An epidemiological study of major camel diseases in the Borana lowland, Southern Ethiopia

By Bekele Megersa

September 2010

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Drylands Coordination Group
TØRRLANDS-KOORDINERINGSGRUPPEN
GROUPE DE COORDINATION DES ZONES ARIDES

The Drylands Coordination Group (DCG) is an NGO-driven forum for exchange of practical experiences and knowledge on food security and natural resource management in the drylands of Africa. DCG facilitates this exchange of experiences between NGOs and research and policy-making institutions. The DCG activities, which are carried out by DCG members in Ethiopia, Eritrea, Mali and Sudan, aim to contribute to improved food security of vulnerable households and sustainable natural resource management in the drylands of Africa.

The founding DCG members consist of ADRA Norway, CARE Norway, Norwegian Church Aid, Norwegian People's Aid, The Stromme Foundation and The Development Fund. Noragric, the Centre for International Environment and Development Studies at the Agricultural University of Norway, provides the secretariat as a facilitating and implementing body for the DCG. The DCG's activities are funded by NORAD (the Norwegian Agency for Development Cooperation).

This study was organized by Hawassa University on behalf of the Drylands Coordination Group

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

This research project was financially supported by the Drylands Coordination Group (DCG) Norway and DCG Ethiopia in collaboration with Hawassa University. DCG is working in dry regions of Africa including Ethiopia, with the thematic objective of alleviating challenges related to food security among vulnerable households and issues related to natural resource. DCG have supported indispensable development oriented research activities, needed to address the problems of food insecurity of vulnerable people. Hence, the support of DCG to carry out this camel disease research project in pastoral area of Borana is gratefully acknowledged.

The role and contribution of the DCG Ethiopia coordinator, Mr. Abiye Alemu, was essential for the study, and his good facilitation, coordination and timely information provision and respond to any inquiry deserve a sincere gratitude. Similarly, the facilitation and support from the research and extension office of Hawassa University, particularly Dr. Yewlsew Abebe and Dr. Andergachew Gedabo have contributed to the successful implementation of this project.

At last, the willingness and cooperation of camel owners and effective field works of veterinary professions in the field team have added more credence to the completion of the field investigations. All contributions are warmly acknowledged.

SUMMARY AND RECOMMENDATIONS

This report describes the seasonal occurrences of major camel diseases along with participatory investigations of constraints and potentials of camel production in the Borana lowland areas. Much emphasis was given to the seasonal occurrences of major camel diseases, causes of calf morbidity and mortality. Comparative indigenous knowledge of camel pastoralism between Gabra and Borana herders was also discussed. The study was also dealt with traditional management practices (herd movement, foraging, watering, salt supplementations and breeding), health care, morbidity and mortality in camel herds. The study was based on three seasonal field investigations conducted by the researcher and other two or more veterinary staffs (one veterinarian and one to two animal health assistants). It was carried out during the dry period (December, 2007), major wet season (April to May, 2008) and minor wet season (October to November, 2008) with the financial support from Drylands Coordination Groups (DCG) Norway. Classical disease investigation methods; herd health investigation and clinical examinations of individual animals, sample collection and laboratory examination as well as participatory epidemiological study, questionnaire survey, secondary data and literature review were carried out. In the result and discussion part, the research findings were illustrated with logical explanations and in-depth literature information. For this purpose the findings of this research has been presented in a national workshop arranged for awareness creation, experience sharing and drawing attention of different stakeholder participants. Since little is known about the health problem of Ethiopian camels, this research plays a magnificent role in filling the knowledge gap and drawing attention towards the improvement of health care and management practices with subsequent enhancement of production performances. This may substantially contribute to food security and human welfare particularly in vulnerable households of arid and semi-arid areas practicing camel pastoralism.

This research work was conducted in the food insecure areas of the Borana region with the aim of improving the production performances through control of camel diseases. The research output may avail information and optimize the knowledge on camel diseases, which contributes to the improvement of health care. This leads to boost up milk production and increase income generation of pastoral households.

Thus, this epidemiological camel disease investigation was conducted by combining the indigenous knowledge and modern scientific research approach. Accordingly, application of participatory epidemiology supplements the conventional (scientific) epidemiological diseases investigation approaches.

ABBREVIATIONS AND ACRONYMS

BZDPED	Borana Zone Department of Planning and Economic Development
CBPP	Contagious Bovine Pleuro Pneumonia
CFT	Complement Fixation Test
DCG	Drylands Coordination Groups
ELISA	Enzyme-Linked Immuno Sorbent assay
FAO	Food and Agricultural Organization of the United Nation
NVI	National Veterinary Institute
PA	Pastoral Association
PPD	Purified Protein Derivatives
PPR	Peste des Petite Ruminant
RPV	Rinder Pest Virus
RBPT	Rose Bengal Plate Test

1. INTRODUCTION

In Ethiopia, camels represent a subset of major livestock resources with a population estimated at >2.3 million (MOI, 2005). Although the exact figures on number of animals kept in the study area are not available, local data claim the total camel population to be 467,119, while the population size in Yabello and adjacent districts were claimed to be of 11,036 in Yabello, 22,606 in Arero and 44,697 in Dire districts (BZEPD, 1998). The dominance of other ruminant species over camels perhaps might have masked the potential contributions of these animals to the national and household economy. As a result, the camels have been neglected, or at least their importance underestimated, by the society as such. Consequently, livestock production planners and researchers have overlooked its usefulness for the local community and roles in national economy, and have not so far considered the animals in any research and development agenda. Camel production is practiced by pastoral communities under diverse constraints in dry and marginal areas.

Infectious and parasitic diseases appear to be the major constraints that are hampering the potential performances of the animals. Scarce research information on disease reveals that camels may be either carriers of, susceptible to or suffering from a vast array of infectious and parasitic diseases. Trypanosomiasis, camel pox, contagious skin necrosis, pneumonia, mange mite infections and internal parasites are among the major health problems previously reported in camels in Borana areas (Richard, 1979; Demeke, 1998).

Camel calf morbidity and mortality have been reported to be hindrances to production enhancement and population growth, with a mortality reported to be as high as 50% from pastoral areas. The crude mortalities reported from Ethiopia were 30% by Tuffa and Baars (1998) and 45% by Getahun and Kassa (2002) from Eastern Ethiopia, and 15 to 20% by Megersa *et al.* (2008) from Borana area. Similarly, Kaufmann (2005) reported mortality rates of 25%, 22% and 27% in Rendille, Gabra and Somali camel calves of Northern Kenya, respectively. This suggests a loss of calf crops that vitally affect the replacement stock in particular, the herd productivity and population growth in general.

Camel pastoralism among the Gabra constitutes an age-old tradition that historically proved capable of adapting to frequent and often dramatic climatic variation and disease episodes. Thus, Gabras are endowed with rich indigenous knowledge in camel keeping. It has been speculated that Gabra herders along with Somali ethnic groups played an instrumental role in the introduction of camels to the Borana areas (Coppcock, 1994; Megersa *et al.,* 2008). According to Hukka (1998) the Borana pastoralists probably started camel production in early 1560 in the Gedda period of Abbay Orro. For this reason the late comers into camel business, such as Borana and Guji have less experience with dromedaries and acquired less adequate traditional knowledge. Thus, a difference in the level of indigenous knowledge of camel keeping between the Gabra and Boranas can be observed. Difference in camel herding strategies that has already been demonstrated to influence some production parameters may also result in variations in disease occurrences (Megersa *et al.*, 2008).

Those late comers have traditionally been based on cattle husbandry for milk production and wealth storage. They have recently developed considerable interest to shift to camel production as asset diversification for uncertainties and drought mitigations. Ecological changes, socio-

cultural conditions and extensive seasonal migration have been the main driving force behind their coming into camel production business. Moreover, increased frequencies of drought recurrence, shrinkage and deterioration of the rangeland by bush encroachment (grazing land for their cattle) together with increasing aridity are the major governing factor for the expansion of dromedary camels into the Borana plateau (Biffa and Chaka, 2002). It was found that number of camels per holdings has showed increasing trend among Borana while reverse scenario was reported by Gabras. Similarly, Solomon *et al.* (2007) reported that camel holdings among Boranas have shown an increasing trend over time, while other livestock holdings were declining. It was also found that Borana households keep more diverse animal species than Gabrans; the majority of 71% keep cattle, camel and small ruminants compared to 31% of Gabra herders having those three combinations, suggesting existence of high desire of livestock diversification among Boranas. Similarly, a study by Solomon *et al.* (2007) has demonstrated the existence of keeping more species diversity by the Borana households.

The Borana range land of Southern Ethiopia has been once regarded as the best range land in East Africa and the source of outstanding Borana cattle that have been supplying quality beef for both domestic consumption and export. In recent decades, however, this area has come under enormous pressure, which undermined the ability to maintain the standard of living of a large sector of the pastoralists. The main causes are increased frequencies of drought recurrence, shrinkage and deterioration of the rangeland by bush encroachment (grazing land for their cattle) together with increasing aridity over time. Thus camels have been indispensable alternative to cope up with the escalating rangeland ecological challenges. The camel is a more reliable milk provider than other classes of livestock in arid areas, during both dry seasons and drought years. There is also an increasing demand for camel milk and meat in local towns with increasing demand at Kenya side Moyale. A traditional camel milk market chain has already been established along Yabello - Moyale Kenya milk shade.

In spite of the great ecological and economical value of the camel production, little is known about cons and pros of its production compared to that of other domestic animals. As, previous works conducted on camels are more concentrated on prevalence of diseases and reproductive physiology, and the information on camel production potentials and its contribution to households and national economy is not well addressed. The camel has many uses, which range from provision of food, prestige, payment of dowry to recreational activities.

Camels as part of livestock diversification have economic and ecological advantages in this particular area in and represent a minimal competition with other ruminants. Camels supply the households with milk and reduce vulnerability to food insecurity even during the dry periods, while other animals could not do. Camel herding enhances a wise utilization of the rangeland resources with minimum pressure on the environment.

Despite all its ecological and economic importance and significant role in the life of pastoral community, until recently the animals were neglected by researchers and development planners in Ethiopia. Research agendas, promotion programs, regular vaccination and animal health service deliveries are almost always excluding camels. The few previously conducted studies mainly concentrated on the prevalence of specific diseases based on short time surveying and a limited sample size. Little is known about cons and pros of camel production and health problems of camels compared to other livestock. The depth of information on camels and camel production has not been adequate to solve its multifaceted problems. A particular problem has been that the

traditional knowledge harvested over centuries have not been appreciated, and the local competence of pastoral people have not been assessed and compared to the more modern scientific approach.

1.1 AIMS AND OBJECTIVES OF THE PROJECT

The overall aim of this study was to investigate the major health constraints hampering the potential productivity of camels traditionally managed by Borana and Gabra herders. The research output aimed to fill the knowledge gaps pertaining to epidemiology of camel diseases and general health constraints together with needed disease control measures. Subsequent mitigation of those constraints may improve the production and reproduction performances with much contribution to food security.

The specific objectives of the study were to:

- Assess camel health constraints and knowledge gaps among the herders in disease prevention and control;
- Investigate the occurrences of major camel diseases as well as associated factors;
- Determine major causes of camel calf mortality and morbidity as well as associated risk factors;
- Identify possible disease control measures that could be implemented;
- Lobby and advocacy works to draw attentions of policymakers, development planners and researchers to consider camels in future development and research agenda.

2. STUDY METHODOLOGY

2.1 STUDY AREA

The study was conducted in selected camel herds in Borana lowland, Southern Ethiopia. Due to existing veterinary facilities, Yabello district was selected as center for this study, and camel herds found at about 70 km radius were regarded as study population. The town of Yabello is geographically found at 5^0 23'49 N 39^0 31'52 E, and located at distance of 565 km Southern of Addis Ababa (Figure 1). The Borana zone is divided into districts and pastoral associations; the lowest administrative unit was composed of villages. The settlement of households in pastoral villages (camps) in Borana and elsewhere is characterized by clustering of households with close proximity in a village. Villages are traditionally managed by chiefs, "*Abba Olla*", which are important contact persons for any cooperation of village members. For this study, villages were selected as sampling unit from which herds were selected and investigated over three seasons.

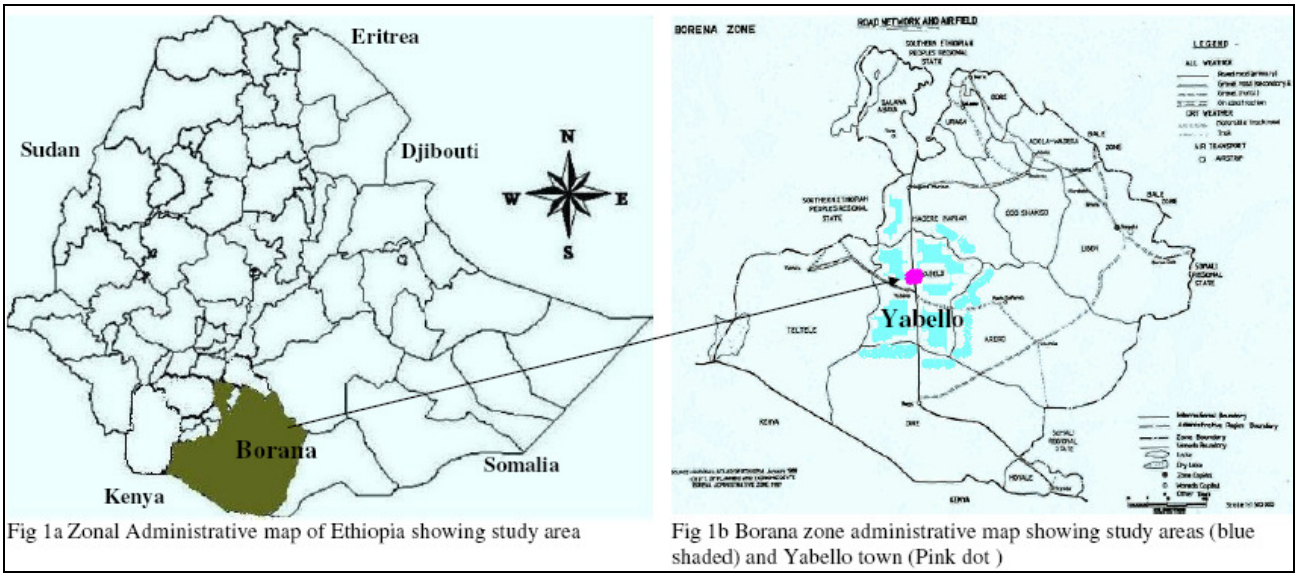

Fig 1a Zonal Administrative map of Ethiopia showing study area

Fig 1b Borana zone administrative map showing study areas (blue shaded) and Yabello town (Pink dot)

Figure 1 Administrative map of Ethiopia and Borana Zone showing the study area

The Borana plateau of 95.000 km^2 gently slopes from high mountain massifs in the north (1650 m.a.s.l) to the south bordering Kenya (1000 m.a.s.l) with a slight variation due to central mountain ranges, and scattered volcanic cones and craters (Coppcock, 1994). The climate is generally semi-arid with annual average rainfalls ranging from 300 mm in the south to >700 mm in the north. The rain pattern is of a bimodal type with the main rainy season called *ganna* extending from mid-March to May and the small rainy season (*haggaya)* from mid-September to mid-November. The other two seasons are the cool dry season (*adolessa)* extending from June to August and the major dry season (*bonna*) extending from December to February (BZDPED, 1998).

Animal husbandry in the region is characterized by extensive pastoral productions system and seasonal mobility. Cattle are the dominant animal species followed by goats, camels and sheep. As aridity increases, the principal stock shifts gradually from cattle combined with small stock to camels combined with small stock, with a relative degree of the social and cultural values

accounting for differences. Camel herd movement may move the whole herd to water points and to relatively better areas where green fodder is available, or by herd splitting where lactating and young animals are kept around homesteads and moving the rest to distant located forage areas (Demeke, 1998).

2.2 STUDY METHODS

This research project could be considered as an action research which follows the methodology in accordance with the DCG strategic approach, which enhances a participatory approach, playing a facilitation role and empowerment. The research utilized participatory epidemiological tools and principles which supports a conventional scientific method of data collection and interpretation. Camel owners, men and women, participated in the assessment of diseases and other constraints having negative impact on the productivity of camels. In addition to information provision on problems, the local people were also involved in problem analysis, generation of ideas for control measures, and showed readiness to take part in disease control measures and influencing the policymakers.

2.3 STUDY DESIGN, HERD SELECTION AND SAMPLING STRATEGY

A prospective study was designed and conducted during three seasonal investigations of selected camel herds. This was intended to examine the effects season on disease occurrences and production and reproduction parameters. Selected herds were visited during 30 days of each seasonal field investigations; during the dry season (December, 2007), the major rainy season (April – May, 2008), and minor rainy season (October to November, 2008).

Camel herds found within a radius of 70 km were considered as the study population. This area coverage was conveniently chosen to do daily laboratory analysis of faecal and blood samples at Yabello regional laboratory. Herds were visited and sampled early in the morning before released to the field, and the samples were processed in the afternoon. A total of 11200 camels were estimated to be found in the study coverage, with approximately 620 herds with an estimated average of 18 animals per herds (Megersa *et al.,* 2008).

A total of 12 villages were selected from six pastoral associations (PAs), namely Surupa, Jijido, Dadim, Dida Yabello, Dida Hara and Dartu were included in the study. The villages were selected randomly, but with some restrictions on the selection imposed based on accessibility to villages by vehicle or proximity to road and camel population. Subsequently, at least 6 herds per village were randomly selected for investigation. The study animal selection strategy was by categorizing animals in the herds into adult breeding animals, young animals and calves from which animals were selected for follow up study. Attempts were made to select animals and individually identify for regularly monitoring the animals throughout the study period. Finally, a total of 70 herds were selected on which seasonal investigations were conducted. These 70 investigated herds belonged to both Borana (34 herds) and Gabra (36 herds) ethnic groups. Clinical examination and sample collection were carried out from a total of 764, 752 and 459 animals during the dry, major rainy and minor rainy seasons.

Due to the dynamic nature of pastoral herds, there was some moving out and in of animals or herds in the study. Newly introduced animals or herds were used to replace those moved out animals or herds in the selected villages. More notably, the conflict that occurred during October

2008 between the Gabra and Borana represented a certain obstacle for our investigations. As a result some of the pre-selected herds were displaced from their villages and travelling to the conflict areas (part of Surupa and Dadim PAs) was also risky. This somehow reduced the sample size to be surveyed during the minor wet season.

2.4 SAMPLE COLLECTIONS AND LABORATORY ANALYSIS

Various samples were taken during the clinical examination of the animals, to be examined for serum antibodies, blood parasites or faecal parasites and protozoa. Further, some animals were tested for mastitis, tuberculosis, and a small number of slaughtered animals were examined post-mortem. Sampling was partially done by random selection, partially based upon clinical findings. Thus, the specific samples examined were from the following animals:

1. **Serological Survey:** A total of 1178 serum samples were collected and initially tested for antibodies to *Brucella* at the National Veterinary Institute (NVI), Debre Zeit. The serum samples were also planned to be tested for other diseases; Peste des Petite Ruminant (PPR), contagious bovine pleuropneumonia (CBPP), Q fever, toxoplasmosis and Trypanosomiasis, which are diseases of economic and public health importance. Due to lack of kit (antigen) for Q fever, toxoplasmosis and trypanosomiasis, their tests were not done. Additionally, due to increased cost of ELISA test at NVI, only 400 samples were tested for PPR and CCBP.
2. **Blood parasite test:** Blood samples were taken from selected animals for the diagnosis of trypanosomiasis by blood smear tests and buffycoat test at Yabello Veterinary Laboratory. Additionally, attempts were made to determine PCV of the animals to see the effect of the parasites. A total of 154 and 103 animals were blood sampled during dry and wet seasons.
3. **Faecal Examination:** Faecal samples were regularly collected from camels for the presence of gastrointestinal parasite eggs and protozoal parasites. A total of 442, 423 and 362 faecal samples were examined during dry, major wet and minor rainy seasons, respectively. A floatation technique and modified McMaster was used to identify the parasite eggs and protozoal oocyst. Among the parasites detected round worms (nematodes) were the major ones while cestode and protozoa parasites were also observed. The mean parasitic count per gram of faeces was also calculated per type of animals (adult or young animals) and parasite groups.
4. **Mastitis tests:** Clinical mastitis, udder lesions and blind teats were recorded during clinical examinations. Additionally, possible sub-clinical mastitis was tested using a mastitis card test (Bovivet®, indicator paper, Kruuse, Denmark). In relation to mastitis and udder damage, ticks were collected from udder region and species identified.
5. **Tuberculin Test:** This test was conducted once on a limited number of animals (98 animals) using the comparative intradermal injection of bovine and avian purified protein derivatives (ppd) according to procedure described for cattle.
6. **Abattoir survey**: Attempts were made to slaughter camels in order to collect additional information on parasitic diseases such as hydatidosis and internal lesions (abscess) and pathology. This was carried out by local meat inspectors. However, as the number of slaughter camels were so small (one animal per week), it was not possible to get adequate abattoir data, and only 35 animals were inspected.

2.5 HERD HEALTH INVESTIGATIONS AND CLINICAL EXAMINATION OF INDIVIDUAL ANIMALS

Individually identified animals were observed and clinical examinations performed during each visits for diseases showing clinical manifestations. All events observed during the seasonally regular visits were recorded on respective formats for a specific herd and individual animals. Events related to disease occurrences and risk factors such as management factors, environmental and animal factors were also recorded for respective animals. Clinical examination includes visual observation, palpations and auscultation procedures. This was further supported by laboratory diagnosis of samples.

2.6 PARTICIPATORY EPIDEMIOLOGICAL INVESTIGATIONS AND QUESTIONNAIRE SURVEY

A participatory epidemiological investigation was carried out on 12 groups (both from Gabra and Borana) each having 6 to 8 key informants. Information was collected using the semi-structured interview and participatory techniques (tools) and principles. The key informants were men or women herd owners with good herding experience and who had rich indigenous knowledge related to camel husbandry and health care. Scoring, proportional piling and ranking methods were employed to gather information, using corn grain (stones) and visualizations. Thus, information on health constraints, camel diseases, management practices, herd productivity, traditional knowledge in health care and disease prevention, their perception on traditional knowledge and existing veterinary services were collected. Important diseases with local vernacular names were listed, characterized in comparison with modern veterinary knowledge. The finding of participatory discussions was compared with field observations, and the validity of information was assessed.

In addition to participatory discussion, a fully structured questionnaire was used to collect data on herd and individual animal disease occurrences and performances during each visit. Information on management practices, productivity, disease occurrences, traditional health care, disease prevention measures and use of veterinary service were collected. Important diseases with local vernacular names were listed, described and characterized for possible translation into veterinary terms or English names.

Collection of secondary data and literature review

Information and relevant secondary data were gathered from different institutions such as research centres, animal health serves, pastoral development offices found in Borana. This information included disease reports, clinic case books and camel related literature. A thorough general literature review was done as a basis for interpretation of our findings.

2.7 DATA ENTRY AND MANAGEMENT

Questionnaire and biological data were stored in Excel® spreadsheets. After initial validation of data and simple descriptive analyses, data were transferred to statistical packages as Stata (SE for Windows, version 8.0, StataCorp, College Station, TX) and SPSS (ver. 11.5 for Windows, SPSS Inc, Chicago, IL).

Prevalence, crude and specific mortalities and morbidity were presented using the proportion,

with and without 95% confidence intervals. Continuously measured outcomes were presented as means with standard errors or as medians. For most of the results, a seasonal split was done, for some also sex, age groups etc. For statistical inference, a regression approach was used, to compare means (linear regressions) and proportions (logistic regression) across predictor factors such as herd size, management practices and seasonal/climatic factors.

Data from participatory investigations were presented as bar and pie chart graphs based on median score values. The validity of the data from the participatory study versus the scientific data was assessed using Kendall's concordance of agreements.

A full statistical interpretation will be performed in subsequent scientific papers based upon the same material.

3. RESULTS: I. CAMEL PRODUCTION IN THE BORANA PLATEAU

3.1 CAMEL HERD STRUCTURE, HERD MANAGEMENT AND HEALTH CARE

The herd structure of both ethnic groups has similarity with higher proportion (48%) of breeding females (Figure 2). They also have similar family size of about 12 persons per households. However, apparently large sized herds (25.2 + 2.2) are kept by Gabras than Borana (18.4 +1.8) with overall herd size of households included in this study to be 23 animals.

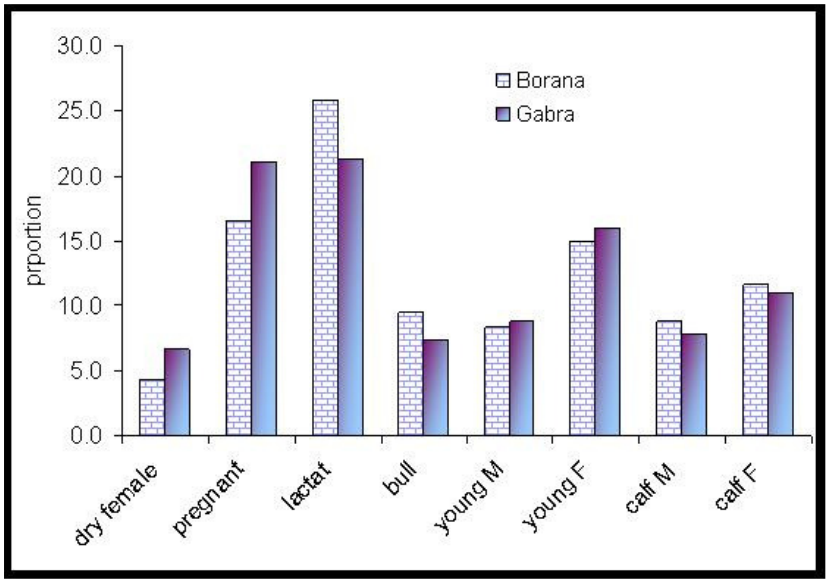

Figure 2 Herd structure of 70 camel herds having 1612 animals in Borana areas

Those owners who recently started camel production possess less number of animals and mix with family or village herds until the number increases. Thus, the average herd size may not necessarily indicate the actual size per individual household for the area. Average pastoral camel herds have similar structure to the herds included in this study. Most pastoral herds have higher proportions of breeding females; such as 50% (Megersa *et al.*, 2008), 45% (Baars, 1998), 51% (Getahun & Kassa, 2002) in Ethiopia, 47% Elmi 1989) in Somalia and 62% (Sato, 1980) in Northern Kenya. Larger proportions of females in herds in the areas indicate a strong desire of herdsmen to maximize herd size and the importance of milk production in pastoral areas. Slow rates of reproduction and long gestation intervals are also considered as factors that result in higher proportions of breeding females (Wilson, 1998).

Seasonal herd mobility was observed particularly during the dry season for foraging and watering purposes, and to some extent during wet season to avoid disease occurrences. Mobility is characterized by moving whole herd or splitting a herd into mobile *forra* and homestead or *worra* herds. Gabras are more mobile than Borana; 79.2% of the formers responded to do seasonal herd mobility compared to 58.3% of the later. Fewer herds are kept in Borana villages which may get better forage locally. However, Gabras who occupied small territory between Borana and Guji areas often suffer from feed shortage and move their herds to distant located foraging areas. Mobile *forra* herds are often attended together with five or more village herds to reduce the labor demand at distant. Therefore, about two adult men are often engaged in herding for sometimes until shifted by others. It is important to notice that *forra* herds have higher likelihood of

acquiring infection due aggregations and coming in contact with new herds. Trypanosomiasis was frequently diagnosis in herds that has been moved to other locations. Labor division among family varies with a type of activities in that most of the home based *worra* herd attending and foraging activities are done by youngsters while adult men engaged in watering, health care and delivery assistances. Women are mainly involved in milking activities with men and milk marketing.

Herds get access to water point on average at every five days and salt supplementation every week depending on season and decision of herd owners. Health care is mainly practiced by herders and traditional healers. A large proportion of owners (90%) provide health care to their animals using mainly modern drugs or herbal rededicates or consulting traditional healers. According to participatory group discussion with group of key informants, contribution of veterinary service (when camels coming to veterinary clinics or veterinary staffs visit herds for any health care) to camel health care was estimated to be not more than 10%. Table 1 display the median score values (out of 100) of health care, source of drugs and their knowledge related to camel health when judged by owners. As Borana herders have less traditional knowledge (20%) compared to Gabra (70%), they utilize relatively limited veterinary service or consult nearby experienced traditional healers. Moreover, Boranas have experience of using veterinary service to their cattle, which helped them to exploit the service for camels more frequently than Gabras. The latter groups consider veterinary service as only useful for cattle and not for camels. As a result, they provide health care by themselves using mainly drugs from open market and private veterinary drug shops. Such variation in the level of experience regarding husbandry practices and health care has already been demonstrated to account for difference in performances and mortality among the Borana, Guji, Gabra and Somali ethnic groups (Megersa *et al.,* 2008). However, using substandard drugs (unauthorized, expired and poorly handled) by Gabras may have considerable disadvantages, often with enviable economic losses associated.

Table 1 Median score values of health care, drug source and herder level of indigenous knowledge related to camel health.

Parameters	Health care		Source of drug		Indigenous knowledge related to camel health
	Veterinary service	Self treatment, traditional healer	Veterinary clinics	Open market, private	
Borana					
Median	10	90	50	50	20
Maximum	20	100	50	80	30
Minimum	0	80	20	50	10
Gabra					
Median	5	95	25	75	70
Maximum	30	100	60	90	80
Minimum	0	70	10	40	50

3.2 OPPORTUNITIES AND POTENTIALS OF CAMEL PRODUCTION IN BORANA

High milk production (45%) was reported to be the primary purpose of camel production in the area followed by transportation (26%), income generation (16%) and meat production. However,

their contribution as means of draught power seems to be insignificant. Figure 3 shows the mean score values given by twelve groups of key informants to the relative importance of camels in the areas. Similarly, Mehari *et al.* (2008) have described the potentials camel production in Eastern Ethiopia including provision of food, transportation and draught power. In addition to high milk production, drought mitigation and to some extent use as alternative means against bush encroachment are also reported to initiate camel keeping among the Borana pastoralists. Currently with increasing camel price sale income generation was becoming important than ever before and households with two to three adult camels for market may secure the family demands for more than one season.

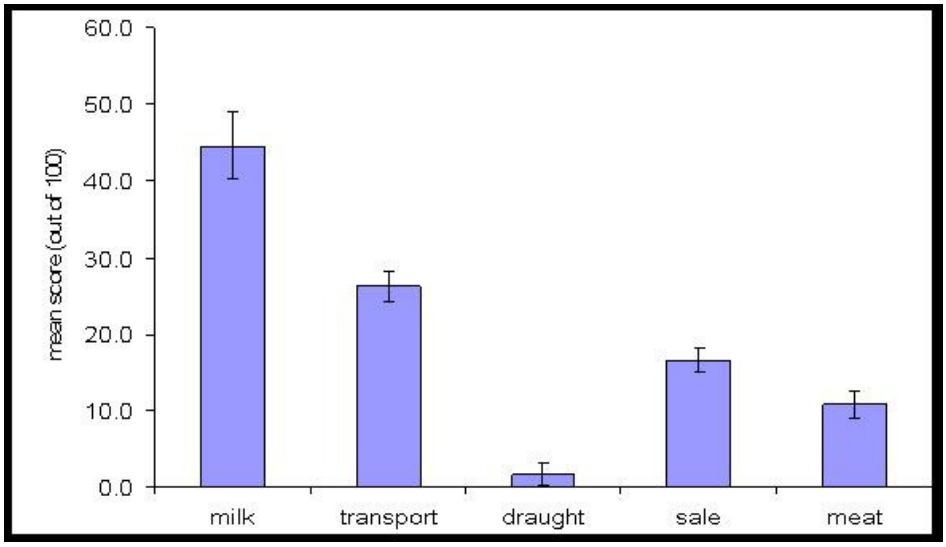

Figure 3 Mean score of potentials for camel production in Borana area: values given by 12 groups of key informant

Camels are mainly kept for milk production, which is used to feed the family and income generation**.** Additionally, they produce meat, hides, and also serve as means of transportation and draught power. Milk is the most important product that camels produce elsewhere and in the area. Long lactation and ability to maintain milk production over long dry spells are important facets of camel productivity.
Apart from home consumption, the majority of the households sell at least one-third of the produced milk to generate cash income (Getahun and Bruckner, 2000). Meat production is regarded as minor importance by the groups whereas draught power is not provided in the area. Camels are not commonly slaughtered even by Gabras except for cultural ceremonies and festivals. Moreover, camel slaughtering is uncommon except for emergency slaughtering and its meat is not preferable among Boranas. They do not consider camel as their traditional animal descendant from their ancestors.

Camels are used as animal of transport in the most inhospitable areas of the world, so called as "ship of the desert", and represent an important security for movement and trade activities for the nomadic and semi-nomadic population of the arid and semi-arid areas of Africa. In lowland areas of Ethiopia in particular, camels still play an important role in trade, transport and movement of people. Male camels are used to fetch water and transport people, huts, goods, goats, sheep,

grain, firewood and building materials (Negatu, 2002). Camels are also rented out for cash for transportation purpose within and outside the national boundary (e.g. Djibouti, Somalia and Kenya). Camels have been regularly involved in a long distance salt transportation along the salt caravan routes of Afar-Tigray. An attempt has been made to harness camel power for use in ploughing, levelling, digging and de-silting stock ponds. When the importance of camels and cattle are compared by Borana and Gabra groups, there is a difference between the two ethnic groups in giving value to the animals; the Borana give more credence to cattle while Gabra had tendency of favouring camels (Figure 4).

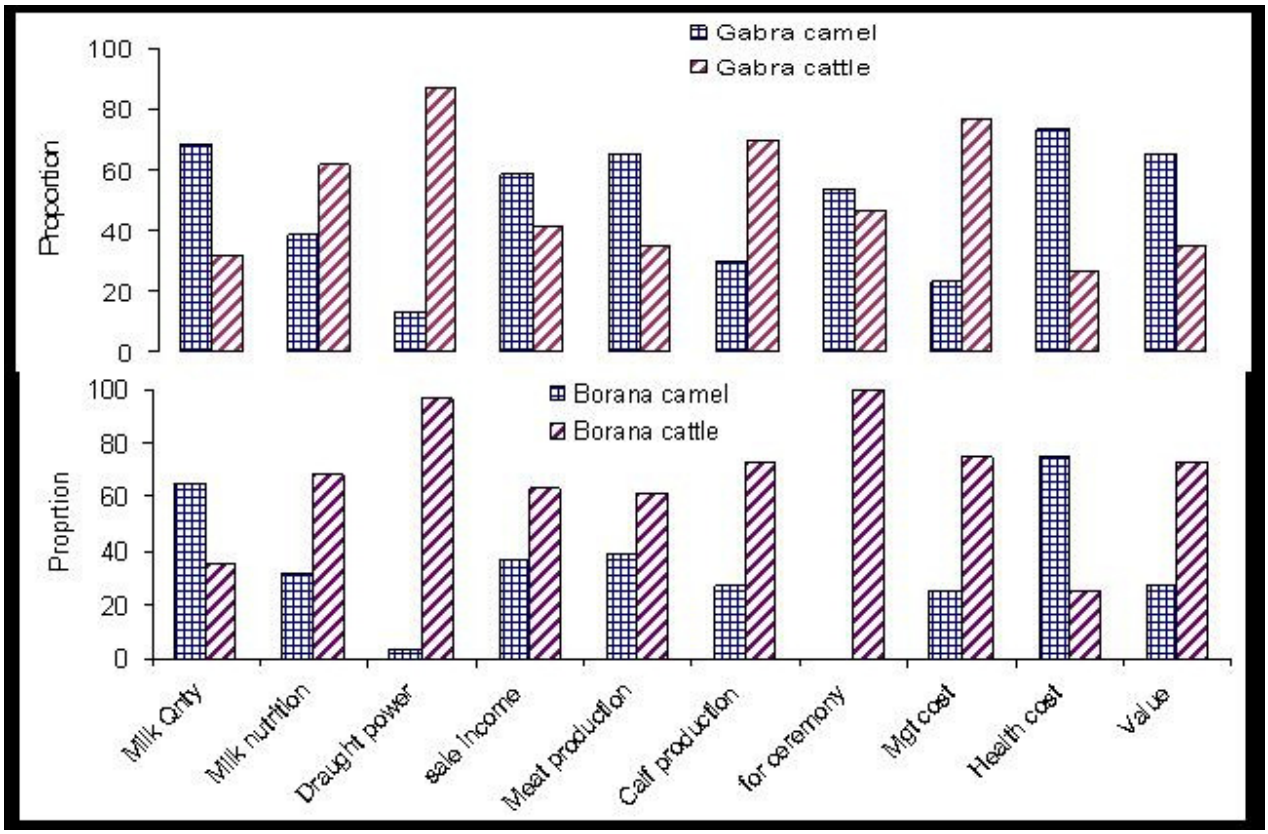

Figure 4 Comparative importance and characteristics of camels and cattle as judged by 12 Borana and Gabra groups

3.3 CONSTRAINTS TO CAMEL PRODUCTION

Participatory epidemiological discussions with 12 groups has identified the major constraints to camel production to be widespread diseases (25%), lack of attention to camels (20%), inadequate veterinary services (21%) and feed shortage (12%) associated with limited mobility. Figure 5 shows the major constraints to camel production reported by herders during group discussion. Figure 6 is comparing the two major groups for any apparent variation on issues under discussion. On most issues, except two, there have been similar perceptions between the two major groups. Boranas have less experience with camel and lack adequate indigenous knowledge in health and management aspects of camels. Thus, they indicated inadequate indigenous knowledge as a restraining factor for them. On the other hand, Gabra groups emphasized that

ethnic conflict is more important to them. This is due to the fact that Gabras are small in number and occupied a territory between the two major cattle herder groups; Borana and Guji, and often prone to conflict related to access to forage resource and herd movement.

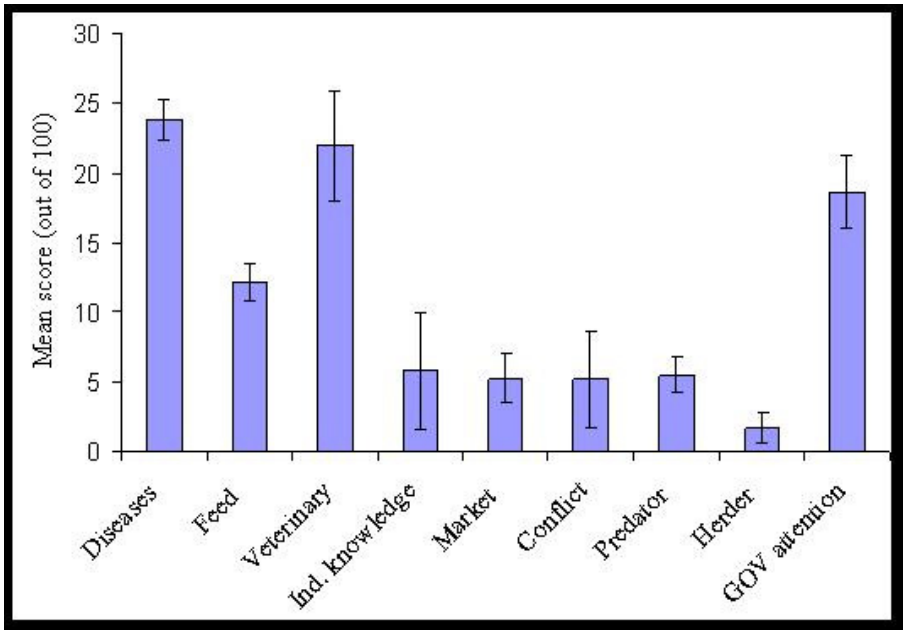

Figure 5 Relative mean score values given by Camel herder groups to constraints of camel production (n=12).

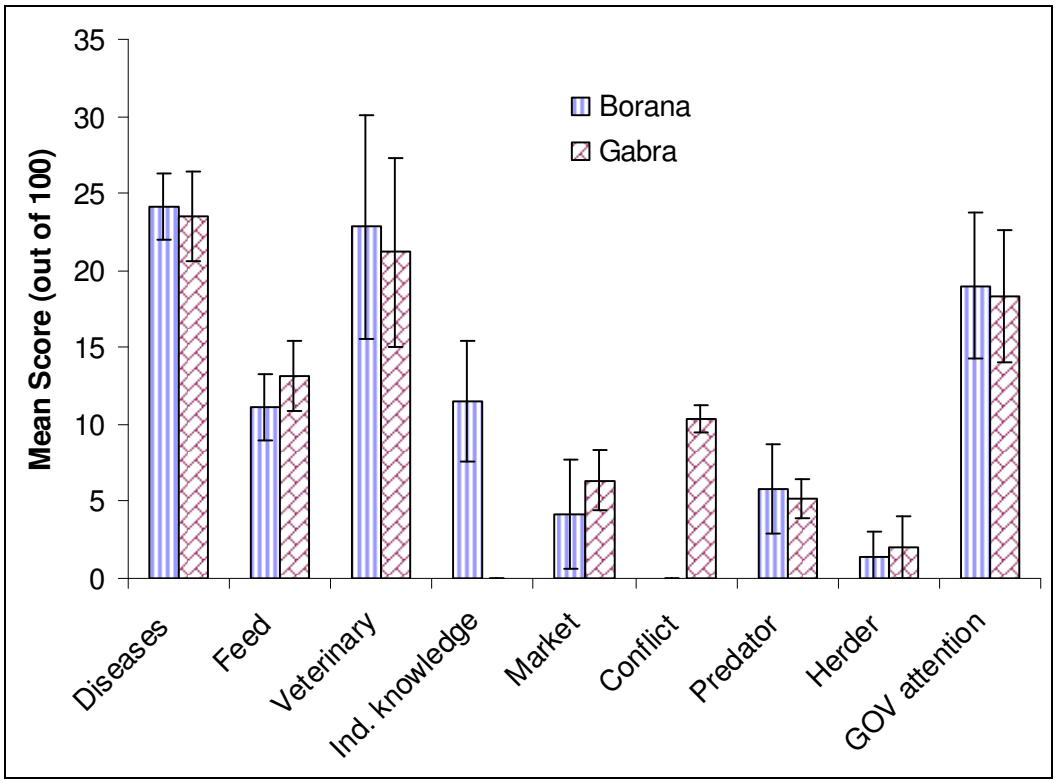

Figure 6 Comparative mean score values given by Borana (n=6) and Gabra (n=6) to constraints of camel production

Widespread diseases, poor veterinary service and lack of attention by the government are the major constraint to camel production in the area. Both groups had similar views on the issue in that there is nobody possessing more competence for camel health care then the herders. They have produced camels for centuries by their own efforts without much assistance. In most developing nations, much attention was not given to camels regarding improvement of health care and production aspects. In spite of its vital importance particularly to the marginalized communities in the dry zones of the tropics and subtropics, studies about camel are very few. Due to the fact that camel production is in remote, migratory and poor infrastructure condition, available studies were based on small animal numbers, small surveys, questionnaires, estimation and simulations. From the last two to three decades onwards, scientific interests in different aspects of dromedary have shown progressive development. However, this is yet not the case in Ethiopia, as no national or local research agenda featuring any aspect of this animal. So far, almost all research works were conducted by students; by veterinary students or MSc students as thesis research. This illustrates the existence of negligence by development planners and researchers. There are regular vaccination programs and other treatment and control services for cattle as well as other stocks, while almost nil for camels. It is important to notice that training program in Ethiopia has been insufficient to backup the veterinary personals to deal with multifaceted constraints and health problems of camels. Most camel diseases are known by herders' local vernacular names, but not in medical terms or English names with which most health workers are familiar. As a result, proper treatment is not given to them even with drugs and facilities at hand. The herders perceived this situation as "*camel is regarded as property of pastoralist only*", so that only owners are responsible for it. They further stated their complaint in that most government officials have been highlanders who never utilize camel products and as a result less attention was given to this animal. Accordingly, efforts to promote production and health care were not attempted when compared to other ruminants. Supporting the view of herders, Mehari *et al.* (2007) have suggested that the camel represents something of an orphan commodity that neither animal scientists and veterinarians nor wildlife conservationists feel responsible for. It is a poorly understood and highly underestimated animal in many cultures except amongst the pastoralists who have had experience with them. Thus, it is high time to change the situation and remove the stigma that has come to be associated with camel breeding as a backward activity. Currently with increasing attention to pastoral community and establishment of pastoral development institutions, there is a green light in future favouring promotion of camel husbandry and health care. This study contributes by large to awareness creation and filling knowledge gaps concerning the constraints and epidemiology of important camel diseases. Translation of local vernacular disease names into possible English name or medical terms that could ease disease diagnosis, treatment and prevention.

The other important constraint in the area is feed shortage and limited herd mobility. Local changes such as land ownership, increased farming, demarcation of administrative sub-units (pastoral associations and sub-units), as well as declining productivity of rangeland are increasing in dimension and intensity. Herders reported that herds from one administrative unit may not be permitted to utilize the forage resource in another unit. This is a critical problem for Gabra pastoralists as their territory is so small and inadequate to feed their large camel herds. The Borana herders on the other hand keep small camel herds with cattle and have better forage in their localities and not much affected by feed shortage. This suggests that the rangeland is progressively losing its communal nature, and subsequently, affect the socio-economic aspects of pastoral community. It will primarily affect the prospects of traditional camel pastoralism and further contributes to competition over resources with enviable conflicts.

Other minor problems raised by herd owners such as insufficient market for animals and animal products, predator attacks and labour shortage for herd attending may affect camel production. Markets for camel in particular and livestock in general have a fluctuating nature strongly influenced by season. The current camel market is reported as better than ever before. This is due to the establishment of an export camel abattoir by foreign investors. So, animals are slaughtered and chilled meat is exported. The problem associated with market is milk marketing. It seems that the local demand for camel milk is lower than the potential supply, perhaps due to existence of more preference to cow milk. This has forced camel herders to look for an alternative market at the Kenyan side of the border.

Predator attacks were also reported mainly due to hyena bites, cheetah (attack calves) and occasionally due to lions. The naked mole rat is often causing traumatic wound to camels even leading to death. The post-bite complication was reported to lead to severe swellings and deep wounds. The naked mole rat is not a carnivore and the bites may be as self defence or behavioural activity.

Though currently not a problem, it was indicated that labour shortage for herding and attending camels is a future challenge. Increased human mobility, other job opportunity, and increased school enrolment rates of pastoral children are the major reasons influencing labour demand in pastoral camel production. It has been demonstrated that labour needs for watering and herding camels are perhaps the major non biological factor affecting camel herd size and population expansion. Thus, families and herds develop together for subsistence (Elmi, 1989). Our finding also supported this idea in that family and herd size had moderate positive linear relationship.

4. RESULTS II. EPIDEMIOLOGY OF CAMEL DISEASES

4.1 CLINICALLY MANIFESTED DISEASES

Camels have been formerly considered as hardy animals and less susceptible to most of the diseases that affect other livestock in the same ecological zones. However, as more research was conducted camels were found to be susceptible to a large number of pathogenic agents. They may contract many other diseases, some of which are still unknown. For some diseases such as pox, enterotoxaemia and mange, camels are indeed more susceptible and manifest more severe signs than other ruminants in the same area. Pastoralists have herded dromedary camels for centuries in the arid and semiarid areas of Ethiopia and elsewhere in the Africa, they have repeatedly encountered and named various diseases. However, the exact causes of many of these illnesses, known by local vernacular names, remain unknown.

During the three seasonal surveys, a total of 70 selected herds having about 23 animals on average were investigated. Table 2 illustrates the clinical diseases recorded during the three seasons. Similarly, the diseases encountered were distributed by age, sex and ethnic groups as described by Table 3. Clinical examinations and sample collections were conducted on 764, 752 and 459 animals during dry, major wet and minor wet seasons of the study period, respectively. A total of 2769 clinical cases (excluding mastitis) were recorded from the investigated animals making an overall morbidity rate of 140.2% for the entire period of the study. This suggests the existence of a high disease burden among camels, where one animal can be affected with more than one disease or health problem at a time. More disease loads were recorded during the minor wet season (during October) than other seasons, while disease like respiratory infection was higher during the major wet season. Specifically, tick infestations and camel pox cases were higher during this study period. On the other hand, the severity and prevalence of parasitic diseases (sarcoptic mange and internal parasites) was higher during the dry season probably added to prevailing malnutrition during dry periods. There was also similar pattern of disease occurrence in camel calves. Mange mite infection was higher during the dry season while contagious ecthyma, abscess and respiratory infections were more common during major wet season, and camel pox occurred during minor wet season in the form of an outbreak. Photos of some of the diseases are included in Annex 1.

In addition to climatic factors (seasons), factors like age, sex and ethnic groups of herd owner significantly affected disease occurrence (Table 3). Diseases like sarcoptic mange, abscesses, contagious skin necrosis, contagious ecthyma, pox, diarrhoea and septicemic conditions were more common in calves than other age groups. On the other hand, respiratory infections, tick infestations, night blindness and internal parasitic infections were higher in adult animals. Young animals with underdeveloped immunity are more susceptible to infectious diseases as traditionally reported in literature (Abbas and Omer, 2005). The prevalence of sarcoptic mange and tick infestations were higher in females than male animals, while significantly higher contagious skin necrosis was recoded in males, particularly young animals. The disease burden was considerably higher in Gabra camels compared to those belongs to Borana. Mange mite infections and contagious skin necrosis were more frequently observed in Gabra camels. This is due to the fact that mobility of Gabra camel herds was limited due to the current ethnic conflicts that resulted in aggregation of large herds in fodder resource poor small territory.

4.1.1 Diseases Affecting Integument (Skin) system of Camels

Mange mite and tick infestations

Mange mite infection due to *Sarcoptes scabei* var *cameli* was one of the most commonly encountered camel diseases in Borana with severe clinical manifestations. Sarcoptic mange infections were more prevalent and severe during the dry periods. Moreover, the disease was more severe in young animals with prevalence over 50% (Table 3) as well as breeding females. Various authors (Wernery and Kaaden, 2002; Abbas and Omar, 2005) have provided an extensive account on infectious diseases of camels, and suggested mange mite infection is the major health problem. Mange infection is a highly contagious disease which can spread to animals associated with infected animals. The mite may transmit directly by contact or indirectly through objects such as saddle, harnessing materials, bedding and tree trunk. It tends to spread more quickly during cold weather when animal coats usually grow long and the animals huddle together more often (Mukasa-Mugerwa, 1981). Agab and Abbas (1999) had observed seasonal pattern of mange mite infection with lower prevalence during the summary season. Close contact of camels particularly at water point could be responsible for increased exposure during the dry period of our study. Moreover, feed shortage that reduces the immunity of the animals may also account for increased prevalence and severity of the disease during periods. Young animals were the most affected group with severe lesions, poor body conditions and often with concomitant infection with other diseases (contagious skin necrosis, abscess and contagious ecthyma). The disease was more prevalent in Gabra camels which are large sized herds and affected by feed shorted due to limited mobility. More importantly, mange mite treatment was not commonly practiced using effective drugs such as Ivermectin. Herders often treat their animals either with organophosphate products or other greasy lubricants which are less effective. However, after our first field investigation, camel owners had the chance to observe the response of the disease to Ivermectin treatment and started looking for Ivermectin. This might have reduced the subsequent prevalence and severity of the disease during successive surveys. Thus treatment of severely affected animals particularly during the dry season may reduce mortality, morbidity and even susceptibility to other diseases.

Tick infestation was not as serious a health problem as mange, even though there was no tick-free animal. Based on rough counts, only animals with more than 10 ticks were considered positive. The burden has been progressively increased during the subsequent wet seasons and peaked in the minor wet season (October to November). In addition to feeding on animal blood, ticks are important as vector for diseases, causing tick paralysis, and causing damage to udder, so that opening door for opportunistic micro-organisms and fly larvae. The seasonal tick burden and species dynamics showed that the average udder tick counts were 2.8, 3.6 and 4.3 with higher burden during the minor wet season. Pooled seasonally collected ticks belonged to the three genera, namely *Rhipicephalus* (83.2%)*, Amblyoma* (13.6%) *and Hyaloma* (1.2%). The species identified include *R. pulchalus* (77.5%)*, R. eversi* (18)*, Amblyoma gemma* (13.4%)*, Amblyoma vargatum, Amblyoma lipedum* and *Hyaloma dromedari.* Amblyomas - long mouthed ticks - are more important in inflicting udder damage and is a risk factor for mastitis in camels. Thus, tick control has vital importance in reducing udder lesion and mastitis, which are substantially affecting milk production.

Abscessation and contagious skin Necrosis:

Abscess (*mala)*: Mala is described as an extensive swelling on different parts of the body and oozing out of pus. It occurs on external and internal organs. It is quite common and is less likely

to find abscess free herds in pastoral camels. The commonly affected external parts are lymph node, udder, chest pad, neck and limbs. Internal abscesses occur in heart, liver, kidneys, stomach, intestine and sometimes in lungs. Internal abscess is more serious as drainage and healing is hardly possible and less responding to antibiotic treatments. Most affected animals are weak, chronically debilitated and eventually die. During the dry season of our survey, a higher proportion of abscess cases were recorded with two death cases due to abscessation of internal organs. One case had an abscess in the intestine (abscess and proliferation of intestine), and liver and kidneys abscess in another case. Treatment is similar to basic wound treatment, drainage, dressing, cleaning and systematic administration of broad-spectrum antibiotics.

Table 2 Prevalence of clinical diseases in camel herds in Borana during three seasons (2007-2008)

Clinical Diseases/ Health problems	Dry season		Major Wet season		Minor wet season	
	animal examined	Affected (%)	animal examined	Affected (%)	animal examined	Affected (%)
Mange mites	764	260 (34.0)	752	218 (29.0)	459	144(31.4)
Tick infestation *	764	431 (56.4)	752	485 (64.5)	459	392(85.4)
Abscess	764	96 (12.6)	752	74(9.8)	459	30(5.6)
Contagious skin necrosis	764	56 (7.3)	752	39 (5.2)	459	18(3.9)
Traumatic wound	764	26 (3.4)	752	10(1.3)	459	7(1.5)
Naked mole rat and hyena bites	764	4 (0.5)	752	5 (0.7)	459	7(1.5)
Onchocercal lesions	764	4 (0.5)	752	2 (0.3)	459	0
Papillomatosis	764	1 (0.1)	752	2 (.3)	459	0
Contagious ecthyma	284	4 (1.4)	169	27 (16.0)	98	21(21.2)
Camel pox	764	0	752	2 (0.3)	459	65 (14.2)
Chronic wasting disease	764	0	752	0	459	18(3.9)
Dermatophytosis	284	9 (3.2)	169	14 (8.3)	98	3 (3.0)
Fracture and myositis	764	12 (1.6)	752	5 (0.7)	459	2 (0.4)
Neck and shoulder paralysis syndrome	764	7 (0.9)	752	4 (0.5)	459	5(1.1)
Respiratory infection	764	8 (1.1)	752	114(15.2)	459	32 (7.0)
Diarrhoea	764	12 (1.6)	752	15 (2.0)	459	9 (2.0)
Septicaemia conditions	764	4(0.5)	752	7 (0.9)	459	5(1.1)
Eye infection & blindness	764	5 (0.7)	752	7(0.9)	459	13(2.8)
Night blindness	764	14 (1.8)	752	9 (1.3)	459	6(1.3)
Total	764	953 (124.7)	752	1039 (138.2)	459	777 (168.3)

*Tick infestation by more than 10 ticks (rough count) was considered as positive for infestation

Contagious skin necrosis (Dhulla):

Dhulla was found to affect mostly young animals, while adults seemed to be relatively resistant, owing perhaps to previous exposure. The lesions were mostly located on the neck, shoulders or legs, but other sites such as the flank region or ventral abdomen were also affected. Contagious

skin necrosis is a specific dermatitis of camels characterized by necrosis, abscessation and sinus formation in different parts of the skin. The lesions usually begin as a small nodular and swollen painful area, which increased in size over 2 to 3 weeks. The lesion then develops a well demarcated necrotic centre which sloughs off exposing an ulcerated, purulent or hemorrhagic layer underneath. The lesion sometimes healed spontaneously over a period of two months, but lesions that have remained open with a streak of pus expressible upon manipulation. The lesion further characterized by pruritic itching when affected animals were observed rubbing themselves with any standing post. This may contribute to the transmission of infectious agents to susceptible animals. It was prevalent throughout the study season, with a high occurrence in some herds, while in all other herds it was sporadic. Similarly, Agab and Abbas (1999) recorded occurrence of the disease throughout study periods with higher prevalence during summer.

Different microorganisms have been incriminated in the aetiology of the disease, but *Staphylococcus aureus*, *Streptococcus spp*., *Corynebacterium pyogenes*, *Nocardia cameli*, *Actinomyces sp*. and *Erysipelothrix sp*. were the agents most commonly isolated from typical lesions (Domenech *et al.,* 1977; Yagoub and Mohamed, 1996; Tejedor *et al.,* 2000). Camel herders put forward a suggested association of contagious skin necrosis with salt deficiencies. Similarly, some earlier researchers speculated that contagious skin necrosis arises as a result of salt deprivation and noted that the disease was rare among free ranging camels with ready access to salty bushes (Wilson 1984). Although there is no controlled study conducted to disprove this speculation, recent evidence may not support this assumption, as the disease was reported to affect pastoralist camels, with some herds showing up to a 55% prevalence (Yagoub and Mohamed, 1996). Ticks were suggested as possible transmitting agents as highest disease incidence corresponded with high tick infestation in affected herds but the location of the lesions were not typical tick feeding sites in camels. The mixed bacterial infection characteristic of the disease may indicate soil as the source of infection, animals becoming infected when they lie down or sand-bathe on contaminated ground. Although highly contagious, the disease is not fatal, and responds well to treatment with parenteral antibiotics and local iodine tincture (Abbas and Omer, 2005). It is important to start treatment during early course of the disease.

Traumatic wounds and bites (mada)

Wounds were among the common health problems affecting the surveyed camels, with a peak incidence during the dry season. Wounds are commonly inflicted by any sharp objects, bites and thorny bushes, and gets worse due to fly larvae or bacterial complication. Tick infestations as well as complete reliance on thorny bushes for browsing throughout most of the dry season, could be partially responsible for this seasonality. Bites were commonly caused by hyena, naked rat mole (*Heterocephalus glaber*) aggressive males and snakes. Among the predators, hyena commonly attack camels in the area, with more recorded bites during the wet seasons. Hyena attacks young and weak animals either in the villages or in bush when some camels are departed from a herd.

The naked mole rat locally called *Tuqa or Franfarki* is an important cause of traumatic wound in camels, which brings about severe swellings of bitten areas (which is often the belly, between the udder and sternum, and, in male camels, the penis), abortion in pregnant animals, and general depression and fever. Treatment with long acting broad-spectrum antibiotic was reported to result in fully recover (Dirie and Abdurahman, 2003). The naked mole rat is native to the drier parts of the tropical grasslands of East Africa, predominantly South Ethiopia, Kenya, and Somalia, living in clusters averaging 75-80, in complex system of brows (tunnels). It is notable for its eusocial

lifestyle, nearly unique among mammals, and for a highly unusual set of physical traits that enables it to thrive in a harsh, underground environment; including a lack of pain sensation in its skin, oxygen shortage and a nearly cold-blooded metabolism (Wikipedia, 2008). This mole rat may accidentally attack camels as self defence or through a habit of biting. According to Dirie and Abdurrahman (2003) the mole-rat, which has a poor thermo-regulation system, is attracted to the warmth of recumbent camels, particularly the area between the hind legs and the sternum, and probably bites in defence as the camel, irritated by the rat, moves in search of a more comfortable position. The four sharp incisors and powerful jaw muscles of the naked mole-rat, which feeds on hard roots and tubers, are quite capable of wounding a camel. The fact that camels suffering from Firaanfarki generally respond well to treatment with antibiotics adds further weight to the possibility that Firaanfarki is caused by micro-organisms transmitted through the bites of the mole-rat. Hence it is import to aim at treating affected animals antibiotics or wound treatment rather than rodent bite prevention.

Dermatophytosis (ring worm), oncocercosis and papillomatosis

Dermatophytosis (ring worm) was observed on young camels during the wet season, an observation similar to ours was made by Agab and Abbas, (1999) who recorded highest incidence of the disease during summer and lowest during winter in Sudanese camels. This suggests the importance of temperature and moisture for multiplication and invasion of dermatophytes. A literature review by Abbas and Omer (2005) showed that dermatophytosis occurs commonly in young camels while camels above four years of age are apparently immune. Younger camels of up to three years of age were those affected most by ringworm. The most commonly isolated dermatophytes are *Trichophyton spp*. and *Microsporum sp.*

Nodular lesion due to oncocercal species (*Oncocerca fasciata)* was detected in four camels during the dry period, with the existence of nodular lesions on lateral and ventral sides of the flank as well as hind limbs. El-Massry and Derbala (2000) observed the nodular lesion distribution mainly on the two sides of abdomen, hind limbs (concentrated in thigh region) and forelimbs particularly on the shoulders and nuchal ligament of Egyptian camels. The authors demonstrated the microfilaria from blood and reported these be due to *Oncocerca fasciata.* In our study the fact that the cases were responded to Ivermectin treatment gave some credential on the assumption of oncocercal occurrence, otherwise there was no more evidence. Papillomatosis was observed on few animals with one animal having extensive lesion that covered major part of the body. The disease was observed in young animals of about 3 years of age. Similarly, Munz *et al.* (1990) have reported the disease to fairly commonly occurring in young animals and causes eruptive lesions on several parts of the skin, particularly around the mouth, which could be mistaken for pox upon casual examination.

Contagious Ecthyma and Pox Infections

Camel contagious ecthyma (CCE) (*Amburur): Amburur *i*s predominantly a disease of young camels less than one year old, and is caused by a parapox virus. The disease occurred in young calves born during the same season with higher incidence rates during the wet seasons (16.0 – 21.2%) than dry period (1.4%). Such seasonal pattern of occurrence of the disease was also observed by Agab and Abbas (1999), with higher prevalence during the rainy season. Khalafalla et al. (1994) have indicated that browsing on thorny trees during the early rainy season may be one of the important predisposing factors as the injuries inflicted while browsing could facilitate the entrance of the causative agent into the body. CCE was characterized by pustular lesions around the mouth, lips, buccal cavity and swelling of heads. Some affected calves showed

lacrimation and head swelling. The disease spreads quickly in affected herds; all camel calves born during the same calving season could develop the disease. The disease has been reported from neighbouring countries, including Kenya (Munz *et al.,* 1986), Somalia (Moallin and Zessin, 1988) and Sudan (Khalafalla et al., 1994; Agab and Abbas, 1999). CCE is characterized by the sudden onset of a pustular dermatitis involving primarily the oral mucosa, particularly the gums around the incisors, lips, and nostrils (Munz *et al.,* 1986). Housawi *et al.* (2004) reported severe lesion of the disease in one month old Saudi camel calves suffering from lesions on the lips and hard palates and manifested clinical signs such panting and restlessness and pain and anorectic since the appearance of the lesions. The pustules develop into fissured crusts that affect lips severely, leading to complete cessation of feeding or suckling. Head swelling and buccal haemorrhage have been described in severe cases. This may reduce the body condition of the animal and defence of the animals increasing susceptibility to infectious diseases. The disease usually passes off without causing death, but a 6.6% herd mortality and 38% case fatality rates have been reported (Khalafalla *et al.,* 1994).

Pox (*Baga)*: *Baga* was observed during the minor wet season, in the form of outbreaks. It was more severe than contagious ecthyma and found causing deaths in 6.2% of affected animals (4 out of 65). Unlike CCE, pox can affect young animals over one year of age with lesions affecting most part of the body (belly, face, neck and limbs). The Mortality due to camel pox reported to ranged between 2% in the mild form, and 28% to 40% in the severe or systemic form (Abbas and Omer, 2005). It is important to note that most animals affected by camel pox had sarcoptic mange (perhaps as a predisposing factor) as concomitant infection. Pox is the commonest viral disease of camels and has been encountered throughout the camel range with the exception of Australia. The causative agent is a true poxvirus, and except for minor variations in their terminal fragments, different isolates of the virus have identical DNA sequences (Afonso, 2002). Camel pox virus has been shown to be strongly related to the *variola* virus, the causative agent of smallpox (Gubser and Smith, 2002). The epidemiological significance of these findings is not yet known, but could revive interest in the historic belief held by some camel researchers that camel pox is a zoonotic disease (Mukasa-Mugerwa, 1981). The disease is essentially an acute dermatitis that starts with mild fever and the development of papules which quickly develop into pustules and scabs involving most of the body, with concentration around the eyes, lips, nares, the thighs and the upper neck region (Mukasa-Mugerwa, 1981; Khalafalla, and Mohamed, 1996; Abbas and Omer, 2005). Most animals usually recover slowly within two to four weeks. Some camels develop a long lasting corneal opacity. A malignant form of the disease has also been described in younger camels or old camels exposed for the first time. This clinical pattern of camel pox is characterized by systemic involvement leading to severe and mutilating labial lesions and often fatal pneumonia, haemorrhagic gastroenteritis and generalized adenopathy (Kinne *et al.,* 1998). Both CCE and camel pox were observed to occur with higher prevalence during the wet season, particularly in young camels. This may be due to the fact that moisture may enhance virus stability in the environment and increase subsequent transmission to susceptible animal. As there is no effective treatment for the diseases, prevention by limiting herd contacts, care for sick animal and treatment of other parasitic diseases that may reduce the defence mechanism of animals are possible alternative approaches.

4.1.2 Diseases of other Body Systems

Musculoskeletal Problems: Fracture and lameness

Fracture of long bones was lower in proportion of occurrence, but an important cause of mortality in camels. We observed a higher occurrence of fracture and myositis during dry season with a

prevalence of 1.6%, and deaths in 25% of the affected animals (2 deaths out of 8 bone fractures). Higher occurrence of the problem during dry season may be associated with feed scarcity in which camels tend to forage in hilly or irregular landscape. Fractures of bones with incurable conditions have resulted in euthanisation (emergency slaughtering). The feet of camels are not suitable to slippery, hilly and undulating landscape which could pose camels to fall down and subsequently cause bone fractures. A study by Agab and Abbas (1999) suggested that lameness or locomotory disturbances were among less common clinical problem and were mainly due to joint and muscle lesions. The long distance that camels had to cross in search of pasture during the summer and on the way back from migration (distant located browse area) could predispose camels to these health problems. The camel's foot is adapted for sandy soils and can be described as a tyre filled with fat instead of air. Camels may walk on tarred, hard surfaced roads and ground which is littered with sharp objects such as nails, wire and broken glass, which can cause damage to the foot and result in lameness. The camel's foot is flat and soft and divided into two with a toe nail at the end of each side. The pain from the wound can make the animal lame. Simple wounds can be treated with tincture of iodine in addition to removing and cleaning any foreign materials. If severe, systemic antibiotic treatment is needed and sometimes the camel's foot can be covered with thick cloth or leather to stop the swelling from becoming worse.

Myositis and muscle spasm

Myositis is a disease condition of low occurrence mainly in adult camels but with grave consequence. It is characterized by lameness, difficulties in walking, sometimes with signs of muscle or joint pain and loss of muscle mass. This condition is locally called ***Milmur or Lukmur*** that affects both fore- and hind limbs. Affected limb may show swelling of the area at early stage or eventual thinning of affected muscle. Branding of the affected area was reported to cure some cases. Some affected animals were recumbent for some time and subsequently died. Post-mortem finding of such animals showed loss of muscle mass and darkness in muscle colour, similar to black quarter in cattle. Black quarter, caused by *Clostridium chauvoei,* mainly affects cattle and may also affect camels. There are evidences of the occurrences of black quarter (*Clostridium chauvoei*) in young and adolescent camels (Abbas and Omer, 2005). Similarly, Makinde *et al.* (2001) reported that 29.3% of dromedaries slaughtered over three months in Nigeria were serologically positive for *C. chauvoei*. Thus, prophylactic vaccination in the area may be helpful to reduce the cases. Muscle and joint problems may also be associated with long distance travelling when camels had to move longer in search of pasture during the summer and on the way back from migration (distant located browse area) could predispose camels to these health problems. One animal was observed to be suffer from muscle spasm like condition which frequently occurred during the morning, which relived after sometimes and able to walk with the herd was observed.

Neck and shoulder paralysis syndrome

Neck paralysis is a less prevailing health problem, although the prognosis can be bad. These conditions were manifested in different clinical forms and known by different local names. One case with stiff neck, head held up and limb paralysis was observed, which is locally called *Matadhab matatag (*Head held upward) or *Dhukubasatawa* (giraffe disease). The name is derived from the fact that affected camel behaves as giraffe with head held upward, stiff neck and held tail strait. The animal stops feeding, becomes stiff with legs splayed and pregnant animals have birth difficulties. Froth is coming from mouth and nose, and the jaws appear deformed. According to informants acute cases die soon and others may be recovered over longer period. The clinical finding in acute form has strike similarities to tetanus. Tetanus is mostly known to

affect humans and horses, but may also affect camels. Camels were reported to be affected by different clostridia species. A severe outbreak of botulism (*Clostridium botulinum*) reported in camels in Chad was presumed to have occurred after drinking from a contaminated water source (Provost, *et al.,* 1975). Clinical signs of the disease included ataxia, inability to stand, and paresis particularly in the hindquarter, preceding death. There are few reports on tetanus (*Clostridium tetani*) in the camel (Morcos, 1965; Mustafa, 1987). Clinical signs of tetanus in the camel are similar to those in the horse, namely, "locked jaw", opisthotonus, and limb stiffness. Successful treatment of an affected camel with 60,000 IU of antitetanic serum over 72 hours in addition to routine care of the wound has been reported (Marcos, 1965).

The bent neck or wry neck syndrome - shimbri or shimriki

This is a condition of unknown aetiology that develops slowly and often terminates fatally. It is locally known by the vernacular names *Shimbri, Shimbriki* or *Gudanki. Shimbri* is more severe than *gudanki* and can result in death of the animal. *Gudanki* is a mild form of the disease that characterized by one side neck bending and aimless movement. Informants reported that branding of the neck may help recovery. One affected animal was observed exhibiting a characteristic neck bending in a semicircle manner or S- shape. The animal was moving aimlessly, frequently falling down, unable to stand properly and becomes recumbent. Such an animal is unable to feed properly, so starved, becomes weak, debilitated and eventually dies.

Wry neck syndrome has been reported from different neighbouring countries including Sudan (Agab and Abbas, 1999), Kenya (Dirie and Abdurrahman, 2003) and Somalia (Pegram, 1976). Regardless of different suggestions forwarded by researchers, the aetiology of wry neck syndrome remains vague. Schwartz and Diolli (1992) considered the disease known in East Africa as "wry neck" a form of local tetanus, but they provided no evidence in support of that claim. It was also suggested that the disease may be due to vitamin B deficiency and such cases can respond to vitamin B treatments (Wilson, 1998). The disease, which cause gives a conspicuous bend in the upper half or third of the neck in adult camels, was also encountered in eight out of over 2000 camels in the Sudan (Agab and Abbas, 1999), while seven of the eight cases manifested wry neck syndromes were serologically positive for brucellosis (Agab *et al.,* 1996). Dirie and Abdurrahman (2003) described wry neck syndrome as *Laaba* in Kenya, literally 'the one that twists', which characterized by uncoordinated movements or unsteady gait, and paralysis of the hind legs, resulting in recumbency with neck twist into an 'S' shape (hence the name *Laaba*). The animals that develop this 'wry-neck syndrome' often do not recover and subsequently die, whereas those that do not develop a twisted neck usually recover after a recumbency of three to seven days. The authors reported *Laaba* occurs periodically and generally, as in the 1998 outbreak, after unusually heavy rains, as a result of tick paralysis due heavy tick infestation by *Rhipicephalus appendiculatus*. Poisoning by the bush *Capparis tomentosa* was also implicated as the prime cause of 'the bent-neck syndrome' (or 'wry-neck') by Idris *et al.* (1979) who attempted to produce a similar condition by experimentally dosing camels with the leaves of this plant.

In some cases regarded as *Gudanki,* the head of the affected animal is raised erect and the neck is stiff or bends to one side. The animal is restless, runs around aimlessly, looks confused and stops feeding. In some cases the camel behaves like a mad animal and hates any kind of disturbance, which is similar to rabid animal. Most affected cases starve and die. Thus, this form of complication may be related to diseases such as rabies, listeriosis and myiasis or coenurosis which have similar clinical pictures. As there is no effective treatment, it is important to make the

animal to rest or sedate it to reduce further self-inflicting damage. Shoulder paralysis was also encountered particularly in older female camels in poor body conditions. Affected animal often become recumbent or stand-up with difficulties. It is similar to downer syndrome in cow and may be associated with mineral deficiency.

Respiratory infection

Respiratory infections are quite common in camels and occur in two forms: acute and chronic forms. The chronic form with coughing is locally called "*Dhuguda, or kufa"* while the acute form with nasal discharge is named as "*Furi."* The most important and severe form is the acute respiratory infection, which has occurred in the form outbreak during the major wet season (15.2% compared to 1.1% in dry period). Pneumonia is among the most important and commonly encountered disease of the camel. Despite low mortality and morbidity rates, the recovery period is quite long having negative impact on overall productivity. Similar to our observation, Agab and Abbas (1999) reported pneumonia as the ninth most common disease problem with peak incidence during autumn. Several risk factors including sudden climatic changes as well as the stress of migration from the south to the north during early rainfall were reported to be associated with pneumonia. Higher incidence of respiratory infection during the wet season was associated with change of climatic condition from warm dry period to wet, predisposing factors being draft, cold, rain, poor nutrition as well as migration that may distress the animals. It has been suggested that the long treks undertaken by camels during the rainy season (Abebe, 1991; Schwartz and Dioli, 1992; Agab and Abbas, 1999) as well as the housing of camels in unsheltered pens (Chauhan *et al.,* 1986; Abbas *et al.,* 2002) are major predisposing factors. Dust storms emerging during the first weeks of the rainy season in the African Sahel can also contribute to respiratory disease in camels. Hansen *et al*. (1989) described an outbreak of pneumoconiosis in Somali camels and reported the presence of large numbers of dust laden macrophages in the lungs of 94 out of 134 camels that had pneumonia. The crowding of pastoralist camels around limited watering points during the summer also contributes to the spread of respiratory pathogens as camels from different geographical regions often use the scanty open water sources (Hassen and Mustafa, 1985; Melaku and Feseha, 1988).

Likewise, more fatal and highly contagious camel disease with respiratory syndrome has also occurred as a large scale outbreak during wet season (April to May) of 2007 in Borana areas. The disease resulted in disastrous death losses causing 18% morbidity and over 50% mortality in affected herds. Bekele (1999) described the outbreak of pneumonia in camels that involved camel herds from as far east as the Ogaden and Afar regions to Borana and southern part of Ethiopia causing up to 30% morbidity and 6.4% mortality. Although the causative agent still remain obscure, *Pasteurella organisms* (Bekele, 1999), *Streptococcus equi* (Yigezu *et al.,* 1997) and antibodies to morbili viruses (Roger *et al.,* 2001) were detected from camels affected camels, and claimed as aetiology or having association with the disease. Higher seroprevalences to morbili virus in convalescent animals has added more weight to potential involvement of this virus.

Specific signs of chronic respiratory infection (pneumonia) were loud, severe open mouth coughing weight loss, restlessness, dullness, lacrimation and prolonged recumbency. Weakness, reduced milk yield in lactating and abortion in pregnant camels were observed. In support of this, Richard (1979) also described abortion as an important sequel of pneumonic pasteurellosis in camels. Acute respiratory infection (acute pneumonia) affects both adults and calves and manifested by sneezing, mucus discharge from the nostrils, fever, depression and reduced feed intake. Mucus discharge eventually becomes pus and blocks the nostrils, leading to difficulties in

breathing and death. Respiratory infection appears severe in camels due to the fact that primary infection is induced by virus and further complicated by bacteria.

A variety of viral, bacterial, fungal and parasitic microorganisms have been associated with respiratory disease problems (Abbas and Omer, 2005). *Pasteurella multocida* is the most commonly isolated pathogen from pneumonic camels (Hassen and Mustafa, 1985; Wernery and Kaaden, 2002) while *Pasteurell*a *haemolytica* has also isolated in association with severe pneumonia (Bekele, 1999). Numerous other bacteria including, *Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae, Rhodococcus equi,* and *Neisseria sp.* have been incriminated in the aetiology of pneumonia in camels (Chauhan *et al.,* 1987). Lung abscesses due mainly to *Arcanobacterium pyogenes* and *C. pseudotuberculosis* were reported by Abubakr *et al*. (1999) to affect both young and adult camels. There is very little in the literature with regards to the role played by mycoplasmas and other mollicutes in the aetiology of pneumonia in camels (Wernery and Kaaden, 2002). Elfaki *et al*. (2002) isolated *M. arginini* along with several other bacteria from 8.8% of camel lungs with lesions suggestive of chronic interstitial pneumonia. Similarly, several authors have reported high antibody titers against numerous respiratory tract viruses such as adenovirus, parainfluenza 3, respiratory syncytial virus, morbili viruses (Roger *et al.,* 2001) etc. (Olaleye *et al.,* 1989) in camel sera, but the pathological and epidemiological significance of these findings is not clear. Hence, respiratory infection is mainly due to primary or secondary bacterial infections that may respond to antibiotic treatments. Antibiotic therapy must be attempted with broad-spectrum agents.

Diarrhoea "Albati, Hardik"
Diarrhoea was a common manifestation of gastrointestinal disorders, particularly in young camels (calves) with morbidity rate ranged from 4.2% during the dry season to 6.5% during wet season. The signs seen include watery diarrhoea with froth, sometimes reddish and foul smelling. Loss of appetites, loss of condition, dullness, potbelly and stunted growth were observed in young animals. Affected young animals showed dehydration, loss of body condition and sunken eye. Agab and Abbas (1999) reported a high incidence of calf diarrhoea that affected 21.9% of one-year-old calves studied, with the peak of occurrences during early summer coinciding with the peak of the calving period for camels in the Sudan. Thus wet season is an important risk factor due to favourable environmental conditions for the pathogens and existence of susceptible newborn calves. It is also important to note the role of adequate colostrum ingestion during early age of life as means of prevention.

Calf diarrhoea has a multi-causal background that could be due to bacterial (yellowish, watery with blood) and viral infections (yellowish watery faeces), internal parasites, drinking too much milk (white diarrhoea) and sudden change in feed. Etiologically, the disease is caused by mixed infection with numerous microbes, notably *Salmonella spp.* and *E. coli* (Abbas *et al.,* 1992; Moore *et al.,* 2002). The diarrhoea due to viral infection (corona virus, rotavirus) and bacterial infections (colibacillosis, salmonellosis, *Clostridium perfringens* and *Mycobacterium paratuberculosis*) are often severe and end with death (Schwartz and Dioli, 1992). Early cases of diarrhoea are mainly due to *E. coli,* rotavirus and adenovirus, while after three weeks to two months of age, it is caused by *Salmonella*, *Clostridium*, *Campylobacter* and possibly coccidian. *To prevent and control camel calf diarrhoea, sanitary measures, adequate colostrum intake, and treatment of affected animals using broad spectrum antibiotic and fluid therapy are vital measures.*

In adult animals, diarrhoea occurred mainly during the onset of rainy seasons, due to feed change and ingestion of toxic plants or parasitic infections, and in male animals at rutting. It is not such a serious health problem in adults except for plant toxicosis which is locally called "*Butala*". In plant toxicosis, affected animals showed signs including bloating, diarrhoea, depression and lacrimation. Although most of the affected cases recover, convalescent animals are emaciated and in poor body condition. In line with the problem, several toxic plants were reported cause bloat and diarrhoea. *Datura alba, Euphorbia tirucalli* (milk bush) *Lantana indica, Sorghum bicolor, Calotropis procera* are among the plants that cause diarrhoea, bloat and gastrointestinal disorder (Schwartz and Dioli, 1992).

Eye problems and night blindness - ill-bora

Eye infection was more common during the minor rainy season in October (affecting 2.8% of examined animals); while night blindness was seen throughout the study period with fairly increased prevalence during dry seasons. Eye infections more often affected young and calves, while loss of vision and light blindness is more common in females and proportionally seems to increase with age. Eye infection and blindness appear to be more common in camels than other ruminants in the same eco-zone. Camels may lose vision in one or rarely both eyes. The causes are mainly of traumatic origin including blows, thorn shrubs on which they browse and other foreign bodies. Injuries also occur during the night when animals are confined in small enclosure built of acacia branches. Excessive rubbing due to irritation by flies, ticks, sarcoptic mange and pruritic disease (contagious skin necrosis and contagious ecthyma) can lead to eye injuries with further complication by bacterial infections. Camel Pox infection can also cause eyelid inflammation and blindness.

Night blindness (nyctalopia) was reported from camel herds in Sudan (Agab *et al.,* 1993) and Eritrea (Gebrehiwet, 1999) as a result of vitamin A deficiency. In a study by Agab and Abbas (1999) the disease was ranked to be the fifth important camel disease with 7.5% prevalence and peak of occurrence during summary. The authors observed complete disappearance of the condition during autumn, owning to availability of green fodder as source of β-carotene, the precursor of vitamin A. Unlike our observation, Agab and Abbas (1999) reported the disease to occur in young animals, particularly in one herd as form of an outbreak in camel calves born during December to March, but the authors did not clearly indicate whether the deficiency was associated with in adequate milk intake or scarcity of green fodder for those calves.

Table 3 Distributions of clinical diseases by age groups, sex and ethnic groups represented with numbers and % of group total.

Clinical Diseases	**Age**		**Sex**		**Ethnics**		**Total**
	> 2years (n=1424)	≤ 2 Years (n=551)	male (n=361)	female (n=1614)	Borana (n=897)	Gebra (n=1078)	(n=1975)
Mange mites	360 (25.3)	262 (47.5)	92 (25.5)	530 (32.8)	174 (19.4)	448 (41.6)	622 (31.5)
Tick infestation	1167(82..0)	141(25.6)	162 (44.9)	1146 (71.0)	589 (65.7)	719 (66.7)	1308 (66.2)
Abscess	94(6.6)	106(19.2)	44(12.2)	156 (9.7)	129(14.4)	71(6.6)	200 (10.1)
Contagious skin necrosis	26(1.8)	87(15.8)	42 (11.6)	71(4.4)	28 (3.1)	85(7.9)	113 (5.7)
Traumatic wound	37(2.6)	6(1.1)	9(2.5)	34(2.1)	23(2.6)	20(1.9)	43 (2.2)
Naked mole rat and hyena bites	16(1.1)	0	2 (0.6)	14 (0.9)	6 (0.7)	10(0.9)	16 (0.8)
Contagious ecthyma	0	52(7.8)	12 (3.3)	40(2.5)	20(2.2)	32 (3.0)	52 (2.6)
Camel pox	31(2.2)	36(6.5)	11 (3.0)	56 (3.5)	32 (3.6)	35 (3.2)	67 (3.4)
Chronic wasting disease	0	18(3.3)	8 (2.2)	10 (0.6)	8 (0.9)	10 (0.9)	18 (0.9)
Dermatophytosis	0	26(4.7)	5(1.4)	21(1.3)	9 (1.0)	17 (1.6)	26 (1.3)
Fracture and Myositis	19(1.3)	0	4 (1.1)	15(0.9)	8 (0.9)	11 (1.0)	19 (1.0)
Respiratory infection	129(9.1)	25(4.5)	26 (7.2)	128 (7.9)	61 (6.8)	93 (8.6)	154 (7.8)
Diarrhea	8(0.6)	28(5.1)	5 (1.4)	31 (1.9)	15 (1.9)	21 (1.7)	36 (1.8)
Septicemic conditions	6(0.4)	10(1.8)	4 (1.1)	12 (0.7)	5 (0.6)	11 (1..0)	16 (0.8)
Eye infection & blindness	20(1.4)	5 (0.9)	1(0.3)	24 (1.5)	10 (1.1)	15 (1.4)	25 (1.3)
Night blindness	29(2.0)	0	2 (0.6)	27 (1.7)	10 (1.1)	19 (1.8)	29 (1.5)
Other diseases	25(1.8)	0	4 (1.1)	21 (1.3)	10 (1.1)	15 (1.4)	25 (1.3)
Total	1967(138.1)	802(111.6)	433 (119.9)	2336 (144.7)	1137 (126.8)	1632 (151.4)	2769 (140.2)

4.1.3 Morbidity and mortality of camel calves

Most of the diseases that affect adult camels also affect young animals, with varying degree of occurrence and severity. For instance, diseases that affect the integument system, including sarcoptic mange, contagious ecthyma, pox and contagious skin necrosis are more common and severe in calves than in adults. Among other infectious diseases, septicaemia and joint-ill, calf diarrhoea and chronic wasting disease *elgof* are more important in young animals due to their fatal outcomes. Table 3 displays important clinical diseases occurred in calves during the study periods. The most prevalent diseases were sarcoptic mange, contagious skin necrosis, abscess and pox. However, the most important causes of death were septicaemia and joint ill, pneumonia, chronic wasting disease and diarrhoea (Fig 8). This is more or less similar to the listed important calf diseases by camel owners (Fig 7). According to herders, the three most important calf diseases were septicaemia and joint-ill, pox and chronic wasting disease *elgof*.

Septicaemia and joint-ill *dhidhiksi* is the common cause of deaths at early age and occur throughout calving seasons. Chronic wasting disease is more common in advanced ages (above 6 months) and probably associated with internal parasitic or bacterial infection which further exacerbated by malnutrition. Respiratory infections and pox may occur in the form of outbreak and may affect all age groups. According to key informants *Kanicha* (swollen lymph nodes), a disease characterized by swelling of superficial lymph nodes is also reported as important disease of calves. We have encountered such cases during our survey in adult animal but not in calves. In addition to lymph node swellings, there was swelling of neck region, loss of appetite, diarrhoea, reduced urination and sternal recumbency in affected animal. Herders reported *Kanicha* is further characterized by reduced urination, so that distended bladder can be observed at post-mortem. Literatures regard *Kanicha* as hemorrhagic septicaemia due to pasteurellosis or *Bacillus cerus* intoxication or anthrax.

Septicaemia and joint ill *dhidhiksi* is the most important camel calf problem with increased occurrence during wet seasons. According to herders *dhidhiksi* is the top problem of calves due to its high fatality and sudden death of calves. Figure 5 shows that septicaemia in combination with joint ill and pox were report to be the most important camel calf diseases. Similarly, higher proportion of calf deaths was recorded due to this disease complex followed by respiratory infections (Figure 8). Affected calves had clinical manifestations of diarrhoea, swellings of joint, collapse and death just sometimes after birth. They become weak, hyperaemic eyes, swelling of eyelids and cannot stand up. It seems that the disease is septicaemia due to naval infections just following birth as swelling of the joint indicates joint-ill that resulted from naval infection. Additionally, enteric bacterial infections may also be causes of such problems. Thus, this disease is known to cause early mortality, particularly below 2 months of age. Figure 10 shows comparative age at death of actual death records and participatory discussion data, indicating similar trends with higher proportion of early death (over 50% of death below 2 months of age).

Table 4 Diseases and health problems of camel calves diagnosed during seasonal surveys

Diseases/ health problems	Dry season		Major Wet season		Minor wet season	
	animals examined	Affected (%)	animal examined	Affected (%)	animal examined	Affected (%)
Mange	284	156 (54.9)	169	71 (42.0)	98	37 (37.8)
Contagious skin necrosis	284	48 (16.9)	169	25 (14.8)	98	14 (14.1)
Abscess	284	56 (19.7)	169	38 (22.5)	98	12 (12.1
Dermatophytosis	284	9 (3.2)	169	14 (8.3)	98	3 (3.0)
Injury and fracture	284	2 (0.7)	169	3 (1.8)	98	1 (1.0)
Respiratory infection	284	4 (1.4)	169	14 (2.4)	98	7 (7.1)
Calf diarrhoea	284	12 (4.2)	169	11 (6.5)	98	5 (5.1)
Contagious ecthyma	284	4 (1.4)	169	27 (16.0)	98	21 (21.4)
joint ill & septicaemia	284	2 (0.7)	169	5 (3.0)	98	3 (3.1)
Pox	284	0	169	1 (0.6)	98	35 (35.7)
Chronic wasting disease (*Elgof*)	284	15 (5.3)	169	3 (1.8)	98	0
Eye infections	284	0	169	0	98	5 (5.1)
Total Morbidity	284	293 (103.2)	169	191 (113.0)	98	131 (133.7)

A study by Kamber *et al.* (2001) has showed elevated pre-colostral IgG titers in some examined camel calves that suggested possibilities of prior intra-uterine infections. Newborn camel calves that were not fed with adequate amount of colostrums may be susceptible to such infection. Occasionally, camel owners either prevent early colostrum consumption or feed the calf first with water instead of colostrums and even milk out the colostrum due to fear of calf diarrhoea. Such traditional practice has been already reported from camel rearing areas (Wilson, 1998).

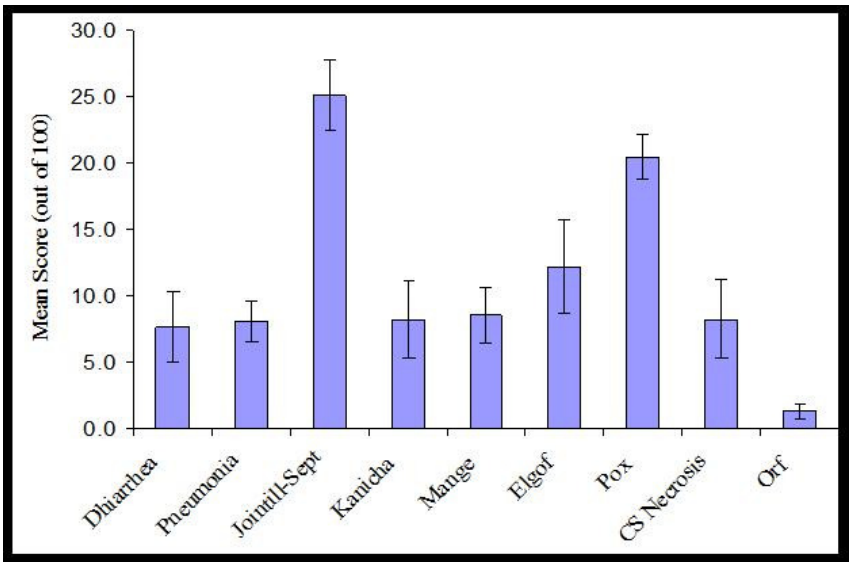

Figure 7 Mean score of important camel calf diseases reported by camel herder groups (n=12) During group discussions

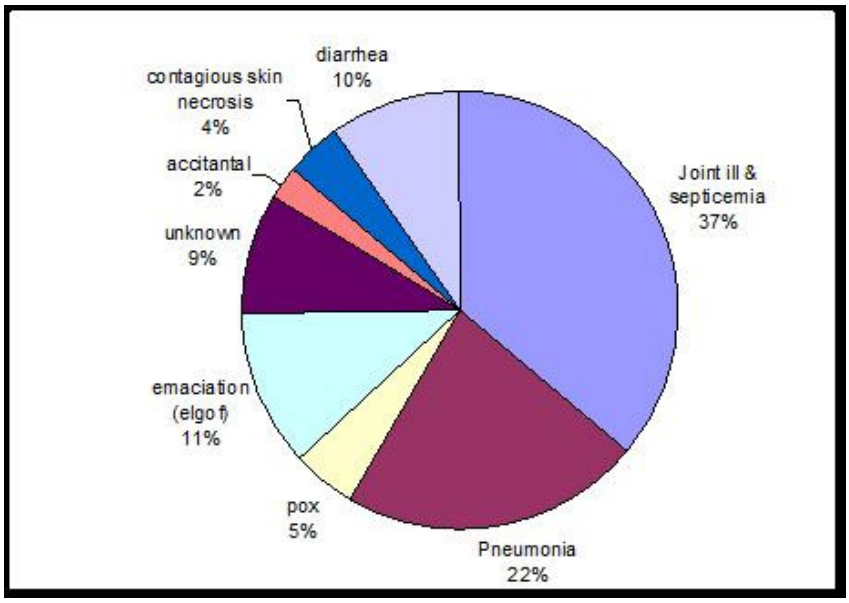

Figure 8 Proportional causes of camel calf mortality during three seasonal surveys (n=122)

Early death of newborn camels may be associated with the factors of dam as calves born from some dams were recorded repeatedly dying during reproduction history profiles of breeding females. This will add some weight to the role of inadequate colostrum intake and failure of passive transfer in contributing to early calf deaths. In a study by Kamber *et al.* (2001), it was suggested that low colostrum intake during the first 24 hours of life is presumably associated with early mortalities of camel calves. In fact, the authors recorded that 39% of the examined calves had maximum serum colostrum concentration below 4g/litre, which is considered to be critical value for cattle and horse. So, it is important to note that adequate colostrum intake during the first 24 hours is vital for survival of calves. If calves are not able to suck within 12 hours after birth, assistance from the herdsmen is needed. Additionally, early treatment of such cases with broad spectrum antibiotics may also reduce early mortality due to septicaemia and joint-ill.

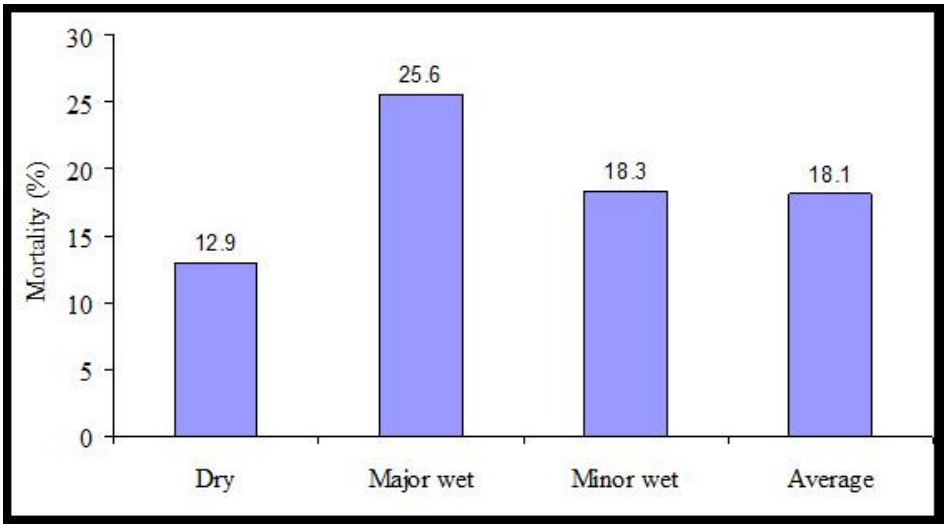

Figure 9 Calf mortality in different seasons

The present morality data showed significantly higher mortality rate during the wet seasons than the dry season (Figure 9). This could be coincidence with higher prevalence of infectious diseases during wet seasons together with existence of increased newborn susceptible animals. The overall mortality of 18.1% is similar to the previous mortality report of 15 to 20% by Megersa *et al.* (2008) from Borana area. In general, camel calf mortality has been reported to be the major hindrance to production enhancement and population growth. Mortality has been often reported to be as high as 50% particularly in pastoral herds. The crude mortality rates reported from Ethiopia were 30% by Tuffa and Baars (1998) and 45% by Getahun and Kassa (2002) from Eastern Ethiopia. Similarly, Kaufmann (2005) has reported mortality rates of 25%, 22% and 27% in Rendille, Gabra and Somali camel calves of Northern Kenya, respectively. This suggests huge loss of calf crops that vitally affect the replacement stock in particular, the herd productivity and population growth in general. Hence, is important to minimize such high death losses by implementing feasible intervention measures like effective veterinary services particularly during calving periods (wet seasons) to reduce early mortality. The extension work to improve care to young animals such ensuring ingestion of adequate colostrum is also crucial to improve camel calf survival. Obviously, some herders often avoid early colostral ingestion due to fear of calf scour. Some provide water or milk from other animals, while others milk out the first colostral milk before consumption by calves. So, this practice must be improved to reduce death losses.

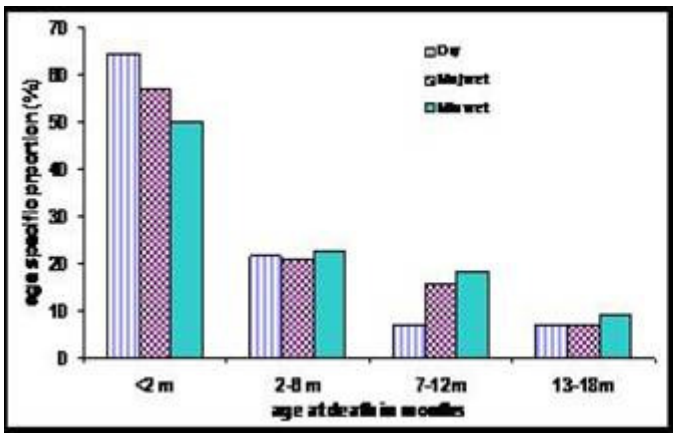

Fig 10a. Age at death during three seasons

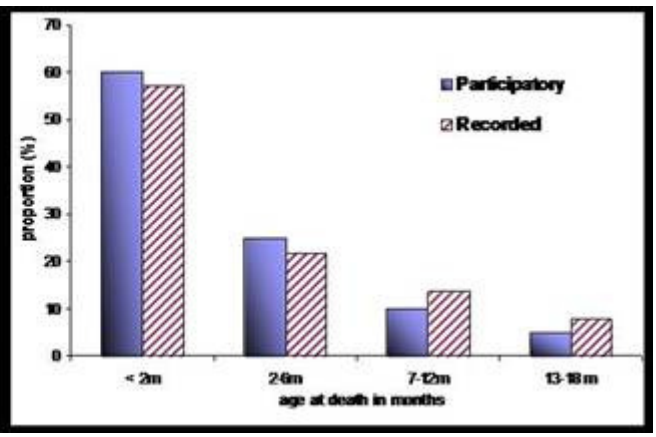

Fig 10b. Comparison of age at death records with participatory data

Figure 10. Proportion of calf deaths by age category of death cases during three season (Fig 10a) and comparison of actual death case records (n=122) with participatory data generated by 12 informant groups (fig 10b)

4.1.4 Reproduction Associated Diseases

Mastitis and Udder lesions

Mastitis or Inflammation of the mammary gland is an important camel disease, owning to its economic and public health significance. Using a card test, sub-clinical mastitis was found to be the most frequently detected udder problems among lactating camels with prevalence ranged from 28.6 to 37.6%. Clinical examination of udders also found clinical mastitis to affect over 10% of the studied animals, which moderately increased to 17% during minor wet period in October. More importantly about 10% - 16% of the studied camels had one or more blind teats where passage of milk was obstructed and 4.4 – 6.8% of them had udder lesions (wound, abscess or swellings). Table 5 displays the seasonal distribution of mastitis, udder lesions and other reproduction associated diseases. In addition to udder examination and mastitis test, udder tick load recording and species identification were conducted. Most of the animals had ticks with seasonal average counts ranged from 2.8 to 4.3 with higher burden during the minor wet season. Pooled seasonally collected ticks belonged to the three genera; namely *Rhipicephalus* (83.2%), *Amblyoma* (13.6%) and *Hyaloma* (1.2) of which *Rhipicephalus pulchalus* was the most prevalent tick species (77.5%). So, ticks can be regarded as risk factor for mastitis and udder lesion. Similarly, most of the herder in the study area uses anti-suckling device, tie the teat with tree fibres, to prevent calves from suckling the dam. This device may cause trauma to the udder and predispose to mastitis.

Table 5 Seasonal distribution of udder infections and other reproductive associated problems

Reproductive diseases	Dry season		Major Wet season		Minor wet season	
	animal examined	Infected (%)	animal examined	Infected (%)	Animal examined	Infected (%)
Clinical mastitis	294	36 (12.2)	221	24 (10.9)	194	33 (17)
Sub clinical mastitis*	161	56 (34.8)	142	48 (33.8)	122	35 (28.7)
Blind teat	294	32 (10.9)	221	23 (10.4)	194	16 (8.2)
Udder lesion	294	13 (4.4)	221	15 (6.8)	194	12 (6.2)
Uterine infections	294	11 (3.7)	221	9 (4.1)	194	5 (2.6)
Hypogalactia	136	3 (2.2)	221	0	112	0
Hypocalcaemia	136	19 (14)	142	5 (3.5)	112	13 (11.6)
Abortion	136	10 (7.4)	142	15 (10.6)	112	17 (15.2)

*Sub-clinical mastitis was assessed on lactating animals using card test, and the result was recorded by evaluating degree of card discoloration

Udder infection or mastitis continues to be the most important economic disease problem among pastoral camels as it is in dairy cows worldwide (Agab and Abbas, 1999; Guliye *et al.*, 2002; Abdurrahman, 2006). Obeid *et al*. (1996) stated that only 5% of milking camels in eastern Sudan had sound and healthy udders. On clinical examination, approximately 50% of tested camels were found mastitic. Guliye *et al*. (2002) reported up to 40% mastitis in Bedouin camels, whereas 81.4% of apparently healthy camels had sub-clinical intramammary infections. Bekele and Molla (2001) recorded 12.5% clinical and 47.3% sub-clinical mastitis in 152 traditionally managed lactating camels in Ethiopia. It affected considerably higher proportion of the breeding females with substantial reduction in milk yield. Mammary gland diseases are known to have negative effects on milk production, health and growth of newborns and can pose public health hazards for populations consuming camel milk. However, the depth of information on camel mastitis is limited. Indeed, it is an undeniable fact that camels are kept in infrastructure and resource poor marginal areas for the subsistence production system, where the prevalence of other major diseases occupies the concerns of herders and specialists. Hence, it is unlikely to take control measure through early problem recognition and improved hygienic action that may reduce the losses due to mastitis.

The udder is a predilection site for tick infestation which causes skin and teat lesions, facilitates bacterial entry and leaves behind permanent tissue damage. Lesions due to ticks, poor udder hygiene and cauterizations of the udder skin (Obeid *et al.,* 1996; Almaw and Molla, 2000; Woubit *et al.,* 2001) are a big problem to overcome if udder health and milk hygiene is to be improved. In traditional husbandry practice, anti-suckling device, fibres from plants are tied to the teat to prevent the calf from sucking the dam (Agab and Abbas, 1999; Abdurrahman, 2006). Younan *et al*. (2001) described a severe outbreak of mastitis that involved 207 lactating camels in six different herds and commented that pox might have been a contributing factor in the exacerbation of the disease.

Direct bacteriological culture has been employed to diagnose camel mastitis or to detect udder infections. The most commonly isolated organisms were *Micrococcus sp., Streptococcus agalactiae, Staphylococcus aureus, Arcanobacterium sp.* and *E. coli,* rare isolations include *Klebsiella pneumoniae and Pasteurella hemolytica* from cases of mastitis (Almaw and Molla, 2000; Woubit *et al.,* 2001; Bekele and Molla, 2001; Abdurrahman, 2006). *Pasteurella*

haemolytica was isolated *from* a case of chronic obstructive mastitis (Ramadan *et al.,* 1987; Bekele and Molla, 2001), and *Clostridium perfringens* from subclinical cases (Mustafa *et al.,* 1987). Most of the bacteria isolated from camel milk are known mastitis-causing organisms in the cow, sheep and goat. *Staphylococcus aureus, Streptococcus agalactiae* and coagulase negative staphylococci seem to be important udder pathogens in the camel (Tibary and Anouassi, 2000; Abdurahman 1996) as in other dairy animals. However, the camel has not been the subject of experimental mastitis studies and the epidemiology and pathogenicity of mastitis causing organisms remain unclear.

Camel owners usually treat mastitis by a combination of cauterization and certain phytotherapeutics. These treatments are usually ineffective, and the resulting delay leads to chronic, often fibrostic sequel (Ramadan *et al.,* 1987). Although most cases of mastitis were well advanced by the time of examination, a remarkable improvement was observed following systemic antibiotic therapy with broad spectrum antibiotics. Because of the particular anatomy of the *Camelidae* udder and because of the difficulty in administering such as intra-mammary treatments, systemic antibiotics (e.g., trimethoprim-sulfametoxazole or penicllin/aminoglycoside) and anti-inflammatory drugs (flunixin meglumine) with regular stripping of the mammary glands was recommended to treat acute mastitis in camels (Tibary and Anouassi, 2000).

To control mastitis in camel it is a good practice to remove ticks even when the animal is not lactating. This can be done by gripping the tick as close to the host's skin as possible and removing it by a gentle rotation and firm downwards pulling motion. This will strip the tick's mouthparts encased in the cement material from the host's skin, sometimes leaving a small wound that might bleed for a few minutes. The potential danger of ticks transmitting infection will also be avoided. Advice to herders to avoid use of anti-suckling device may also reduce the traumatic damages caused by it, and reduce subsequent bacterial infections.

Hypogalactia
In addition to mastitis, Agalactia or Hypogalactia was detected in some younger breeding camels, particularly after the first parturition. Three females out of 136 (2.2%) lactating animals examined during dry periods had problem of milk letdown. The fates of their calves were either death or looking for foster mother. We did not observe such cases during the subsequent rainy seasons, which may give accreditation to the effects of feed shortage. In many instances, milk production and letdown is very limited in camels particularly during the first few days following parturition. The aetiology of agalactia is unclear in these animals, but it could be associated with severe oedema, problems in milk let down, hormonal imbalances, nutritional problems or mastitis (Tibary and Anouassi, 2000).

Uterine Infection (Pyometra or Metritis) - "Bushdere"
Evidences of uterine infections were detected in 2.6-4.1% of the clinically examined breeding females. Some affected animals with pyometra had yellowish discharge with foul smelling which occurred during the first few weeks post calving. Depression, loss of appetites and reduction in milk production were some of the observed symptoms in acute endometritis and pyometra. Pyometra or metritis as in other animals can occur in camels as a result of bacterial infections of the uterus. Uterine infection and abortion represent the major complaint in camelid veterinary practice. The major infectious organisms in endometritis and metritis are *E. coli, Streptococcus equi* ssp. zooepidemicus, *Actinomyces pyogenes* (Tibary *et al.,* 2003). Yagoub (2005) recorded important reproductive diseases of she-camels to be acute catarrhal endometritis, pyometra and chronic endometritis, the incidence of which increased with age and peaked in autumn. The isolated bacteria include *Staphylococcus aureus, E. coli, Klebsiella* spp*, Corynebacterium* spp*., Proteus, Streptococcus* spp. *and Salmonella* spp. Thus,

uterine infection in female camels can be treated with intrauterine antibiotic bolus as in cattle or systemic injection with broad-spectrum antimicrobial agents.

Abortion "Salesa" and still birth

Abortion in pregnant camels was quite common throughout the study season and progressively increased during study periods from 7.4% (dry period) to 10.6% (major wet) and 15.2% (minor wet season). This was probably co-incident with increment of some infectious diseases and biting fly population during the wet period. Potential diseases like camel pox, acute respiratory infections and trypanosomiasis occurred more commonly during wet seasons. It was also observed that when biting flies and mosquitoes severely attack camels; the animals become restless and kick their abdomen leading to abdominal hematoma and abortion in pregnant females. On the other hand, the association of brucellosis seroprevalence among breeding camels with abortion was not observed in this study. Several diseases and conditions can be associated with abortion in camels. Trypanosomiasis is one major diseases reported cause frequent abortion in camels as a result of endocrine dysfunction (Enwezor and Sackey, 2005). Brucellosis as a cause of abortion was recently reported by Musa and colleagues (2008) from a field outbreak of abortion in Sudanese camels. Similarly, Musa and Higidi (2001) reported association of high abortion in camel herds with brucellosis seropositivity. Several other bacterial (*Chlamydia, Salmonella* and *Leptospira*) and viral (Rift valley fever) infections, toxic plants and malnutrition and mechanical factors are incremented to be the causal factors. Abortion and still birth are important constraints hindering reproductive performances of camels, but difficulty to contain the problem due to their multi-causal factors.

Hypocalcaemia, Chachabsa

Hypocalcaemia cases were observed mainly during the dry season in late pregnant animals. Similar to other ruminants affected animals were recumbent and unable to stand up for some times. Other observed clinical signs include hindquarter paralysis, lameness and inability to walk. The condition usually occurs in late pregnancy and recently calved camel with high milk production similar to hypocalcaemia (milk fever) in dairy cattle. Thus, *chachabsa* commonly occur in high milk producing local breeds of called Horki. *Chachas* is probably hypocalcaemia in camels as in cattle; high amount of the mineral is required during late pregnancy and high milk production. This results in decreased blood level calcium (hypocalcaemia) leading to hindquarter paralysis and recumbence. The only treatment known to pastoralists is firing on both sides of the pelvic area and around the tail, but this treatment is not likely to be very effective.

Similarly, Dirie and Abdurrahman (2003) have observed cases of hypocalcaemia in Kenyan camels and named as *Jajabsa,* which literally translates as 'the one that breaks up', is a disease of pregnant camels during the later stages of gestation and is characterised by paralysis of the hind legs. The disease affects all camel breeds, but the most susceptible is the 'horr' breed, known for high milk yields. Most animals recover after parturition but complications, such as dislocation of the hip joint and piercing of the hipbone through the skin, occasionally occur. Similar cases of hypocalcaemia were also reports from camels in Israel. Thus, hypocalcaemia or chachabsa in dromedary camels, especially in high milk producing local breeds of Horki (Ethiopia) or Horr (Kenya) can be treated with intravenous injection of calcium boro-gluconate preparations with dose rate for dairy cattle (500ml).

4.2 GASTROINTESTINAL TRACT PARACITIC DISEASES

The seasonal prevalence of internal parasites was over 80% and similar across the season. Parasite prevalence was generally lower in camel calves compared to adults as calves managed separately. However, severity and parasitic load was higher during the dry season than wet periods. During dry periods there was an increased EPG count of *Strongyloides papillosus*, and oocyst of *Eimeria* species in young animals, which contributed to an overall increment of parasitic load during dry period. *S. papillosus* load was higher in calves with poor body conditions and seems to be associated with a chronic wasting disease in calves, locally called *Elgof or Ilqot*. Affected calves were poor in body conditions, chronically debilitated, with eyes sunken into sockets and depressed supra orbital fossa (a condition from which the vernacular name *Elgof or Ilqot* derived). On the other hand, the load due to strongyles (major nematode) was increased during the major wet season.

Parasitic infection, especially helminthiasis is a well-recognized problem in free-ranging, particularly pastoral camels. Previous studies have shown that higher proportion of pastoralist camels were infected by one or more helminth parasites. On the basis of faecal (1,500 samples) and post-mortem examination, Richard (1979) estimated that 92% of the animals examined in various parts of Ethiopia were to some degree infested with internal parasites (80% with *Strongylus* ova, 10% with *Strongyloides* larvae and 16% with *Trichuris* ova). Fourteen helminth species were identified on post-mortem examination, the main ones being *Monezia* spp*., Stilesia vittata, Avitellina centripunctata, Trichuris globosus, Haemonchus contortus, Trichostrongylus* spp. and *Impalaia somaliensis.* Mixed infections with *Haemonchus* sp., *Trichuris* sp., *Cooperia* sp. *Nematodirus* and *Trichostrongylus* sp., to name a few, are the most common. In the present study, while the infection prevalence was almost constant throughout the year (about 80 percent), camels infected during wet season sustained a heavier strongyle parasite load (Table 6 & 8). This season is apparently the season during which the developmental stages of nematodes can resume activity in the study area. Furthermore, the early weeks of the major wet season are a time of stress for camels as pastures are still sparse, and the animals are not yet in good body condition. In a study by Agab and Abbas (1999), there was similarity of parasitic prevalence (65%) across the study periods, but with higher load during autumn.

It is important to implement strategic internal parasitic treatment in camels. As strategic treatment with broad-spectrum anthelmintics, treating camels at least during two seasons; dry and wet have vital importance for two reasons. Treatment during the dry period reduces the overall stress on animals that associated with parasitic burden, malnutrition and further reduces susceptibility to concurrent infections. Wet season treatment may reduce re-infections and environmental contaminations, so that hinders the life cycles of parasites.

Table 6 Seasonal parasitic prevalence of camels

Parasitic Diseases	Dry season		Major Wet season		Minor wet season	
	Samples	Positive (%)	Samples	Positive (%)	Samples	Positive (%)
1. Internal parasites	442	365 (82.6)	423	349 (82.5)	362	292 (80.7)
▶ *Strongylus* spp.	442	353 (79.9)	423	324 (76.6)	362	279 (77.1)
▶ *Monezia* spp.	442	56 (12.7)	423	76 (18.0)	362	54 (14.9)
▶ Coccidia spps.	442	59 (13.4)	423	18 (4.3)	362	12 (3.3)
▶ *Trichuris* spp.	442	25 (5.7)	423	19(4.5)	362	23 (6.4)
▶ *Strongyloides*	442	23 (5.2)	423	15 (3.5)	362	15 (4.1)

Table 7 Seasonal Parasitic load as mean of faecal egg count per gram of faeces

Parasites	Dry season	Wet season	Minor wet season
Total parasite	1877.8	1790.2	1580.5
▶ *Strongylus*	1395.3	1663.5	1482.5
▶ Tapeworms	55.1	79.0	40.9
▶ *Strongyloides*	169.7	16.2	25.6
▶ *Trichuris* spp.	21.3	7.3	14.9
▶ *Eimeria* spps.	234.1	24.2	9.3

Table 8 Seasonal parasitic prevalence of camel calves

Diseases detected in tested animals	Dry season		Major Wet season		Minor wet season	
	Samples	Positive (%)	Samples	Positive (%)	Samples	Positive (%)
1. Internal parasite	129	102 (79.1)	116	82 (70.7)	96	71 (74.0)
▶ *Strongylus*	129	96 (74.4)	116	80 (69.0)	96	67 (69.8)
▶ *Monezia*	129	21 (16.3)	116	25 (21.6)	96	9 (9.4)
▶ Coccidia	129	30 (23.3)	116	2 (1.7)	96	3 (3.1)
▶ *Trichuris* spp	129	9 (7.0)	116	5 (4.3)	96	7 (7.3)
▶ *Strongyloides*	129	17 (13.2)	116	3 (2.6)	96	6 (6.3)

Table 9 Seasonal Parasitic load of camel calves as mean of faecal egg count per gram of faeces

Parasites	Dry season	Wet season	Minor wet season
	Mean	Mean	Mean
Total parasite	1841.1	1334.5	1045.9
▶ Strongyles	906.6	1166	943.8
▶ Tape worms	81.4	108.6	62.4
▶ Strongyloides	552.7	19.8	18.4
▶ Trichuris	21.3	11.2	12.4
▶ Eimeria spps	279.1	28.9	8.9

4.3 OTHER INFECTIOUS DISEASES

4.3.1 Brucellosis and Tuberculosis

The prevalence of antibodies to *Brucella* was generally low (2%) in camels of the area. This seroprevalence is similar to the previous reports from different areas (Omer *et al.,* 2000; Azwi *et al.* 2001; Teshome *et al.* 2003; Megersa *et al.* 2005). However, it is lower than other reports; 9.3% in slaughtered camels in Egypt (Moghney, 2004), Sudan (Majid *et al.* 19999), 8.4% in Saudi Arabia (Radwan *et al.,* 1992). Status of brucellosis in camels depends on the *Brucella* species prevalent in other animals sharing their habitat and on the husbandry methods of camels. Recently, Musa and his colleagues (2008) reported higher prevalences of brucellosis (23.8%) from camels kept mixed with ruminant species. The author further suggested that cattle were the possible source of infection for the camels as small ruminants were seronegative. According to Abbas and Agab (2002), seroprevalence of camel brucellosis appears to follow two distinct patterns: a low prevalence (below 5%) in nomadic or extensively kept camels and high prevalence (8-15%) in camels kept intensively or semi-intensively. Camels are mainly browsers, less frequently drink water, and reach maturity late with prolonged reproduction intervals. These factor contribute to a low prevalence of brucellosis among pastoral camels.

Table 10 Prevalence of other infectious and parasitic diseases of camels

Diseases	**Samples examined**	**Positive (%)**
Brucellosis	1178	21 (1.8)
Tuberculosis (ppd)	98	12 (12.2)
Contagious Bovine Pleuropneumonia (CBPP)	400	16 (4%)
Peste des Petite Ruminant (PPR)	400	6 (1.5)
Trypanosomiasis	257	27 (10.5)
Hydatidosis*	35	9 (25.7)

* As the number of camels slaughtered in Yabello district was too small, our data on hydatidosis is inadequate

Even though the small number of animals were skin tested (comparative intra dermal test), the recorded prevalence of tuberculosis (12.2%) was high. More importantly, one case was with a typical pulmonary tuberculosis symptoms; coughing and poor body conditions. The case was negative for parasitic infections, adding value on our suspicion. There is dearth of information about tuberculosis in camels. Bovine tuberculosis (TB) is caused by *Mycobacterium bovis* also can cause TB in camels. The organism causes granulomatous abscesses in various tissues with a predilection for lymphoid tissues and lungs (Wernery and Kaaden, 2002). However, Tuberculosis due to *M. bovis* is considered as a rare disease in camels, although high percentages of skin tested positives can be recorded. The relatively recent isolation of *M. bovis* from the lungs of a camel in Mauritania (Chartier *et al.,* 1991) has led to renewed interest in this zoonotic disease of camels. However, evidence from Australia where none of the 22% tuberculin test-positive camels revealed post mortem signs of infection with any *Mycobacterium spp.* lends strong support to the conclusion of a rare disease in camels. Many camels showing non-specific reactions to tuberculin were infected with *Corynebacterium pseudotuberculosis* abscesses; such reactions also occur in sheep infected with the closely related *Corynebacterium ovis* (Brown, 2004). It is important to note that for Johne's disease (*Mycobacterium avium paratuberculosis* infection) camels are more severely affected than other ruminants. Johne's disease affects camels worldwide causing characteristic clinical illness of severe diarrhoea and ends in death (Wernery and Kaaden, 2002). The course of disease is often more rapid than that in cattle

4.3.2 Mycoplasma infections

The seroprevalence of contagious bovine pleuropneumonia (CBPP) was low (4%) in tested camels. In Borana area, CBPP has been endemic in cattle and frequently occurred as outbreaks with higher morbidity and mortality. However, there were no such cases observed in camels sharing the same ecology particularly during the outbreaks in cattle. On the other hand, different *Mycoplasma* species were isolated from lungs of camels with lesions. There is very little information in the literature with regards to the role played by mycoplasmas in the aetiology of pneumonia in camels (Wernery and Kaaden, 2002). Elfaki *et al*. (2002) isolated *M. arginini* along with several other bacteria from 8.8% of camel lungs with lesions suggestive of chronic interstitial pneumonia. The pathogenic role of this mycoplasmal isolate was not confirmed by other methods, and its involvement in respiratory tract disease of camels remains doubtful.

4.3.3 Peste des Petite Ruminant (PPR) Infections

Our current seroprevalence of PPR was too low (1.5%), only 6 animals out of 400 samples tested by ELISA were positive. It appears that this disease is less important in tested camels. On the other hand, serological surveys have indicated the sensitivity of the camels to viruses belonging to the *Paramyxoviridae family*, initially classified as morbillivirus. A study in Egypt showed 4.2 % of 142 healthy camels at a slaughterhouse were positive for PPRV antibodies by serum neutralization test (Ismail *et al.,* 1992). Similarly, Abraham *et al.* (2005) have recorded PPRV antibodies in 3% of Ethiopian camels. However, a clinical disease in camels due to PPRV had not yet been established. Roger *et al.* (2001) detected antibodies to morbillivirus and suspected this virus as the initial cause of the outbreak of respiratory infections in camels. The serological results showed a global seroprevalence of 7.8 % for PPRV antibodies and 21.3 % for Rinderpest virus (RPV) antibodies in contact and convalescent camel groups. None of the sera from the non-affected area was positive which increased their presumption as initial cause of the disease. In accordance with several authors, the sensitivity of the camel to these viruses appears to be a reality. However, its susceptibility to RPV and PPRV had never been confirmed, as well as its role as a potential reservoir of these viruses which cause two major diseases of ruminants. It was suggested that the virulence of these viruses could be foreseen taking into account that morbilliviruses have an

immunosuppressive effect (Haas and Barrett, 1996) that led to secondary bacterial infections effectively treated by the antibiotics.

4.3.4 Trypanosomiasis and Hydatidosis:

Trypanosomiasis is an important disease of camels which occurs widely in camel rearing areas. The disease was reported in 10.5 % of the animals (27 out of 257 examined animals). The prevalence was relatively higher during the wet season (13.6 %) compared to dry season (8.4%). Trypanosomiasis was more common in herds that have been moved to other areas where green fodder existed. The seasonal pattern of camel trypanosomiasis was also reported by Demeke (1998) in Ethiopia and Agab and Abbas (1999) in the Sudan. This was attributed to the seasonal abundance of biting flies such as Tabanus, and other flies capable of mechanical transmission of *T. evansi*. The disease can easily be treated with trypanocidal drugs like Cymerlarsan and Quinapyramine methyl sulphate (Antrycide or Quintrycide).

There is evidence of hydatidosis occurring in camels, although the number of camels slaughtered at the areas was too small to give good picture of the disease. In this survey, 25.7% of the investigated animals were found infected with the disease. According to the literature review of Mukasa-Mugerwa (1981), the presence of echinococcosis (caused by *Echinococcus granulosus)* in Nigerian camels, out of 3,410 slaughtered animals examined, 1,952 (57.2%) were found to be infected with the disease. Similarly, 35% of the camels surveyed in central Sudan were infected with hydatidosis. Hydatid cysts were found in the lungs, liver and spleen of infected animals (but not in the heart), and losses of what would otherwise have been parts for human consumption were considerable.

4.4 TREATMENT OF SELECTED CLINICAL CASES AND TREATMENT RESPONSES

4.4.1 Helminth treatment response

In an effort to reduce the health risk of helminthiasis, a treatment trial has been conducted on selected herds in which camels are given therapeutic doses of two broad-spectrum anthelmintics, namely Albendazole and Ivermectin after EPG determinations. Seventy five adults camels having EPG above 500 were allocated into Albendazole (n=25), Ivermectin (n=25) and without treatment control (n=25) groups. EPG was determined 14 days post treatment, demonstrating faecal egg count reduction percent of 99.8% with Albendazole and 31.4% with Ivermectin and no difference in controls (without treatment) groups. The result with Ivermectin was surprisingly low, perhaps due problem with the drug used or due to the pharmacokinetics difference of Ivermectin in camels. However, as Ivermectin was recently introduced and not commonly used in the area; the observed low efficacy is not due to development of drug resistance. The result showed that Albendazole is a convenient (ease administration), dependable and economically feasible drug to treat and control camel helminthiasis.

4.4.2 Sarcoptic mange treatment response

Over 120 clinical cases due to sarcoptic mange were treated during dry periods by subcutaneous injection of Ivermectin. Treated animals were observed after two to three weeks and any clinical changes were recorded. Consequently, complete clinical recovery was observed with eventual improvement of body condition and new hair growth among the treated cases. The response has been very good with a significantly reduced occurrence of clinical signs and improvement of body conditions in treated camels. As a result, there was increasing interest and cooperation of camel herders during the consecutive field investigations. They had also great desire to get Ivermectin and treat their animals. Thus, this has probably contributed to reduction of prevalence and severe clinical cases of mange mite

infection during the second round investigation.

In general, anthelmintics and acaricides were the two drugs in greatest demand by the pastoralists. An efficient method for delivery of the much needed veterinary service to a widely scattered, continuously moving population of herders has still to be devised. Obviously, the existing conventional veterinary service (stationed vet clinics) is not doing well to satisfactorily serve the pastoral community. As strategic treatment approach, treating camels at least during two seasons; dry and wet are vital approach for two reasons. Treatment during the dry period reduces the overall stress on animals that associated with malnutrition and further prevents the occurrence of concurrent infections. Wet season treatment may reduce re-infections and environmental contaminations, so that hinders the life cycles of parasites.

4.4.3 Clinical mastitis treatment response

Selected clinical mastitis cases were treated with systemic long acting oxytetracycline and responses to the treatment was observed. Accordingly, 78 lactating females with clinical mastitis (42 during dry periods and 36 during wet seasons) were treated with intramuscular injection of LA oxytetracyclines. Responses such as subsidence of swelling, temperature and pain were checked within week after treatment. Additionally, change in milk colour, consistence and yield was also assessed. These animals were investigated and tested using mastitis card during the successive seasonal surveys. Of the treated animals, 57 (73%) responded well to the antibiotic treatment and did not show any indication of clinical mastitis or card test. Animals treated during dry period responded well to treatments (35 out of 42) compared to those treated during wet season (22 out of 34). Similarly, acute clinical mastitis and cases without previous history of mastitis responded well to the treatments. Therefore, this treatment trial may give insight information on how and when to treat mastitis cases.
Although most cases of mastitis were well advanced by the time of examination, remarkable improvement was observed following systemic antibiotic therapy particularly in acute cases. Thus early treatment is quite important to treatment mastitis in camels. Because of the particular anatomy of the *Camelidae* udder and because of the difficulty in administering such as intra-mammary treatments, systemic antibiotics and anti-inflammatory drugs with regular stripping of the mammary glands was recommended to treat acute mastitis in camels (Tibary and Anouassi, 2000).

5. AWARENESS CREATION WORKSHOP

The purpose of this study was to investigate the major health constraints hampering the potentials of camels traditionally managed by herders, which was aimed at filling the knowledge gaps pertaining to the epidemiology of camel diseases and general health constraints together with needed disease control measures. The finding of the research was presented on a national workshop held on 25 of December, 2008 at Hawassa University conference hall. Different stakeholder participants from different levels (National, regional and zonal) and with different responsibilities were invited and participated on the workshop. The workshop participants were very much pleased by the research finding and in general suggested the research cast new light on disease problems of camels. All participants recommended such work should be encouraged, supported with joint efforts of different stakeholder organization in order to scratch the multifaceted problems of camels. It was also indicated that further research works on priority diseases toward isolation of causative agents so that vaccine production is possible.

Furthermore, much awareness is created when the research finding is to be presented on different forthcoming workshops such as Research Review workshop of Hawassa University, Ethiopian Veterinary Association (EVA) annual conference and Ethiopian Society of Animal Production (ESAP) conference. This may further contribute to draw attention of animal health and production professionals towards improvement of health care and production constraints of camels. It was generally recommended that as there is dearth of information about camel health and production constraints, lobby and advocacy works have vital role in improving attention towards camels and solving the health problems.

6. CONCLUSIONS AND THE WAY FORWARD

Camel husbandry is the main source of living for millions of pastoralists in the semi-arid zones of Ethiopia, including the Borana lowland. Undoubtedly, camels represent a vital contribution to food security and human welfare in vulnerable households of the dry areas. They are important for milk and meat productions, transportation, draft power, and household income generations. They possess several attributes as; minimum contribution to environmental degradation, utilization of scarce natural resources (feed and water), minimum competition with other ruminants and good adaptation to harsh environment.

The most important constraints to camel productions were identified to be widespread diseases, poor veterinary service and lack of attention from government. Among the constraints, camel diseases were the most important one and the main concern of this study. The occurrence and severity of diseases showed variation with seasons, animal groups and camel herding ethnics. Parasitic diseases (helminthiasis and sarcoptic mange infections) were severe during the dry season, while trypanosomiasis had a higher occurrence during the wet season. Other infectious diseases like respiratory infections, pox and clinical mastitis were more frequent during the wet season. Young and breeding females were the most affected animal groups, and higher disease loads were observed in Gabra camels than Boranas. The latter condition was added to malnutrition (limited access to good forage) and large number of camels kept aggregated per village and per holdings among Gabras. This suggests the need for initiating mutual understanding and common utilization of the rangeland resources through traditional dialogues among neighbouring ethnic groups. In general, based on the results of this study, there is a clear need for disease control intervention activities along several lines, notably the following:

6.1 PARACITIC DISEASES

Both external (sarcoptic mange and ticks) and internal parasitic diseases can be controlled by treatment of affected animals. The treatment must be mainly practiced during the dry season as effects and severity of parasitic diseases were higher during dry periods. Secondly, wet season treatment is also helpful to prevent re-infections and environmental contamination of by helminthes. As observed during this field survey treated animals have responded by showing an improvement of body conditions. A selected drug for helminthiasis is a broad spectrum drug like Albendazole, while Ivermectin given as a subcutaneous injection is a drug of choice for sarcoptic mange treatment. Treatment and control of trypanosomiasis can be achieved using prophylactic therapy while herds are moving to other forage areas (where *Trypanosoma evansi* is prevalent) and during the beginning of the rainy season. Infected and sick animals may be treated with effective curative agents like Cymerlarsan and quinapyramine methyl sulphate. Parasitic disease treatment should be seen not only in curing sick animals but also in relation to improvement of body conditions and enhancement of body defence.

6.2 BACTERIAL DISEASES

Bacterial diseases are important causes of mastitis, respiratory infections (pneumonia), gastro-intestinal infections of young animals and skin lesions. Mastitis and respiratory infections are important diseases of camels which often respond well to broad spectrum antibiotics. Hence, systemic treatment with antibiotics for adequate treatment regime (7 days) may effectively cure the cases. Bacterial infections definitely contribute to septicemic conditions, joint-ill and calf diarrhoea, which are the major causes of early mortality in newborn camels. Hence, early

treatment of such cases may minimize the mortality in camel calves.

6.3 NUTRITIONAL DISEASES

Important diseases related to nutritional deficiency include hypocalcaemia that occur during late pregnancy in high milk producing camels, night blindness most likely due to vitamin A deficiency (common during scarcity of green fodder in dry period) and disease syndrome similar to the downer cow (hypocalcaemia). Hypocalcaemia should be treated with calcium preparations like calcium boro-gluconate at dose rate for dairy cattle. Untreated affected animal may die or recumbent for longer times which results in several complications. Animals often recover after parturition but with complications, such as dislocation of the hip joint and piercing of the hipbone through the skin. Animals that develop complications are often killed. The only treatment known to pastoralists is firing on both sides of the pelvic area and around the tail, but this treatment is not likely to be very effective. Hence, treatment with calcium preparations is of paramount importance in saving the life of animal and maintaining its reproduction efficiency. Treatment of Vitamin A deficiency in large animal like camel is not known, and preparations for this purpose is not available. The care for an affected animal, not drive during evening into bush or undulating surface is an alternative consideration, in addition to feeding green fodder. The case of downer syndrome, muscle paralysis and recumbency, perhaps due to mineral deficiency needs more investigation to suggest intervention measures.

6.4 IMPROVING ANIMAL HEALTH CARE DELIVERY TO CAMELS

The health problems of camels in Ethiopia in general are attributable to two major causes. The first cause is the general lack of attention and negligence toward camels. As a result, camels have neither been a subject of research, nor part of any development programs. This has created a knowledge gap about constraints and the potentials of camels. Secondly, the large majority of camel diseases that have been a major setback to herd productivity and population growth are known by local vernacular names by herders, but not by English or Medical terms with which most veterinarians are familiar with. Owning to these facts, camels do not get sufficient health care either due to lack of proper drugs or due to knowledge gaps among animal health workers. For this reason, the output of this survey may play vital role not only in awareness creation, but also in filling the knowledge gabs with disease information including the translations of vernacular names into possible English or Veterinary terms.

6.5 LOBBY FOR IMMUNIZATIONS AND VACCINE PRODUCTIONS FOR CAMELS?

Although, this is a short term survey of camel health constraints, it is important to hope for a long-term intervention activity, vaccine production and vaccination of camels against major infectious diseases as respiratory infections. Lobby and advocacy works must be pushed hard to influence policymakers and development planners to consider camel health care by immunization. This needs further investigation of causative agents of priority diseases specially disease like respiratory infections. An alternative option can be importing selected vaccines from other countries and launching independent immunization programs against specific priority diseases.

6.6 PRIORITY RESEARCH AREAS

Based upon the findings presented in this report the following should be the research priority.

- Research into priority diseases such as respiratory infections and causes of early mortality in camel calves to identify the etiologic agents and looking for control means
- Research into strategic treatment of parasitic diseases to reduce disease burden and effects
- Research into Ethno-veterinary knowledge to bridge the gap between herders' views and concept on disease aetiology and to tap the local arsenal of medical plants and useful indigenous practices
- Research into the improvement of camel production and use of possible production and reproduction technologies used for cattle
- Research into treatment trials of camel diseases such as respiratory infections, mastitis, hypocalcaemia, uterine infections, contagious skin necrosis and abscess are recommended

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ANNEX 1. PHOTOS

Photo 1: Abscess

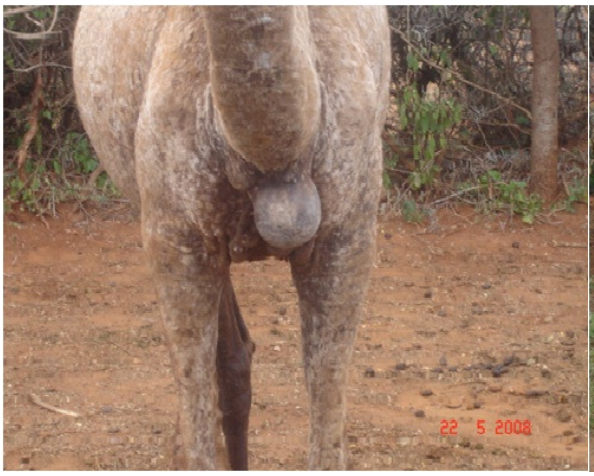

Photo 2: Bone fracture

Photo 3: Cronic wasting disease

Photo 4: Contagious skin necrosis

Photo 5: Eye injury

Photo 6: Fungal infection

Photo 7: Mastitis

Photo 8: Orf or contagious ecthyma

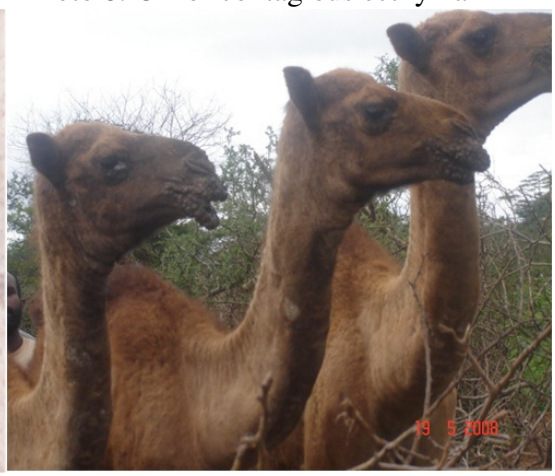

Photo 9: Severe mange mite infection

Photo 10: Skin test positive for TB

Photo 11: Traumatic wound

Photo 12: Traditional health care

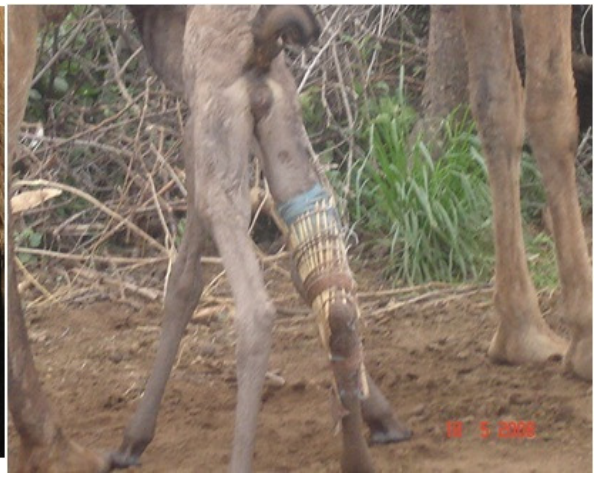

Photo 13: Intimacy with family

Photo 14: Milk marketing

Photo 15: Night resting enclosure (sand bed)

Photo 16: Transportation

Photo 17: Milking camel

List of Publications

Reports:

1 A. Synnevåg, G., Halassy, S. 1998: "Etude des indicateurs de la sécurité alimentaire dans deux sites de la zone d'intervention de l'AEN-Mali: Bambara Maodé et Ndaki (Gourma Malien)", Groupe de Coordination des Zones Arides et Noragric, Agricultural University of Norway.

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2 A. Aune, J.B. and Doumbia, M.D. 1998: "Integrated Plant Nutrient Management (IPNM), Case studies of two projects in Mali: CARE Macina programme and PIDEB", Drylands Coordination Group and Noragric, Agricultural University of Norway.

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3 A. Berge, G., Larsen, K., Rye, S., Dembele, S.M. and Hassan, M. 1999: "Synthesis report and Four Case Studies on Gender Issues and Development of an Improved Focus on Women in Natural Resource Management and Agricultural Projects", Drylands Coordination Group and Noragric, Agricultural University of Norway.

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6. Waktola, A. 1999: "Exploratory Study of Two Regions in Ethiopia: Identification of Target Areas and partners for Intervention", Drylands Coordination Group and Noragric, Agricultural University of Norway.

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14 A. Doumbia, M. D., A. Berthé and J. B. Aune, 2001: “Integrated Plant Nutrition Management (IPNM): Practical Testing of Technologies with Farmers Groups”, Drylands Coordination Group and Noragric, Agricultural University of Norway.

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16 A. Mossige, A., Berkele, Y. & Maiga, S., 2001: “Participation of Civil Society in the national Action Programs of the United Nation’s Convention to Combat Desertification: Synthesis of an Assessment in Ethiopia and Mali”, Drylands Coordination Group and Noragric, Agricultural University of Norway.

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