proportion of respondents reporting service provision

<table>
<thead>
<tr>
<th>Categories of animal health service provider</th>
<th>Number of contact</th>
<th>Proportion of respondents (%) n=30</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Service providers contacted</td>
<td>Frequently used</td>
</tr>
<tr>
<td>Agro-vet shops</td>
<td>56.7</td>
<td>36</td>
</tr>
<tr>
<td>Ethno-veterinarian</td>
<td>20</td>
<td>16.7</td>
</tr>
<tr>
<td>Private veterinarian</td>
<td>6.7</td>
<td>0</td>
</tr>
<tr>
<td>Gok veterinarian</td>
<td>3.3</td>
<td>0</td>
</tr>
<tr>
<td>others</td>
<td></td>
<td>13.3</td>
</tr>
<tr>
<td>CBAHWs</td>
<td>13.3</td>
<td>98</td>
</tr>
</tbody>
</table>
Though the importance of livestock as means of livelihood to pastoralists cannot be underscoring livestock sub-sector is accorded little attention and is one of the most poorly funded in Agriculture sector (GoK, 2010). The observation shows there is a knowledge gap because many of respondent do not seek technical services from relevant institutions. Neither do the institutions reach the pastoralists effectively due to the reasons stated before. Further extension methodologies used are not appropriate to pastoral areas. Appropriate extension methodologies to the pastoral communities needs be developed and used to effectively bridge the knowledge gap.

3.3.5 Management of health problems

Most pastoralists in the study area bought drugs and treated the cases themselves or resulted to herbs and other traditional treatments. When a calf was infested with ticks or mange, old engine oil was applied with or without acaricide. This may have had some negative effect to young calves because pheromones were masked off and more often than not result to calf rejection (Fraiser & Broom, 1997) and caused heat problem as well. The pastoralists are then in a dilemma yet ticks are known to cause paralysis to young calves (Dioli et al, 1992). Ticks find a habitat in the fur along the spine and sucks blood from the calf affecting its health status. This result in tick borne diseases, anaemia or calf paralysis.

Hundred percent (100%) of respondents bought drugs for external parasites, and less than 20% for internal parasites, orf or internal infections (Table 3.7). For almost all animal health problems pastoralists have local herbs to treat implying there is a lot of wealth in indigenous knowledge regarding diseases and treatments (Wanyama, 1997). There are a lot of plants used for medical purposes in Samburu (Wanyama, 1997). Preparation of these types of medicines is an issue. All
Table 3.7: Management of common health problems

<table>
<thead>
<tr>
<th>Health Problem</th>
<th>Management practices reported by respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Call a vet</td>
</tr>
<tr>
<td>Dairrhoea</td>
<td>0</td>
</tr>
<tr>
<td>Plant poisoning</td>
<td>0</td>
</tr>
<tr>
<td>Internal infection</td>
<td>0</td>
</tr>
<tr>
<td>Internal parasites</td>
<td>0</td>
</tr>
<tr>
<td>External parasites</td>
<td>0</td>
</tr>
<tr>
<td>orf</td>
<td>0</td>
</tr>
</tbody>
</table>

n=30
there is the variation of quantities administered resulting in overdose or underdose which has consequences of either killing the animal or causing the resistance. Some plants are known to be toxic. There is little scientific research validating claims made of their effectiveness. The content of active ingredients is unknown and further exploration on medicinal plants is required.

3.4 Conclusion and Recommendation

3.4.1 Conclusion

- Different types of livestock species were kept for the purpose of diversification and optimum utilization of scarce and fragile range resources in Samburu.

- There lacks good camel husbandry practices resulting in poor productivity and reproduction.

- Camel feeds availability fluctuates with seasons. Feeds are plenty and of good quality during rainy seasons and vice versa in drought. Camels turn to poisonous plant Capparis tomentosa in time of feed scarcity.

- Extension and health services are weak causing the pastoralists to turn more to traditional healers who may not have adequate knowledge on some of the diseases for camel.

3.4.2 Recommendation

- Good camel husbandry practices should be promoted to enhance productivity and reproduction of camels.

- There is need to establish the poisonous alkaloids concentration in the various parts of the plant Capparis tomentosa. Develop the antidotes to them.
References


CHAPTER FOUR

4.0 Factors That Affect Growth and Survival of Camel Calf

4.1 Introduction

Camel calf growth rate is affected by milk available from the dam because of its dependency on nutrients from milk. The milk produced by the camel dam is related to the body condition which is affected by the condition of the vegetation it feeds on among other factors. Vegetation in rangelands fluctuates in quality and quantity depending on the moisture availability and nutrients in the soil and forage species. Moisture availability is highly related to erratic and unreliable rainfall. Milk quantity produced by camel dams fluctuates with the vegetation condition. The survival of camel calf highly depends on nutrition though there are other factors such as disease and management. Schwartz and Walsh, (1992) reported high mortality rates of 73% for males and only 37% for females for pastoral herds in Northern Kenya. Such high mortality, greater than the acceptable 15%, requires re-evaluation of the production system to establish causes and establish the intervention points for higher calf survival rates (Payne, 1990; Ndun; et al, 2001). The survival of calves has a bearing in the herd growth which for the camel Kenya has remained fairly constant over years. Pastoralists will not realize the full benefit of camels when the herd decreases or stagnates. There is need to document camel calf rearing practices in this largely pastoral production system to establish the causes of the high calf mortality and suggest management practices to reverse the situation. In this study pastoral car- herders of Samburu District were interviewed, in Northern Kenya to document camel calf rearing.
4.2 Materials and Methods

4.2.1 The study area

This is as described in chapter 3.

4.2.2 The respondents

This is as described in chapter 3.

4.2.3 The survey instrument and the data collected

The structured questionnaire described in chapter 3 had a section to capture data on camel calf management and feeding practices (see Appendix). In addition, a record sheet was used to collect information on each calf sampled in the camel herd. Fifty nine (59) calf records were taken. The calves were suspended on a scale by a sling and the live weight taken. The data collected consisted of the following:

1. Pastoral calf rearing practices: calf management from birth to weaning; housing (if any); access to dam for suckling, age at access to grazing, age at weaning.

2. Range condition in general recorded as observed at the time of administering the questionnaire and recall information at the time of birth.

3. Camel calf mortality and its suspected or identified causes.

4. The calves' live weight was recorded. The calves' body condition was also recorded using the designed scale of 1-9 (see appendix).
4.2.4 Analysis of the questionnaire

The data was screened for outliers after which three categories of the calves were established: very young (1 -100 days), fairly young (100 - 300 days) and post-weaned (300 - 400 days) for further investigation. The proportion of death rates was determined from the record. Further using the Excel and Genstat to run the data, the growth curves, histograms describing various practices and site effects were derived from the data.

4.3 Results and Discussion

4.3.1 Camel calf growth

The estimated average daily gain (ADG) was 212g/day for both the male and female calves. When this was segregated on the basis of calf sex the ADG for male and female was 281 and 141 g/day respectively. The ADG was estimated from the gradient of the best fit line equation of the derived growth curve (Figure 4.1). The derived growth curves were extrapolated to zero days of age to estimate the average birth weight at 47.5 Kg. The respective estimate birth weights for male and female calves were 57.14 Kg and 35 Kg. The regression equation used to estimate ADG is:

$$Y = a + bx$$

where $Y$ = weight at age $x$; $a =$ constant (birth weight); $b =$ gradient of the best fit line of regression

The age at which camel calves were weaned was commonly reported by camel keepers as 4 months (240 days). The average weight of the calves at this age was estimated at 98.4 Kg from the derived respective regression equation ($y=0.212x + 47.14$).
Figure 4.1: The growth curves of the best fit line for camel calves

Live Weight of camel calves in Kg

Age of camel calves in days

Wt. of Male calves
Wt. of Female calves
All camel calves wt.

NB: Wt - Weight
According to Kuria (2004) the average birth weight for Rendille camels in Marsabit was 35 kg. From available literature birth weights ranged from 25.8 kg in Tunisia to 37.3 kg in India and were lower for females than males (Wilson, 1984). The birth weight estimated in the current study was high probably due to the fact that the measurements were taken once for different calves. The calves were managed differently and were from different localities. The estimate is also based on the assumption that recall information on the age of the calves was accurate.

The growth rates exhibited in the area were below the range of 300 to 400 g/day for indigenous herd (Payne, 1990) but close to values of 275.7 g/d and 222 g/d reported by Kuria (2004) and Field (1979) respectively for a similar pastoral production system. The male calves grew at a higher rate than females. Higher growth rate for male animals is widely reported and explained by a higher feed conversion efficiency and lower proportion of fat in the live weight gain (Bishop et al., 1991). However females mature earlier but at a lower weight than males.

According to Wilson (1998) breeds with lighter birth and mature weights may gain weight rapidly than breeds of heavier weights. Field (1979) reported a high growth rate of 378 g/day and 655 g per day (dry and wet season) during the first year of life in an experimental herd with supplementation and health care services in Northern Kenya. In USSR, Meredov (1987) reported a growth rate of 950 to 1030 g/day for one year while Degen et al (1987) reported a rate of 680 g/day up to 180 days of age. In India, Khanna (1988) reported a growth rate of 244 g/day for 610 g/day from birth to one year while Khanna et al (1990) reported 349 - 732 g/day for Bikaner breed and 254-800 g/day for Kachchhi breed. These higher growth rates reported from India and the USSR and by Field (1979) were better due to management including supplementation clearing showing the growth potential of camel calves in pastoral production systems.
4.3.2 Effect of vegetation on growth

Feed availability and vegetation condition fluctuates seasonally indirectly affecting the camel growth. This is because vegetation condition determines the nutrients available to the dam hence the amount of milk she produces. The calf is dependent on milk until the rumen becomes functional usually at 3-4 months of age for a camel calf (Craplet, 1963; Wilson, 1984). The calves were classified based on age in days into very young (1 – 100 days), fairly young (101 – 300 days) and post-weaned (300 – 400 days).

Figure 4.2 shows the effect of vegetation condition at the time of birth on the camel calf weight at the time of administering the questionnaire. The general expectation is for the average weight of the three categories of camel calf to decrease with deterioration of vegetation condition. However the calves reported to be born during the excellent vegetation condition deviates from this. Also defying this trend was the post-weaned group calves all of which had similar weight in spite of vegetation condition at their birth varying from good to poor. This may be attributed to errors associated with recall information. Interpretation of vegetation condition classification such as the difference between excellent and good, would also vary among the respondents and contribute to the errors. However, the fairly young and very young calf groups exhibited a trend towards decreasing weight as the vegetation condition changed from good to poor. This trend was especially pronounced for the youngest calves. This disparity in response to vegetation condition at the time of birth among calf age groups may be explained by the capacity of animals to recover from periods of nutritional stress (Kellems and Church, 1998; Freking et al, 2000; Simmons and Spratt, 2000; Martínez-Ramírez et al., 2008; Read and Tudor, 2004). The older calves would have had adequate time to recover from any earlier growth checks due to nutritional...
Figure 4.2: Effect of vegetation condition at birth on the camel calf live weight during the three stages of growth.
inadequacy. In contrast the very young calves were still dependent on milk so that the vegetation condition at birth as it affects dam nutrition is still critical in determining their growth rates.

From Table 4.1 the average weight of young calves in excellent and good vegetation conditions is 65 Kg and 87.8 while in the fair and poor vegetation condition this is 39.3kg and 38 kg. The average weight of the very young calves born when vegetation condition was excellent would be expected to be higher than for those born when vegetation was described as good. This apparent discrepancy may be due to inaccuracies of the recall information on vegetation condition. The difference in average weight for the very young calves and fairly young calves was significant when the vegetation condition deteriorated. The variation in average weight of post-weaned calves with vegetation condition was insignificant due to their ability to browse and make up for any nutrient deficiencies because their rumen is then functional (Ørskov and Ryle, 1990; Ørskov, 1986). The variation in feed condition affected camel milk production and therefore the calf growth. The average calf body condition followed the trend of fluctuating feed availability.

4.3.3 Sexual activity and calving season

The process of growth is initiated by a successful conception during mating season. Camels are seasonal breeders and increases sexual activity when feeds are in abundance. In the tropic temperature, humidity and nutrition determine the intensity of sexual activity in camels (Hussain and Ahamed, 2009). These condition appear most favourable during the rainy season. Figure 4 shows that most calving took place in April and December which implies that mating took place the same time previous year since the gestation period is about 12 months (Wilson, 1998; Kumar, 2004). This coincided with the long and short rain seasons in the study area.
Table 4.1: Camel calf average weights in relation to vegetation condition at birth

<table>
<thead>
<tr>
<th>Category</th>
<th>Vegetation</th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very young</td>
<td>Av. Wt (Kg)</td>
<td>65</td>
<td>87.8</td>
<td>39.3</td>
<td>38</td>
</tr>
<tr>
<td>Fairly young</td>
<td>Av. Wt (Kg)</td>
<td>107.5</td>
<td>105.6</td>
<td>88</td>
<td>83</td>
</tr>
<tr>
<td>Post-weaned</td>
<td>Av. Wt (Kg)</td>
<td>-</td>
<td>129.1</td>
<td>124.1</td>
<td>122.5</td>
</tr>
<tr>
<td>Av. body condition</td>
<td>camel calves</td>
<td>5.67</td>
<td>4.8</td>
<td>4.6</td>
<td>4.4</td>
</tr>
</tbody>
</table>

Figure 4.3: Frequency of feed availability and counts of calves at birth
Further Fig. 4.3 shows the two peaks of months when feeds for the camels are perceived to be plenty by respondents. The first peak is in the months of April and May and the other in October and November. These peaks correspond to the long and short rains, respectively. Increased moisture in the soil results in stimulation of plant growth and hence increase in herbage biomass. The body condition improves as a result and this in turn stimulates the sexual activity of camel bucks and females.

A comparison of the time of birth and perceived feed availability shows that by three to four months when calves are able to utilize forages, those born in April had a more favourable feed availability situation than those born in December. The latter group of calves was exposed to a subsequent long period of low feed availability up to April. This was reflected in better performance for the calves born in April with an average growth rate of 290 g/day and a low mortality rate of 33%. The respective growth and mortality rates for calves born in December were 150 g/day and 46%.

### 4.3.4 Camel calf survival

The average mortality rate of camel calves in the surveyed area was 50% with the male calves showing a higher rate of 56% compared to 43% for females. The difference in death rates between male and female calves has been associated with preferential treatment of female calves which are viewed as the future of the herd in terms of growth and milk production. Schwartz and Walsh (1992) reported higher milk off-take for human consumption from dams with male calves.

Schwartz and Walsh (1992) similarly reported higher mortality rates of 73% for male calves and only 37% for females for pastoral herds in northern Kenya. The average mortality rates of cam...
calves in the current study is higher than the 15% recommended by Payne (1990) and Ndung’u 
*a* (2001) but similar to the 50% reported by Wilson (1984).

A major contributor to the high camel calf mortality is reported to be denial of access to 
colostrum for the young (Wilson, 1984). In the current study 63.3% of respondents denied 
calf access to colostrum (Table 4.2). Proportion of respondents reporting colostrum limitation 
from Kawop, Opiroi and Barsaloi locations were 50%, 33% and 17%, respectively (Figure 4.2). 
Some pastoralists reported milking off all the colostrum for household use. Though the 
importance of colostrum to the calf cannot be underscored, it was perceived as a cause of 
diarrhoea by some pastoralists. Colostrum is vital for the survival of the new born because it 
provides the neonate with passive immunity when taken within 24 hours of birth (Kamber, 1995; 
Kellems and Church, 1998; Kamber *et al*, 2001). Access to colostrum within the first 24 hours is 
important because the intestinal mucosa becomes increasingly impermeable to immunoglobulins 
in form of macromolecules. After 24 hours of birth closure of intestinal mucosa to absorption 
the macromolecules is reported (Bush and Staley, 1980; Kamber, 1995; Cunningham and Klei 
2007). However even beyond this time immunoglobulins in the gastrointestinal tract provide 
immunity by neutralizing pathogenic bacteria and prevents diarrhoea (Foley and Otterby, 1979; 
Bush and Staley, 1980). Additionally colostrum contains transferrin and lactoferrin binding 
immunoglobulins in the gut (Besser and Gay, 1994). In addition to providing passive immunity 
to the neonate, colostrum is rich in vitamins (A, E and C), protein (caseins), 
minerals and energy in form of fat and sugars necessary for growth (Miller, 1979; Kellems and 
Church, 1998).
Table 4.2: Period of time before postnatal camel milk becomes acceptable for human consumption (% respondent)

<table>
<thead>
<tr>
<th>Period</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediately</td>
<td>9</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>One day</td>
<td>1</td>
<td>3.3</td>
<td>33.3</td>
</tr>
<tr>
<td>Two days</td>
<td>3</td>
<td>10</td>
<td>43.3</td>
</tr>
<tr>
<td>One week</td>
<td>14</td>
<td>46.7</td>
<td>90</td>
</tr>
<tr>
<td>Over one week</td>
<td>3</td>
<td>10</td>
<td>100</td>
</tr>
</tbody>
</table>

Figure 4.4: Proportion of respondents (%) who restrict access to colostrum for their calf in the three study locations

n= 30
Newborn calf rumen being nonfunctional their dietary nutrient requirements are provided through colostrum or milk (Kellems and Church, 1998; Ørskov and Ryle, 1990; Ørskov, 1981). It also has a laxative effect to the calf and makes it expel meconium (Juergenson, 1977; Kambo, 1995). Though pastoralists associate calf scouring with colostrum ingestion, the observed diarrhoea among the camel calves could be attributed to a number of things. The teats could be contaminated with diarrhoea causing organisms such as *E.coli*, *Salmonella spp* and *Clostridium perfringens* and as the calf suckles the milk, they are ingested (Salih *et al.*, 1998). Milk may also ferment in the stomach when taken in excess and cause diarrhoea. Protein and lactose being components of milk including colostrum, if taken in excess could cause diarrhoea (Miller, 1979).

Table 4.2 shows that 43.3% of respondents use camel milk within two days after birth in spite of the fact that milk is highly required by the calf because of the colostral content. Though milk forms the major source of nutrients for the young calves, pastoralists limits its access to allow higher milk off-take for the household. A competitive phenomenon between the calf and human is displayed. In the event of adverse weather, when complementation from other stock as a milk source is limited, this competition intensifies and the calf usually loses out. The extent of this competition is indicated by the reported milking pattern (Table 4.3a). The results show that 63% of the respondents milked out the four teats thus only leaving residual milk for the calf. Respondents milking three teats were 7%, 27% milked out two teats and only 3% milked out one teat. As the number of teats milked out decreases the amount of milk available to the calf increases which would be reflected in improved calf growth and survival. Thus, for Opiroi what 27% of total respondents milked out between one and three teats, the camel calves should have performed better compared to the other two sites. This was true for calf mortality which was measured at 33% compared to 51% and 54% for Kawop and Barsaloi respectively Table 4.3b. The
Table 4.3a: Number of teats milked by respondents (%) in different study location

<table>
<thead>
<tr>
<th>Teats milked</th>
<th>Locations % respondents</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Opiroi</td>
<td>Barsaloi</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>16</td>
</tr>
</tbody>
</table>

Table 4.3b: Dams and camel calf parameters means

<table>
<thead>
<tr>
<th>Location</th>
<th>Camel calf mortality (%)</th>
<th>Camel calf body condition</th>
<th>ADG (Kg)</th>
<th>Dam Milk yield (Kg/day)</th>
<th>Dam body condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opiroi</td>
<td>33.31</td>
<td>5.5</td>
<td>0.47</td>
<td>3.3</td>
<td>6</td>
</tr>
<tr>
<td>Barsaloi</td>
<td>53.77</td>
<td>4.7</td>
<td>0.49</td>
<td>4.0</td>
<td>5</td>
</tr>
<tr>
<td>Kawop</td>
<td>50.56</td>
<td>4.3</td>
<td>0.28</td>
<td>3.2</td>
<td>4</td>
</tr>
</tbody>
</table>
lowest average calf growth rate of 0.28 g/day was recorded in Kawop. This was the site with the highest number of respondents, 40%, milking out all the four teats and exposing the calves to the highest level of competition for milk.

4.3.4.1 Effect of vegetation on calf survival

The average mortality rates of camel calves was reported as 31%, 42%, 61% and 56% for excellent, good, fair and poor vegetation condition respectively (Table 4.4). The survival of camel calves decreases as the condition of vegetation deteriorates. Adequacy or otherwise of nutrit of the dam during the peri-partum period is highly correlated to survival of the young (Bello, 1997). The calves born when vegetation condition is good will have enough milk from the dam.

Most of the new born diseases are nutrition related (Holden et al., 1991; Tibary et al., 2000). Improved calf nutrition is associated with a higher ability to fight off diseases hence higher survival rates.

Table 4.4 show the effect of vegetation on mortality rate of camel calves and other stock. The trend in camel calf mortality rate in relation to vegetation condition at birth was also exhibited among small stock (Table 4.4). The inconsistent response of cattle to vegetation condition may be explained by the fact that cattle herds were reported to have a higher mobility compared to camels. Cattle are mainly grazers (Migongo-Bake and Hansen, 1987, Rutagwenda et al, 1987; and have limited choice of forage especially during droughts. The land is degraded due to interaction of climatic and bio- factors (Ho, 2001) reducing the biomass. Annual grasses characteristic of a degraded land dominates and are short lived reducing the herbaceous layer available to cattle (Tarhouni et al, 2007). The greatly reduced and inadequate pasture for cattle necessitates high mobility of cattle to meet the nutritional requirement for survival (Ellis and Swift, 1988). In contrast camels had low mobility mainly because of their adaptive
Table 4.4: Camel calves and cohorts mortality rates in relation to vegetation condition

<table>
<thead>
<tr>
<th>Category</th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camel calves</td>
<td>31</td>
<td>42</td>
<td>61</td>
<td>56</td>
</tr>
<tr>
<td>small stock</td>
<td>39</td>
<td>42</td>
<td>37</td>
<td>53</td>
</tr>
<tr>
<td>Cattle</td>
<td>-</td>
<td>38</td>
<td>28</td>
<td>5</td>
</tr>
</tbody>
</table>
characteristics (Rutagwenda et al., 1989; Kuria, 2004), especially, their ability to feed trees and shrubs which were abundant in the study area. Because these plants are deep rooted, they tend to stay green longer into the dry season than the herb layer plants. Thus the camels tend to remain closer to the settlements throughout the year.

4.3.4.2 Site effect on camel calf growth and survival

The location effect was significant (P < 0.05) for the dam and calf body condition (Table 4.3a). The camels and their calves had a better body condition score in Opiroi (6; 5.5) than in Barsal (5; 4.7) and Kawop (4; 4.3). The dam body condition influences the calf body condition score since it reflects the dam’s nutritional status thus indirectly affecting milk production. The old calf is also able to utilize roughage and therefore directly influenced by the locality through availability of forage. However, the effect of site on milk yield, calf growth and survival was not statistically (P > 0.05) significant (Table 4.3b above). Though not statistically significant, the difference especially between Kawop location and the other two for ADG; Opiroi and the other two for mortality rate appear biologically significant. Little residual milk was left for calves in Kawop while more milk was availed to calves at Opiroi supported by pattern of milking (Table 4.3a above). The effects of site on milk yield, calf growth and survival are long term and cannot be determined by a one time data collection as was the case with body condition. Milk yield, calf survival and growth are influenced by interaction of many factors. The factors that are likely to affect milk yield are nutrition, temperament, water intake, calf presence when milking and feed availability (Simpkin, 1998). Growth is an inherited trait but is largely influenced by the plane of nutrition (NAP 2000; NAP, 2001). Milk yield too is heritable though its heritability is usually lower than that of growth (Calo et al. 1973; van Vleck et al., 1985; Veseth et al., 1994; Karn et al., 1994; Magana and Segura, 1997; Cilek and Sahin, 2009).
Table 4.5b: Summary of one way analysis of variance of location on dam and calf body condition, daily milk yield, calf survival and calf growth (average daily gain (ADG, g))

<table>
<thead>
<tr>
<th>Response measured</th>
<th>DF</th>
<th>Mean square</th>
<th>F</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam Body Condition</td>
<td>2</td>
<td>13.3226</td>
<td>19.81</td>
<td>P&lt;0.05</td>
</tr>
<tr>
<td>Calf Body Condition</td>
<td>2</td>
<td>4.645</td>
<td>3.99</td>
<td>P&lt;0.05</td>
</tr>
<tr>
<td>Dam daily milk yield (Kg/day)</td>
<td>2</td>
<td>3.976</td>
<td>1.901</td>
<td>P&gt;0.05</td>
</tr>
<tr>
<td>Calf Survival (%)</td>
<td>2</td>
<td>1.917</td>
<td>0.89</td>
<td>P&gt;0.05</td>
</tr>
<tr>
<td>Calf growth (ADG, g)</td>
<td>2</td>
<td>545</td>
<td>0.42</td>
<td>P&gt;0.05</td>
</tr>
</tbody>
</table>
Feeds in the range fluctuate with season affecting the growth. Nutrition and health status determine the survival of camel calves.

4.3.5 Other management practices that may affect camel calf growth and survival

Other management practices that may affect calf growth and survival which include; retained placenta, malpresentation and mismothering. Malpresentation which is an abnormal position of calf at birth may lead to mismothering. The dam suffering a long difficult birth may not be able to stand up for suckling. The calf may also be too weak to suckle and hence the bonding between the mother and the calf is weak (Blackshaw, 1986)

4.3.5.1 Malpresentation

Malpresentation is one of the perinatal problems reported by 10% of camel keepers (Figure 4. In Saudi Arabia, Noakes et al (2001) reported 43% and 57% of the malpresentation cases being maternal and foetal respectively. Malpresentation is an abnormal position of calf at birth making normal delivery difficult and at times impossible. The most common malpresentations observed among camels are lateral deviation of the head and carpal flexion. In a normal presentation the front feet are presented first, with the bottom of hooves facing downward and with head following on top of knees. Hide legs also coming out first is also normal though uncommon. Malpresentation may be because the camels are malnourished, weak, emaciated and have narrow pelvic bones. The resultant effect of malpresentation is dystocia. Of the foetal causes, faulty postures makes 90% of the cases while maternal causes, uterine torsion is the highest with 50%, primary uterine inertia 20%, incomplete cervical dilation 20%, and vagina and vulva stenosis 10% (Noakes et al, 2001).
Figure 4.5: Peri-natal problems as reported by respondents (%)
A dystocia calf may suffer anoxia and if acute the calf may die (Bellows, 1997). If it survives delivery the calf will be weak and take long to stand and suckle. The plasma antibodies in dystocia calf are reported to be low due to time lapse before the calf can suckle Colostrum from the dam (Donovan et al., 1986). The management of malpresentation when it occurs poses danger to the animal but if well handled by an experienced stockman, the dam and the calf may survive.

In case of successful delivery mismothering may be a consequence of malpresentation due to delayed calving, calf weakness and inability of the calf to suckle. Suckling is an essential step creating a bond between the calf and the dam (Blackshaw, 1986). Malpresentation results in postpartum injuries such as vaginal tears, perineum and vulva tear and posterior ataxia condition. Inexperienced pastoralists trying to assist the affected camel may apply too much pulling force on the foetus causing tissue tears. Such injuries are common to heifers bred too early and more by a large bull (Dioli et al., 1992). When these postpartum injuries are untreated they may lead to permanent infertility.

4.3.5.2 Retained placenta

Thirty seven percent (37%) of respondents reported retained placenta among their camel herd (Figure 4.5). Though a high proportion of pastologist reported retained placenta as import literature reports indicate this is a very minor problem with less than 2% recorded in Bikaner camels of India (Sharma et al, 2000). However, Tibary et al., (2005) reported retained placenta and other reproductive disorders as common in camels and associated this to hypocalcemia, other trace mineral deficiencies. Minerals deficiency is a common problem in camels under pastoralists' management (Kuria, 2004). Thus, the camels in the study area may have been
similarly affected. Mineral deficiency reduces milk production directly affecting the calf’s nutrition. Also retained placenta may result from abortion caused by infection such as tripanosomiasis or brucellosis. These infections lower camel productivity and hence little milk for the calf.

4.3.5.3 Mismothering

Mismothering is the inability of the camel dam to take care of the new born calf by either rejecting the calf or producing inadequate amount of milk for the calf. Mismothering by camel dams was more prevalent among the poor (52.5 %) of the respondents compared to (47.5 %) of the wealthy (Table 4.6). There is a relationship between mismothering and calving difficulties. When the dam suffers a long difficult birth it may not be able to stand up for suckling.

The calf may also be too weak to suckle and hence the bonding between the mother and the calf is weak (Blackshaw, 1986). That weak bond between the calf and the dam may result in mismothering. The faster the bond is formed between the calf and the mother, enhanced suckling, the faster the mother accepts the newly born calf. The problem was more common with the first calf heifers though it was also reported among older camel cows as shown in Table 4.6.

Frazier and Broom (1997) stated that maternal care complex is a consequence of genetic, physiological and experiential factors. The first calf heifers lack the experience of suckling the calf and learn with subsequent lactations. Oxytocin the hormone involved in milk let down is low for the first calf heifers and increases with parity (Bruchmaeir et al, 1992; Tanın et al., 2001). Any factor delaying the milk let down may cause mis-mothering. Frightening the animal increases the inhibitory hormones (adrenaline) to the milk let down and that may increase the chances of mismothering. As the animal grows older, hormonal imbalance and other
Table 4.6: Reported mismothering incidences and coping strategies (%)

<table>
<thead>
<tr>
<th>Mismothering</th>
<th>Rich respondents %</th>
<th>Poor respondents %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>First calve heifers</td>
<td>27</td>
<td>30</td>
<td>57</td>
</tr>
<tr>
<td>Older dams</td>
<td>13</td>
<td>14.5</td>
<td>27.5</td>
</tr>
<tr>
<td>others</td>
<td>7.5</td>
<td>8</td>
<td>15.5</td>
</tr>
</tbody>
</table>

Strategies for coping

<table>
<thead>
<tr>
<th></th>
<th>Rich respondents %</th>
<th>Poor respondents %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force mothering</td>
<td>33</td>
<td>27</td>
<td>60</td>
</tr>
<tr>
<td>Hand rearing</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Do nothing</td>
<td>67</td>
<td>70</td>
<td>37</td>
</tr>
</tbody>
</table>
physiological malfunction may set in and explain the reported mis-mothering in older ca
dams in spite of the acquired experience (Houpt, 2000).

To manage the vice pastoralist use several strategies; force mothering through pain infliction
closing the anus to stop defecation causing discomfort, scaring by pretending to be a predi
attacking the calf, blindfolding the mother and retaining her in the enclosure. Schwartz (19
reported the practice by pastoralists of closing the anus of the camel dam in case of calf rejecti
The camel dam cannot defecate causing discomfort which increases to a level it forgets to re_
the calf. These practices are also common among the Somalis (Elmi, 1989). The calves that were rejected were hand fed with milk from other camels or maize meal porridge by a sma
proportion of respondents among the poor. The proportion of respondents practicing forci
mothering was 27% among the poor and 33% for the rich (Table 4.6). More of the re
respondents resulted to forced mothering than the poor while only the poor resorted to ha
rearing. This may suggest that the poor attached a higher value to those calves and were will

to do much more to ensure their survival.

4.4 Conclusions and Recommendations

- The average growth rate of camel calves was 212 g/day. The male calves exhibited
higher growth rate of 281 g/day than females at 168 g/day. Though the growth rate
within the range expected in pastoral production systems, the potential for better gro
exists with improved calf management and provision of health care services as is sho
in available literature.
• The vegetation condition at birth affected camel calf growth and survival. The growth rate and survival increased with good vegetation condition. This was explained by the fact that with good feed availability, nutritional status and milk production by the dam was improved. For the calf mainly dependent on suckling for the first three months of life, this would result in better performance.

• The mortality rates of camel calves remained unacceptably high with an average of 50%. Male calves had a mortality rate of 56% and females 43%. This was largely explained by practices affecting growth and survival namely colostrum denial, milk access limitation and probably malpresentation during birth and mismothering.

4.4.1 Areas for further investigation

• To establish the causes of the perceived high incidences of retained placenta in camel herds.

• Investigate on alternative sources of feeds to revamp nutrients in time of shortage and reduce fluctuation of milk production and calf mortality.

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CHAPTER FIVE

5.0 Correlation of Actual Live weight and Estimates of Live weight

5.1 Introduction
Live weight measurements is an important management tool which can assess the growth rate and the effect of feeding regime on farm animals (Brown et al., 1973; Kunene et al., 2007). Indication of live weight especially for a growing animal is important in assessing growth rate and for determining dosage in drug administration (Hile et al., 1997; Thiruvenkandan, 2000). Estimation of body weight can be useful in the evaluation of feeding programmes, nutritional status and such management practices as selection of replacement heifers (Dingwell et al., 2007). Body weight information can also be used in determining the monetary value of animals and the efficiency of rearing. It’s an important tool in marketing of animals; the farmers can get value for their animals when prices are pegged on the weight. Body measurements are also used in breeding identification and classification, a prerequisite for management and conservation of animal genetic resources (Al-Hazni et al., 1994; Gatesy and Arctander, 2000; Mwacharo et al., 2007). Linear body measurements are useful in estimating the live weight of animals and especially in a place where weighing machines are not available (Bhadula et al., 1979; Hile et al., 1997; Raji et al., 2008; Cam et al., 2010). They indicate animal size and weight in a less complicated and inexpensive way (Heinrichs et al., 1992; Goe et al., 2001). The potential of breeding stock may also be assessed through linear body measurements (Luo et al., 1997; Alderson, 1995). According to Rege (2001) and Zechner et al. (2001), breeding goals can also be evaluated by morphological descriptions. There are two categories of linear body measurements, the skeletal and the tissue measurements (Essien and Adesope, 2003; Kunene et al., 2007). Skeletal measurements such as ulna length, body height and length, chest and chest depth better describe...
inherent characteristics while width, girth and body weight indicate muscle and fat deposit
and are nutrition related (Blackmore et al., 1958; Kamalzadeh et al., 1998; Kunene et al., 2007).

Schwartz et al., (1983) developed the linear body measurement equation from mature camels
while Simpkin (1998) measured calves but included calves older than one year. Kuria et al.
(2007) study was for calves up to seven months. There was only one study for prediction of
weight for calves less than one year old in similar pastoral production systems. This is a critical period for assessing the performance of the camel calf. The current study endeavoured
develop a regression equation to predict weight of camel calves up to one year.

5.2 Materials and Methods

5.2.1 The study area
This is as described in the chapter 3

5.2.2 The instruments and data collected
Randomly selected camel calves were weighed using a scale. Fifty nine (59) camel calves were weighed. These calves were of different age and sex but up to one year old. The age of the calves were determined from recall information given by the camel owners. The camel calves to be weighed were gently suspended on a scale using a sling and the weight taken. A tape measure (30 m) was used to take the linear body measurements, early in the morning, before the calves were fed or taken out to graze, to reduce the error. The linear measurements taken were the shoulder height, the heart girth and abdominal girth of the calves’ body.
5.2.3 Analysis of the data

The linear regression equations of the best fit of the body linear measurements were derived from the data run in Genstat® (VSNI, 2008). The output was fitted into the model which was used to estimate the live weight of camel calves. The estimated live weights were correlated with the actual live weight and coefficient of correlation used to determine the degree of association.

Also projected linear body measurements were fitted into Schwartz’s et al., (1983), Simpkins (1998), Kuria’s et al., (2007) and the models derived from this study in order to compare them and generate respective growth curves.

5.3 Results and Discussion

The general model describing the estimation of live weight through body linear measurements was similar to the one used by Hile et al., (1997), Mwacharo et al., (2006), Alade et al., (2007) and Keith et al., (2009). This model is shown below.

\[ Y_i = a + bX_i + e_i \]

Where \( Y_i = \) estimated live weight of camel calves

\( i = 1, ..., n \) observations

\( X_i = \) Independent variables either heart girth, abdominal girth or shoulder height of camel calves

\( a = \) intercept on \( Y \)

\( b = \) regression coefficient of \( Y \) on \( x \)

\( e_i = \) residual for observation
A descriptive statistics of the linear body measurements and actual live weights generated from this study are shown in Table 5.1 The mean values were $1.17 \pm 0.18$ m, $1.32 \pm 0.26$ m, $1.29 \pm 0.18$ m, and $103.25 \pm 39.04$ Kg for heart girth (HG), abdominal girth (AG), shoulder height (SH) and live weight (Wt), respectively. Body weight is useful in determining the performance of animals in the farm (Keith et al., 2009) but is often unavailable in the resource poor pastoral communities. Regression of linear body measurements becomes handy in estimating the weight of farm animals (Bhadula et al., 1979, Keith et al., 2009).
### Table 5.1: Descriptive statistics of linear body measurements

<table>
<thead>
<tr>
<th>Linear measurement</th>
<th>Mean (m)</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart Girth</td>
<td>1.17</td>
<td>± 0.18</td>
</tr>
<tr>
<td>Abdominal Girth</td>
<td>1.32</td>
<td>± 0.26</td>
</tr>
<tr>
<td>Shoulder Height</td>
<td>1.29</td>
<td>± 0.18</td>
</tr>
<tr>
<td>Live Weight</td>
<td>103.25</td>
<td>± 39.04</td>
</tr>
</tbody>
</table>
A highly significant (P< 0.01) correlation coefficient of $r = 0.957$ and $r = 0.934$ was found between the live weights of camel calves and the abdominal girth and heart girth respectively, except for shoulder height where $r = 0.432$ (Table 5.2). This suggested that the abdominal girth was the best single weight estimator contrary to Kuria et al. (2007) and Mwacharo et al. (2007) who recorded heart girth. However, the $r$ value for abdominal girth is similar to Kuria et al. (2007).

The predictive equation and coefficient of determination ($R^2$) expressed as a percentage variation for the body weight and estimated using the heart girth (HG), abdominal girth (AG), shoulder height (SH) and a combination of two or three linear body measurement is shown in Table 5.3. Abdominal girth coefficient of determination $R^2$ accounts for 91.4%, heart girth 87% and shoulder height 17.2% of the body weight variation respectively. For simple linear regression abdominal girth equation ($-73.9 + 142.42x$) accounts for a higher percentage of variation and would therefore be a more reliable single predictor of the weight of camel calves but the time when measurements should be taken is critical for accuracy. It should be early in the morning when the animals have not fed to reduce the measurement variability. A multiple regression of abdominal girth and heart girth explains 92.2% of the variation. An addition of shoulder height in the regression causes an insignificant percentage variation (0.1%). The correlation of predicted weights and the actual live weights at P< 0.01 was high ($r = 0.963$) for the multiple regression equation ($-100.6 + 101.2AG + 58.2 HG + 9.91SH$) derived from the three linear body measurements.
### Table 5.2: Correlation coefficients (r) between live body weight, heart girth, abdominal girth, and shoulder height of camel calves.

<table>
<thead>
<tr>
<th></th>
<th>Body weight</th>
<th>Heart Girth</th>
<th>Abdominal Girth</th>
<th>Shoulder Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight</td>
<td>1.00</td>
<td>0.934</td>
<td>0.957</td>
<td>0.432</td>
</tr>
<tr>
<td>Heart Girth</td>
<td>1.00</td>
<td>0.941</td>
<td></td>
<td>0.421</td>
</tr>
<tr>
<td>Abdominal Girth</td>
<td>1.00</td>
<td></td>
<td>0.397</td>
<td></td>
</tr>
<tr>
<td>Shoulder Height</td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
</tbody>
</table>

### Table 5.3: The predictive equation and coefficient of determination (R²) for camel calves' body weight using the HG, AG, SH and the combination of the three parameters based on the linear regression analysis.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Regression equation</th>
<th>Adjusted R²</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>HG</td>
<td>(-113.0 + 197.7HG)</td>
<td>0.87</td>
<td>**</td>
</tr>
<tr>
<td>AG</td>
<td>(-73.9 + 142.42AG)</td>
<td>0.91</td>
<td>**</td>
</tr>
<tr>
<td>SH</td>
<td>(19.8 + 92.4SH)</td>
<td>0.17</td>
<td>n.s.</td>
</tr>
<tr>
<td>Combined HG and AG</td>
<td>(-92.5 + 101.2AG + 62.3 HG)</td>
<td>0.922</td>
<td>**</td>
</tr>
<tr>
<td>All three combined (HG, AG, SH)</td>
<td>(-100.6 + 101.2AG + 58.2 HG + 9.91SH)</td>
<td>0.923</td>
<td>**</td>
</tr>
</tbody>
</table>

** P< 0.01  
 n.s. = not significant  
 n=30
In order to compare models and respective growth curves, projected linear body measurements were fitted into Schwartz’s (1992), Simpkin’s (1998), Kuria’s et al., (2007) models and the one derived from this study (Fig. 5.1). Schwartz et al., (1983) estimated the weight of camels by $W = A \times HG \times SH \times 50$. The multiplication factor was modified by Simpkin (1998) to $44.9 \pm 0.26$ for camel calves. The growth curves generated by the regressions of this study are linear and generated higher weight estimates for the first four months but show a low growth rate. Schwartz’s et al., (1983) and Simpkin’s (1998) regressions are exponential though the former depicts a faster growth. Kuria’s et al., (2007) regression model gave a linear growth curve similar to the one in this study. It shows a faster growth. The variation from the expected sigmoid growth curve could be due to the small sample used in this study and the measurements which were taken once each calf. Repeated data collection proves difficult in a pastoral community because of high mobility. Also the calves measured were different and at different age and locality. In addition, the age given was highly dependent on the accuracy of the recall information from respondents. The calves were under different management too. However in the pastoral systems where migration is the norm, a onetime data collection is a better option.
Figure 5.1: Comparison of weight estimates from various regression equations.
5.4 Conclusion and recommendation

Heart girth and abdominal girth regression ($Y = -92.5 + 101.2AG + 62.3 HG$) gave a better estimate of weights of camel calves but for a single linear measurement abdominal girth preferred ($Y = -73.9 + 142.42x$). Shoulder height was non-significant for live weight estimation.

The results suggested that the values for linear body measurements when fitted in the formula gives estimated live weight of camel calves useful in ASAL. The predictive equations developed for estimating live weight of camel calves would enhance management of camels when incorporated in the pastoral production systems.

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CHAPTER SIX

6.0 General Discussion

6.1 Introduction

Camels in a pastoral production system are critical for the supply of milk to the household. The recurrent droughts (Adger et al., 2003), a characteristic of arid and semi arid lands, makes the camel a preferred stock due to its adaptive properties (Kuria, 2004). Camel rearing is constrained by inadequate feed resources which fluctuate with seasons, lack of herding labour, diseases, external and internal parasites and inadequate extension and health services. These result in reduced milk production that has a bearing not only on the growth and survival of the calf but also on the household livelihood. Data were collected on pastoral camel and calf rearing practices using questionnaires which were subsequently analysed. The study sought information on the general camel management practices and the factors that affect growth and survival of camel calf identifying the gaps while proposing the possible future interventions.

6.2 General camel production practices in Samburu

Variation of wealth status in terms of livestock owned existed among the pastoralists in the study area where the rich owned more TLUs than the Poor. This has implication on communal resource use because the few rich in the community have more TLUs and share the same common resources. It does not follow that the products from livestock utilizing
communal resources will be equitably distributed to the community. This result concurs with the literature report that wealth variation among households characterizes African pastoralist communities (Borgerhoff-Mulder and Sellen, 1994; Curry, 1996; Dahl, 1979; Dyson-Hudson 1980; Fratkin and Roth, 1990).

The livestock kept by the pastoralists are multispecies (camels, cattle, goats and sheep) and have a high proportion of females compared to males, the main reason being subsistence. The pastoral herd is essentially a dairy herd which is meant to provide the nuclear family with milk. The high proportion of camels in the study area is a reflection of this subsistence function. The camel is more reliable source of milk in drought prone areas and more so to the most vulnerable members of the society; the elderly, women and children who are normally left behind when livestock migrate. Droughts are a common occurrence with its cycles being less than 2 to 3 years in the recent past (Sivasani, 2000). Due to global climate change the situation is not likely to improve (Adger et al., 2003) implying that reliance on camels as a source of milk will intensify. Keeping more females than males is a safe guard against disaster; there is that hope that at least some breeding animals will survive for continuation of the herd. Inclusion of many species diversifies resource use and is also a way of spreading risks. Different livestock species have different feeding habits (Sanon et al., 2005; Ouedrago-Kone et al., 2006) and given a free choice consume mixed diets showing partial preferences for certain forages (Parsons et al., 1994; Hester et al., 1999; Rutter et al., 2004). Defoliation by animals is selective both between plant parts and between plant species (Bullock and Marriott, 2000). Greater outputs have been reported when cattle and sheep are grazed together and also for camels and cattle/sheep (Nicol and Collins, 1986; Wright and Connolly, ...
Grazing animals are known to exhibit trophic interaction patterns while feeding in the free range (Nyangito et al., 2008) though competition may arise in times of feed scarcity.

There was no defined breeding programme and the market was the main source of breeding animals. Most animals brought to the market in a pastoral setup were culls and therefore not best for breeding purposes. Since milk production is the main function of the pastoral herd, selection of breeding camels should bear that objective. Camels within the herd that are better in milk production should be selected and the germ plasm conserved. Therefore any breeding programme for camels should be to boost milk production putting into consideration the feeds availability to support that productivity. Production is only after body nutrient for maintenance requirements have been met. Lack of feeds may negate the gains of breeding. Adoption of production technologies, including better breeding management would increase milk production per animal. This would have the effect of reducing the number of animals required to support a household which is quoted as 23 – 26 for a household of seven (Field, 1985). The environment will better support fewer camels with higher productivity for a longer period, into the drought and thus more milk in time of greatest need not only for the family but also for the camel calf. Also increased productivity by better management is equally important especially with commercial orientation of livestock sector as envisaged in vision 2030 (GoK, 2007; MoLDSP, 2009)

It was generally observed that heifers were served earlier than the recommended four years (Bissa et al., 1998). That has implication on the camel because the partitioning of the nutrients
gives priority to the foetus needs at the expense of the growing camel (Bauman and Curie, 1980, Van Saun and Sniffen, 1996). This could still be critical in an environment where feed inadequacy is the norm as is generally true of the pastoral range areas. The resultant impaired growth and poor body condition may lower overall heifer performance due to increased incidences of birth complications.

Feed shortage was considered by most respondents as a serious problem. The seasonal fluctuation of feeds remains the most challenging issue to camel productivity in the arid and semi-arid lands. Milk production follows the cyclic nature of feed availability and that has a bearing on the survival and growth of camel calves. Unfavourable climatic conditions which limit forage growth and hence the availability, result in underfeeding of the camels.

Underlying problems of delayed puberty, suppressed ovulation, delayed postpartum ovulation, and increased embryo mortality are unavoidable (Chillard et al., 1998). Feed supplementation though not commonly practiced in a pastoral system could improve productivity tremendously. However, there were attempts of supplementation with salt but they were not satisfactory. A study on salt sources is important to validate the content and advice on deficiencies. Salt supplementation increased milk production and was associated with enhanced calf growth (Kuria, 2004) and is also reported to increase fertility and reduce retentation of afterbirth (NAP, 2000). Majority of camel keepers do not seek extension services and neither do the service providers reach them frequently. The current extension policies are not pro-pastoralists. Revamping of extension services in the pastoral production system is crucial to improving camel productivity.
6.3 Factors affecting camel calf growth and survival

The major factor affecting calf growth and survival was reported to be feed availability which fluctuated with season. There were a lot of feeds during the rainy season which caused increase in milk production. The increased milk production had a direct effect on the camel calves’ growth and survival. The growth rate was observed to be high during the time of feed abundance than the dry period and vice versa. The mortality rates were equally low when feeds were plenty. The mortality rates were noted to be aggravated by marketing of camel milk coupled with high levels of poverty as was in Kawop. The calves were left with very little residual milk to feed on. The growth rate in this location was low compared to other locations. Competition for milk affected growth and survival of camel calves and management practices should endeavour to reduce this phenomenon.

Other factors reported to affect calf growth and survival were access to colostrum and milk and management practices on pre- and post-natal period. Colostrum provision to the neonate within first 24 hours after birth is important for acquisition of passive immunity. Most respondents denied colostrum to the camel calf which partly explained the high mortality of 50% in the system analysed. Their belief that colostrum causes diarrhoea ignores the fact that diarrhoea can be caused by bacterial infection (Salih et al., 1998), worm loads or nutrition especially trace mineral deficiency (Thomas, 2003; Thomas, 2009). Most respondents limited milk access to the calf to increase household off take. This resulted to the low growth rate of 212 g/day while the potential exist for a higher growth rate as was reported in a similar system by Field (1979) where the 75% of the milk yield was fed to the calf.
The reported pre- and post-natal problems of placenta retention, malpresentation and mismothering affecting calf survival can be minimized by improved camel management. Synchronizing breeding season with feed availability and selecting breeding bulls with reported easy calving, can considerably reduce retained after birth and malpresentations respectively. The managerial skills on handling malpresentation and mismothering are crucial for the survival of the affected calf.

6.4 Correlation of actual live weight and estimates of live weight

A strong positive correlation (r=0.963 at P< 0.01) of actual live weight and estimates from linear measurements was exhibited in this study. This validated the use of linear body measurements to estimate live weight of animals applicable in places where weighing machines are not available or are cumbersome to use. Live weight estimates are used for accurate drug administration to the camels and also to assess the growth rate. The linear measurements are growth related and can determine the correlation of growth traits in animals (Schmidt et al., 2006). Weight measuring through estimation is an important tool to the management of camels in ASALs.

6.5 CONCLUSION AND RECOMMENDATION

6.5.1 CONCLUSION

• Variation in the TLU as the measure of wealth exists among the poor, intermediate and the rich pastoralists.
• Pastoralists keep diverse livestock with high proportion of female than males mainly for milk provision for the household.

• Feed fluctuation with seasons impacted negatively on growth and survival of camel calves.

• The average camel calf growth rate in the pastoral production system was 212 g/d with males exhibiting a higher growth rate of 281 g/d than 168 g/d of female calves.

• The mortality rates of camel calves remained unacceptably high; the average was 50% with male calves exhibiting a higher mortality rate of 56% and females 43%.

• Marketing of camel milk impacted negatively on the growth and survival of camel calves.

• Animal health and extension services provision in the area were inadequate.

6.5.2 RECOMMENDATION

• Diversification of livestock herds of Pastoralists should be maintained and improvement on the productivity of the dairy herd sought.

• Community training on appropriate management practices of camels should enhanced.

• Due to the fluctuation of feeds, feed supplementation trials for camels should be carried out.

• Commercialization and privatization of extension and livestock health services should be evaluated and adjusted towards providing adequate extension services in pastoral production systems.
Management practices that reduce pre and post natal problems, allowing colostrum and milk to the calves and hence reducing the mortality rates are important for ensuring survival and growth of camel calves.

References


the third annual meeting of the animal production under arid condition. Vol 2; 132-137, United Arab Emirates University.


Samburu District

INTRODUCTION

I) This information is strictly confidential and will only be used for the purpose of this project

II) Fill answers to questions and/or tick and rank your responses as accurately as you can remember.

OBJECTIVES

The overall objective of the survey is to describe the status of traditional production system of the camel calf in Samburu district.

SITE AND FARM IDENTIFICATION

Questionnaire serial No.__________

1. Enumerator’s name:_________________________ Code:________________

2. Respondent’s name:_________________________ Age:_________ Sex: M [ ] F [ ]

3. Sub location:_______________________________

4. Location:_______________________________

5. Division:_______________________________

RESPONDENT PROFILE

(If possible, these questions should be asked at the end of the interview)

6. Is the respondent the head of this household: Yes[ ] No [ ]

If no to the above:
7. What is the respondents relationship to the head of household?
   Husband [ ] Wife [ ] Son [ ] Daughter [ ] Worker [ ] Other [specify..................]

8. What is the marital status of the respondent?
   Married [ ] Single [ ] Widow/Widower [ ] Divorced [ ]

9. Is the respondent having any formal education? Yes [ ] No [ ]

10. If yes to the above, what is his/her highest level of education?
    Primary school[ ] Secondary school [ ] Post secondary college [ ] University [ ]

11. Have you attended any of the following agriculture-based trainings?
    Short courses in agriculture [ ] certificate agriculture [ ] Farmer Field school training [ ]
    Other [specify......... ]

HOUSEHOLD STRUCTURE AND FARM LABOUR USE

12. How many persons reside in the household according to their age groups and sex? Give numbers.

<table>
<thead>
<tr>
<th></th>
<th>0-14 yrs</th>
<th>15-45 yrs</th>
<th>45-60 yrs</th>
<th>Over 60 yrs</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13. How many persons in the household are involved in livestock rearing activities according to age group and sex? Give numbers.

<table>
<thead>
<tr>
<th></th>
<th>9-14 yrs</th>
<th>15-45 yrs</th>
<th>45-60 yrs</th>
<th>Over 60 yrs</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
14. Who performs the following livestock rearing activities on the farm (*Tick where relevant*).

<table>
<thead>
<tr>
<th>Activity</th>
<th>Father</th>
<th>Mother</th>
<th>Son</th>
<th>Daughter</th>
<th>Hired labour</th>
<th>Others</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleaning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>housing/enclosures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spraying</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk Sales if any</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animal sales</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manure sales if any</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health management/care</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**HOUSEHOLD SOURCES OF INCOME**

15. What are the most important sources of income in your household?.

*(Rank from 1=most important to 5=least important)*

<table>
<thead>
<tr>
<th>SOURCES</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livestock products</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Remittance from relatives</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Salary/Wages</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
</tbody>
</table>
16. Out of the income from livestock produce, what proportion (%) comes from:
Camel Milk sales [ ] other Livestock milk sales [ ] Camels sales [ ] other
[specify...................................................]

17. What proportion (%) of milk consumed by human comes from:
Camels [ ] cattle [ ] sheep [ ] goat [ ]

**LIVESTOCK INVENTORY AND HERD STRUCTURE**

18. What type of livestock do you keep in the manyatta? *(Rank them in order of importance from 1=most important to 5=least important)*

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>/TYPE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camels</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local cattle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Donkeys</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goats</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local chicken</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (specify......)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
19. What is the herd structure of your livestock?

(i) Give the number in each category for camels

<table>
<thead>
<tr>
<th></th>
<th>Mature camels</th>
<th>Young camels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total 1</td>
<td>Breeding females</td>
<td>Breeding males</td>
</tr>
<tr>
<td></td>
<td>males</td>
<td></td>
</tr>
</tbody>
</table>

(ii) Give numbers in each category for cattle.

<table>
<thead>
<tr>
<th></th>
<th>Mature cattle</th>
<th>Young cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total 1</td>
<td>Breeding females</td>
<td>Breeding males</td>
</tr>
<tr>
<td></td>
<td>males</td>
<td></td>
</tr>
</tbody>
</table>

(iii) Give numbers for each species by sex.

<table>
<thead>
<tr>
<th></th>
<th>Goats</th>
<th>Sheep</th>
<th>Poultry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

20. Which breeds of livestock and number are on the manyatta?
21. Are your camel calves put in enclosures: Only at night [ ] Part of the day [ ] Both day and night [ ] Not at all [ ]

22. If enclosed at any time, What type of enclosures do you have?
   i) Enclosed structure: thorn fence [ ] mud walled [ ] Others (specify .......................[ ]
   ii) Housing structure: polythene mud roofed with murram floor [ ] Grass thatched with murram floor [ ] Others (specify .......................[ ]

23. What is the major benefit you get from your camels?
   (Rank from 1=most important to 5=least important)

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk for home consumption</td>
<td>[ ]</td>
</tr>
<tr>
<td>Cash Income</td>
<td>[ ]</td>
</tr>
<tr>
<td>Asset building</td>
<td>[ ]</td>
</tr>
<tr>
<td>Insurance</td>
<td>[ ]</td>
</tr>
<tr>
<td>Others (specify...................)</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

**Camel Calf Management and Breeding**

24. Have your camels had some problem during giving birth? Yes [ ] No [ ]
25. If yes what are the problems? Oversize foetus [ ] wrong orientation of foetus [ ] stillbirth [ ] others specify ..................................

26. Have you had camel mothers rejecting the calf? Yes [ ] No [ ]

27. If yes, which camels reject the calf: heifer [ ] first calving [ ] second calving [ ] calves more than twice [ ] others (specify.........................).

28. If yes what have you done to make her accept the calf? Force mothering [ ] hand rear the calf [ ] inflict pain on the mother [ ] others specify.............

29. After how long does the calve start suckling the colostrum from the mother for the first time?. 30 min [ ] 1 hr [ ] 2 hr [ ] 3 hr [ ] 4 to 12 hr [ ] others specify.......................... hours.

30. State whether the calf is given assistance to get the first milk. Always [ ] rarely [ ] not at all [ ]

31. When the calf suckles for the first time ; the calf suckles the whole of the first milk [ ] milk out the udder once before the calf suckles [ ] milk out the udder once after the calf suckles [ ] others specify ................

32. When calve is suckling colostrum, is there limitation on the amount? Yes [ ] no [ ]

33. If yes, how is this done? Allow suckling one quarter [ ] half [ ] limit time of access [ ]

34. What special care do camel calves require at birth? Ensure calve breathing [ ] disinfecting of the calf naval[ ] tie with sterilized string the umbilicus [ ] colostrums suckling [ ] others (specify ................. )

35. How soon after calving is camel milk acceptable for human consumption? Immediately [ ] one day [ ] two days [ ] one week [ ] over one week [ ]
36. At milking, how many teats are milked? One [ ] two [ ] three [ ] four [ ] half volume the quarter [ ]

37. How is the male calf treated? Denied milk [ ] given little milk [ ] offered equal opportunity to milk [ ]

38. If the male calf is denied or given little, why? Not valued culturally [ ] not a source milk [ ] others specify ................................................

39. What special care do camel calves require from birth to weaning? Feeding [ ] treatment [ ] protection against predators [ ] routine management [ ] others specify ................................................

40. How many calves have been born in the last one year? Specified males/females........................

41. How many are alive? males .............females.............. How many are dead? males........females.........

42. Do you ever see your young camel calves with deformed legs which recover later on live? Yes [ ] No [ ]

43. How many breeding bulls do you have in your herd? specify.................................

44. Do you raise your breeding bulls or do you acquire/borrow them from other pastoralists? Born in own herd [ ] bought breeding bull [ ] borrowed breeding bull [ ]

45. Which are the criteria for selection of a breeding bull? Lack of defects [ ] fertile [ ] strong [ ] lack sexual transmitted diseases [ ] others specify .........................................................

46. For how many years is the same breeding bull serving in your herd? (the present and previous)
Present bull ..................... Years; previous bull ..................... years.

Do you allow the breeding bull to breed his daughters? Yes [ ] No [ ]

47. Did you ever observe abnormalities in the camels of your manyatta, like very small ears or no ears, deformed jaws, blindness or deafness, which are not caused by accident and which do not recover? Yes [ ] No [ ]

If yes which one? Small ears [ ] deformed jaws [ ] blindness [ ] deafness [ ] reproductive disorder( cryptorchidism) [ ] others ................................................

LIVESTOCK FEEDS AND FEEDING PRACTICES

48. Enumerate the Feed types available to camels on your manyatta.

<table>
<thead>
<tr>
<th>Class of feed</th>
<th>Type(specify)</th>
<th>Source</th>
<th>Class of animal fed</th>
<th>(Tick the relevant)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Calves</td>
<td>Milking camel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dry camel</td>
<td>Camel Bull</td>
</tr>
</tbody>
</table>

**Roughage**
1. local pasture grass
2. Acacia pods
3. fodder shrubs
(specify..................)

**Minerals salts**
1. Purchased compound salts
2. Common table salt
3. salt lick:
   frequency
3. Other
   (specify..................)

**Water**
Type
(interval)
distance
MAJOR FEEDING CONSTRAINTS

49. Which of the following are major constraints to livestock feeding in your area?

(Rank follows: 1=always a problem; 2= only a problem seasonally; 3=not a serious problem)

<table>
<thead>
<tr>
<th>CONSTRAINT</th>
<th>RANK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shortage of basal feeds</td>
<td>1</td>
</tr>
<tr>
<td>Lack of labour for feeding livestock</td>
<td>2</td>
</tr>
<tr>
<td>Other (specify....................... )</td>
<td>3</td>
</tr>
</tbody>
</table>

50. In which months of the year do you experience:

Surplus feeds [......,ii....,iii,...] and feed shortages [i.............,ii......,iii......]

51. What do you normally do when you have shortage of feed on your usual grazing area;

Sale some animals [ ] Temporarily loan to friends/relatives [ ] Do nothing [ ] Migrate [ ]

Others; specify.......................................

52. Indicate the feed resource and months when available in your area (Tick months)

<table>
<thead>
<tr>
<th>Forages</th>
<th>Seasonal (month) Availability</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fodder shrubs/trees</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (specify)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

53. What is the source of water for livestock on your manyatta?

River [ ] Pond [ ] Lake [ ] Dam [ ] Borehole [ ] Piped water [ ] Protected spring

Other; specify.........................[ ]
54. How far is the main water source from your manyatta?

It is less than 500 m [ ] about 1 km [ ] about 2 km [ ] about 3 km away [ ] over 3 km [ ]

ACCESS TO EXTENSION AND HEALTH SERVICES

55. How many times in a month do you receive advisory services from the area extension workers?

Once [ ] Twice [ ] more than two times [ ] not at all [ ]

Others; specify ......................................... [ ]

56. If the extension workers visit you at all, what extension messages do they often give you?

Livestock feeding [ ] livestock health care [ ] camel husbandry [ ] crop husbandry [ ] soil conservation [ ]

Others; specify ......................................... [ ]

57. Do you usually visit extension offices to ask for services? Yes [ ] No [ ]

58. If no to the above, why?

Extension offices too far [ ] Service charges too high [ ] I have not thought of it [ ]

Others; specify ......................................... [ ]

59. Who is the main animal health service provider in your area?

Government Vets [ ] Agro-vet shops [ ] Private vets [ ] Ethno-vets [ ]

Others; specify ......................................... [ ]

60. What is the frequency of service provision?

<table>
<thead>
<tr>
<th>Services</th>
<th>Most frequent=1, Less frequent=2, Not used=3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. GoK vet. Services</td>
<td></td>
</tr>
<tr>
<td>2. Private vets</td>
<td></td>
</tr>
<tr>
<td>3. Agro-vet shops</td>
<td></td>
</tr>
</tbody>
</table>
61. What are the three most common animal health problems on your camel calves and do you manage them?

<table>
<thead>
<tr>
<th>Disease</th>
<th>Management strategy practiced (1=call a vet; 2=buy drugs and treat; 3= use herbal medication; 4= do nothing; 5=Other; specify(...............................))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
</tbody>
</table>

**REPRODUCTIVE PERFORMANCE**

62. What is the source of your replacement stock? *(Tick where appropriate)*

- Rear [ ]
- Own [ ]
- Buy from market [ ]
- Exchange/barter [ ]
- Other; specify .........................................................[ ]

63. How do you know if your camel needs a bull? *(Tick where appropriate)*

- Change in camel behaviour (mounting, bellowing, restlessness etc) [ ]
- Change in milk production [ ]
- Change in feed intake [ ]
Mucus discharge from the vulva

Do not know

64. How often do your camels come on heat? (Tick where applicable)
   Every month [ ] Every two months [ ] Do not know [ ] Other, specify

65. At what age do your camels produce their first calf? (Tick where applicable)
   In less than 3 years old [ ] when 3 years old [ ] when over 3 years old [ ]

66. How often do your camels calve down? (Tick where applicable)
   Every 2 year [ ] every 3 years [ ] after more than 3 years [ ]
   What time of the year are most calves born? Specify

MARKETING OF LIVESTOCK PRODUCTS

68. Do you often sell milk? Yes [ ] No [ ]

69. If yes to the above, where do you normally sell?

<table>
<thead>
<tr>
<th>Outlet (Tick where appropriate)</th>
<th>Proportion</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate Neighbors [ ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local market [ ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other, specify [ ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

70. What proportion (%) and price of milk as per the type of the stock is sold?

<table>
<thead>
<tr>
<th>Type of Stock</th>
<th>Price</th>
<th>Proportion</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small stock</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
71. What are your main cash needs in a year?

(Rank as follows: 1= most important; 2= occasionally important; 3=least important)

<table>
<thead>
<tr>
<th>Needs</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>School fees</td>
<td>1</td>
</tr>
<tr>
<td>[ ]</td>
<td>2</td>
</tr>
<tr>
<td>[ ]</td>
<td>3</td>
</tr>
<tr>
<td>Medical bills</td>
<td></td>
</tr>
<tr>
<td>[ ]</td>
<td>2</td>
</tr>
<tr>
<td>[ ]</td>
<td>3</td>
</tr>
<tr>
<td>Cultural events/ceremonies</td>
<td>1</td>
</tr>
<tr>
<td>[ ]</td>
<td>2</td>
</tr>
<tr>
<td>[ ]</td>
<td>3</td>
</tr>
<tr>
<td>Social/welfare engagements</td>
<td></td>
</tr>
<tr>
<td>[ ]</td>
<td>2</td>
</tr>
<tr>
<td>[ ]</td>
<td>3</td>
</tr>
<tr>
<td>Domestic affairs (food, clothings etc.)</td>
<td>1</td>
</tr>
<tr>
<td>[ ]</td>
<td>2</td>
</tr>
<tr>
<td>[ ]</td>
<td>3</td>
</tr>
<tr>
<td>Support to relatives</td>
<td>1</td>
</tr>
<tr>
<td>[ ]</td>
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<td>Others; specify............................</td>
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72. What do you estimate as your annual expenditure?

- About Ksh. 20,000 [ ]
- More than Ksh20,000 but less than Ksh. 30,000 [ ]
- More than Ksh. 30,000 [ ]

73. Finally, is there one thing you would like to suggest which would improve the future of camel calf in your location?

THANK YOU VERY MUCH FOR YOUR TIME
APPENDIX II: BODY CONDITION SCORING CHART

BCS 1. Extremely thin and weak, near death. Rough hair coat.

BCS 2. Extremely thin but not weak. Rough hair coat. Transverse processes project prominently, neural spines appear sharply.

BCS 3. Very thin. All ribs visible. Spinous processes prominent and very sharp. No fat cover felt with some muscle wasting.

BCS 4. Slightly thin. Most ribs visible. Spinous processes sharp. Individual processes can be easily felt. Slight fat cover can be felt over hump.

BCS 5. Moderate. Spinous processes felt but are smooth. Some fat cover felt over hump.


BCS 7. Fat. Ribs not visible, animal smooth and well covered, spinous process felt under firm pressure. Considerable fat over the hump.

BCS 8. Obese. Camel is very fat with spinous processes difficult to feel. Ribs can not be felt. The hump is well covered with fat, the stomach is round and smooth. The rump is round.

BCS 9. Extremely obese. Camel has deep patchy fat over entire body. Dorsal spines, ribs, hooks, and spines fully covered and cannot be felt even with firm pressure. The hump full of fat.
## APPENDIX III: Calf Records

<table>
<thead>
<tr>
<th>Calf Identity</th>
<th>Calving date</th>
<th>Calf dam identity</th>
<th>Milk Yield (Lts)</th>
<th>BC identity</th>
<th>Calf sire identity</th>
<th>BC</th>
<th>Calf grand sire identity</th>
<th>BC</th>
<th>Calf grand sire identity</th>
<th>Where calf is</th>
<th>Cattle Cohort (No)</th>
<th>No survived</th>
<th>Cause of death of cattle calves</th>
<th>Vegetation at camel calf calving</th>
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<td>mortality</td>
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<td>current vegetation condition</td>
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