THE UNIVERSITY OF NAIROBI

COLLEGE OF AGRICULTURE AND VETERINARY SCIENCES

FACULTY OF VETERINARY MEDICINE

PREVALENCE OF BOVINE MASTITIS IN CHEMUSIAN FARM NAKURU COUNTY

BY: CHEPNG'ENO EVALINE

SUPERVISOR: PROF. HENRY MUTEMBEI

DEPARTMENT OF CLINICAL STUDIES

FACULTY OF VETERINARY MEDICINE

UNIVERSITY OF NAIROBI

2015

DECLARATION

I, Chepng'eno Evaline, hereby declare that this is my original work without any assistance sought from unauthorized persons unless placed under reference. The work has never been submitted nor presented to the best of my knowledge by anyone to any learning institution for award of any degree.

SIGN……DATE……

J30/2071/2010

This project has been submitted with the approval of University of Nairobi supervisor

PROF. HENRY MUTEMBEI (BVM, MSC, PHD)

SIGN……DATE……

Department of Clinical Studies, Faculty of Veterinary Medicine, University of Nairobi

DEDICATION

I dedicate this research project to my dear parents and siblings. I really appreciate all for their support, advice, guidance and encouragement they granted me throughout this period and my academic life. Am also proud of them for they have molded me to be the kind of person I am today. God bless you abundantly.

ACKNOWLEDGEMENT

All glory and honour be to the Almighty God for His sufficient grace and mercy in my life.

I also wish to register my deep and sincere gratitude to my supervisor, Prof. Henry Mutembei for his intellectual advice, brilliant professional guidance, informed decisions and suggestions and his patience throughout the entire project period.

Special thanks also to Chemusian farm fraternity for allowing me to carry out my research on their farm, their trust on me and willingness to share farm information honestly.

Enormous gratitude goes to my family, friends, classmates and everyone whose contribution and support enhanced successful completion of this project. Be blessed all.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

CMT- California Mastitis Test

SCC- Somatic Cell Count

GDP- Gross Domestic Product

DNA- Deoxyribonucleic Acid

LF- Left Fore

RF- Right Fore

LR- Left Rear

RR- Right Rear

Mls- Mililitres

&- And

No. -Number

ABSTRACT

Mastitis was noted to have affected Chemusian farm in Nakuru County significantly reducing the milk production. The current project was designed to address this problem by determining prevalence, causes and effectiveness of treatment options used.

California Mastitis test (CMT) on individual cows together with review of treated cases was conducted in the farm in 2014.

The overall prevalence of mastitis in the farm in 20 dairy animals that were randomly tested was 75% (n=15). 15% (n=3) were clinical form of mastitis and 60 %(n=12) were subclinical cases. The study showed that the left quarter prevalence of subclinical mastitis was higher 57.5% (23/40) compared to right quarter prevalence 42.5% (17/40). The prevalence of mastitis was found to be statistically significant among the different age groups and lactating ages ($p<\_0.05$).

From the study it shows that mastitis is the greatest challenge in the farm as far as dairy production is concerned. It caused reduction in milk production. The farm had also incurred a lot of economic losses due to milk rejection and expenses on treatment and replacements of culled animals.

To mitigate this problem of mastitis, it is recommended that proper mastitis control program techniques should be employed. These include hygienic practices on equipment, animals and environment and culling of chronically infected cows.

Key words: prevalence, bovine mastitis, Chemusian

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background information

In Kenya livestock are kept mostly by smallholder farmers manly for milk and meat production. These farmers produce 56% of the total milk in the country that is 80% of Kenyan's milk supply (Majiwa *et al.,* 2012).

Reports indicate that there is inadequate milk production in Kenya to meet consumers demand (Majiwa *et al.,* 2012). Many factors affect milk production in cows. Some of these factors include inadequate nutrition, animal genetics and diseases. Bovine mastitis is a disease known to be major problem in Kenyan dairy herds affecting milk production (Shitandi *et al*., 2004).

The current prevalence of bovine mastitis has however not been estimated in Kenya smallholder dairy cattle (within a size of 1-5 animals) in the Rift Valley region. This is despite the importance of this sector and region as evident from production statistics where over 70% of the total milk in Kenya is known to come from smallholder dairy farmers. The sectors animals (Bos Taurus and their crosses with Bos Indicus) at various grading levels, average milk yields estimated at 1300 liters per lactation from approximately 3 million dairy cattle (Shitandi *et al*., 2004).

Mastitis is a single most common disease syndrome in adult dairy cows accounting for 38% of all morbidity. On annual basis 3 of every 10 dairy cows have clinically apparent inflammation of mammary gland of affected cattle. Seven (7%) are culled and 1% will die as a consequence of the disease. The same survey presented data suggesting that more than 25%

of all disease-related economic losses of dairy cattle can be directly attributed to mastitis (Blood and Radostits, 1989).

There are two types of mastitis; clinical and subclinical mastitis. In clinical mastitis signs of disease are detectable with decrease in milk production. Subclinical mastitis is of major concern since the gross signs are not detectable and causes drop in milk production (Ahmadzadeh *et al*., 2009).

Mastitis is caused by various pathogens which include bacteria, fungi among others. They are further classified into major and minor pathogens. Major pathogens are either contagious or environmental organisms. Mastitis has important effects on both milk quality and animal welfare. It is the most expensive disease of cattle and the second most expensive in terms of animal welfare (Regassa *et al.*, 2010).

Mastitis is of major concern as it affects milk production negatively and having serious impacts on the economy of dairy production. It is the most costly disease of dairy animals and losses mainly occur through rejected milk, reduction in milk yield, extra labour, cost of drugs, premature culling of animals and replacements (Radostits *et al*., 1989).

This condition is addressed by treating the emerging cases, reporting to the veterinary office or investigation is done to determine the cause and come up with remedies to curb the incidence as well as designing appropriate mastitis control measures (Sharif *et al*., 2009).

Mastitis could be reduced by improving milking procedures and hygiene in the herd. Dry cow treatment, milking techniques, post milk dipping and antimicrobial treatment of clinical mastitis are management factors that have significant effect on reduction of mastitis cases and bulk tank milk somatic cell counts(SCC) (Arimi and McDermott 2002).

1.2 OBJECTIVES

1.2.1 GENERAL OBJECTIVE

To enhance mastitis control for improved milk production in Chemusian large scale farm in Nakuru County through investigations of the on-going farm mastitis cases and their treatment options.

1.2.2 SPECIFIC OBJECTIVES

The following are the objectives of the project:

1. To determine prevalence of mastitis in the farm
2. To evaluate the causes of mastitis in the farm
3. To determine the effectiveness of treatment options employed in the farm

1.2.3 Project justification

Mastitis is a condition that has greatly influenced the performance of the dairy cows in terms of milk production. During my attachment in County Veterinary Office, Nakuru County, many small and large scale farmers presented complains on mastitis as a condition of economically great significant in milk production. Its rate of prevalence keeps inclining due to poor hygiene practices observed during milking process which predisposes the animal to mastitis. Therefore, development of control measures towards mitigating the incidences is imperative. This project was designed to provide information for such mitigations in future.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 LIVESTOCK SECTOR

The livestock sub-sector contributes about 10% of the Gross Domestic Product (GDP) and accounts for over 30% of farm gate value of agricultural commodities. Livestock production is a major economic and social activity for the communities that live in high rainfall areas for intensive livestock dairy production and in the arid and semi-arid areas (ASALS) for meat production (kiptarus, 2005).

The population of major livestock species in 2003 is estimated at 9 million zebu cattle, 3.5 million exotic and grade cattle, 9.9 million sheep, 11.9 million goats, 895,000 camels, 415,200 pigs, over 25 million chicken and 470,000 rabbits (Kiptarus, 2005).

2.2 MILK PRODUCTION

The dairy production which is a dynamic sub-sector in Kenya is a major source of livelihood for the families of about 6-800,000 small-scale farmers for whom dairy farming is a primary activity. Dairy sub-sector also offers employment along the milk marketing chain. It constitutes the largest share of livestock contribution to the country's GDP that is 3.5% total GDP (Kiptarus, 2005).

Small dairy production accounts for over 70% of total milk production. The milk is primarily produced by cattle, camels and dairy goats. Their relative shares in the estimated total milk output being 84%, 12% and 4%, respectively. Cows are the main source of milk in the country. The country contains 70% of dairy herd in Eastern and Southern Africa. The dairy industry is the most developed within livestock sub-sector and is dominated by small-scale producers who account for 80% of dairy industry's output (Kiptarus, 2005).

2.3 MASTITIS

Mastitis is the inflammation of the parenchyma of mammary gland regardless of the cause. It is characterized by physical, chemical and usually bacteriological changes in milk and by pathological changes in the glandular tissue. Most important changes in milk include discoloration, presence of clots and presence of large number of leukocytes (Radostits *et al.,* 1989).

The condition may result from introduction of microorganisms through the teat sphincter. Inflammation of mammary gland is indicated by wide variety of clinical signs. The clinical course of the disease varies with the ability of the bacteria to colonize and thrive in the mammary gland secretions, their inherent virulent and type, magnitude and duration of host response to bacterial invasion (Sharif *et al.,* 2002).

Mastitis affects milk production negatively and having a serious impact on the economy of dairy enterprise. It is considered to be the most costly disease of dairy animals and losses mainly occur through: discarded milk, reduction in milk yield, premature culling of the animal and replacements and cost of veterinary care and drugs. It is due to the effects of infection by bacterial and mycotic pathogens. Pathological changes to milk secreting epithelial cells from inflammatory process often about a decrease in functional capacity (Radostits and blood, 1989).

Depending on the pathogen, functional losses may continue into further lactations which impair productivity and potential weight gain by offspring. Although most infections result in relatively mild clinical, subclinical inflammation and, more severe cases can lead to agalactia or even profound systemic involvement resulting in death (Yang *et al.,* 2011).

Surveys of incidence of mastitis show that generally in most countries there is about 40% morbidity amongst dairy cows and 25% quarter infection rate and *Streptococcus agalactiae*

and *Staphylococcus aureus* being the leading etiological agents (Blood and Radostits, 1989). Recent studies show that there is high prevalence of *Staphylococcus aureus* followed by *Escherichia coli*, coagulase negative *Staphylococcus*, streptococcal species, *Bacillus* species, *Serratia marcesens* and *Bacillus subtilis* which is compared to a research recently done in Kenya which shows that the leading cause of bovine mastitis or isolates in milk are *Streptococcus* species followed by *Staphylococcus* species, *Escherichia coli*, *Klebsiella* species, *Actinomyces* species and *Pseudomonas* species in descending order and also compared to a research done in Ethiopia by (Regassa *et al.*, 2010). Research done in United Kingdom shows that 80% of clinical mastitis was due to coliforms and also the incidence of coliform mastitis is higher in high yielding cows (Blood and Radostits, 1989). It has been established that coliform mastitis is the most common cause of fatal mastitis. Furthermore, it has been suggested that case fatality rate from peracute coliform mastitis is commonly high and may reach 80% in spite of intensive therapy (Blood and Radostits, 1989).Pathogenesis of the disease involves three phases namely; invasion phase, infection phase and inflammation phase (Radostits *et al.*, 1989).

Clinical findings depend upon the resistance of the mammary tissue and the virulence of the invading pathogen and they include abnormalities of secretion, abnormalities of size, consistency and temperature of the mammary glands and systemic reaction. Coliform mastitis is always accompanied by toxemia, severe systemic reaction and fever (Radostits *et al.*, 1989).Clinical form of mastitis is evidenced by severe inflammation and visual changes in milk while subclinical form is evidenced by inflammation (high somatic cell count) in milk without any visible abnormality of the milk or udder ((Radostits *et al.*, 1989; Bradley, 2002).

Risk factors that involve in mastitis occurrence include, host, environmental and pathogenic factors. Environmental factors are season (most cases occur during summer months in housed cattle and commonly environmental infections especially in wet season), prevalence of

infection-the greater the prevalence of disease in the herd, the greater the new infections. Milking practices such as efficiency of milking personnel, milking machines, too high milking speed and milking hygiene in the milking parlor (Radostits *et al.,* 1989).

Host factors that influence the occurrence of mastitis are age- incidence of infected quarters increase with age peaking at 7 years, stage of lactation- most new infections occur in the first 2 months of lactation especially environmental infections. In heifers there is much greater incidence in the first month after calving. Milk yield-high yielding milk cows are generally considered to be more susceptible to mastitis and to teat in Holstein Friesian than Jersey. The level of inherited resistance- possibly related to teat shape and anatomy of teat canal. Presence of lesions on the teats harbors mastitis organisms. Immunological status of each mammary gland-prior infections increase resistance to mastitis producing pathogens by provoking an increase in polymorphornuclear cells content of the milk (Radostits *et al.,* 1989).

Pathogenic factors include bacterial viability which is the ability of the organisms to survive in the cow's immediate environment and resistance to environmental influences including cleaning and disinfection procedures. Bacterial colonizing ability- they colonize in the teat duct then adhere to mammary epithelium and set up a mastitis reaction. Susceptibility to antibiotics due to excessive exposure to the agent may develop resistance to antibiotic therapy (Radostits *et al.,* 1989)

Treatment of mastitis is taken into consideration of the principle of specific treatment for specific etiological agent for example *Streptococcus agalactiae* infection is best treated with procaine penicillin G, as intra-mammary antibiotic. However, response to treatment in cases of staphylococcal infection is poor but responds to some extend to penicillin and tetracycline (Blood and Radostits, 1989). Effective treatment strategies include early detection, presumed

identification of mastitis pathogens and the use of antibiotics for an appropriate duration for the expected pathogen (Sharif and Muhammad 2009).

Control of mastitis is generally by improvement of hygiene and a basic control program encompasses reduction of duration of infection and reduction of new infection rate (Blood and Radostits, 1989). It is also controlled by implementation of the Five-Point Plan as suggested by Bradley (2002). The implementation of the plan impacts to successful control of contagious mastitis and massive reduction of both clinical and subclinical mastitis (Bradley, 2002).

2.4 DIAGNOSIS

A proper diagnosis is important for effective treatment. Hence a diagnosis should be systematic and orderly in order to identify the underlying cause of the disease.

Bovine mastitis can be diagnosed using several methods such as; history using records which reveals previous infections and cases of genetic predisposition of certain animals as well as getting history of onset, duration and intervention if any has been given, clinical signs if it is clinical mastitis, cow side tests for example use of strip cup and California Mastitis Test also known as California Milk Test (CMT) and laboratory tests which are culture and sensitivity tests (Cullen, 1991). Diagnosis of mastitis using clinical signs such as gross changes in milk and udder is inadequate as a large proportion of mastitis is not readily detectable by clinical findings, it is therefore very necessary to diagnose such cases (subclinical mastitis) using indirect tests which in turn depend on the leukocyte content of milk (Blood and Radostits, 1989).

2.5 MANAGEMENT

Management involves treatment and control. The aim of treatment is to reduce septicemia or bacteremia and restore udder function. Treatment is expensive due to the cost of drugs and lost value of withdrawn milk. Treatment should be done as soon as possible after detection of the infection and parenteral treatment should be done in all cases with systemic involvement. Treatment response depends on the type of organism involved, extent of tissue damage and how soon treatment is started. Principles used in treatment are; broad spectrum antibiotics should be used in all cases of systemic involvement, drying the udder and then an intra-mammary antibiotic is administered after the last milking of the day and treatment lasts for three to five days. Strict hygiene is necessary during treatment period and for the disease control. Milk should be withdrawn for the required period. Antibiotics commonly used include; penicillin, neomycin, erythromycin, polymixin, tetracycline, chloramphenical and gentamycin (Radostits and Blood 1989).

Treatment of subclinical mastitis is best done with oxytetracycline administered intramuscular as first line of treatment and if there is no response in 3 to 5 days of therapy, antibiotic sensitivity test is conducted to choose the next drug (Arimi and McDermott 2002) and intra-mammary mastitis tubes. Steps to control mastitis include; proper preparation of the animal for milking, good and proper milking procedure, proper use of milking machine, teat dipping with a germicidal teat dip and disinfection of environment after milking, monitoring mastitis score regularly, rapid identification and treatment of all clinical cases, segregation of infected cows in separate paddock or stall and milking them last and culling of chronic cases if necessary. Essentially, a proper dry cow therapy should be put in place whilst ensuring a clean environment and properly feeding the cows (Blood and Radostits, 1989; Bradley, 2002)

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 STUDY SITE

The study was done in Chemusian farm. The farm is located in Rongai sub County, Nakuru West Constituency in Nakuru County. It lies at 1800 metres above the sea level. The total farm size is 2600 acres. The region is suitable and favorable for both livestock keeping and crop production. The farm practices mixed farming. Animal species kept are cattle and goats. Breeds of cattle in the farm are; Friesians, Aryshire, Jersey and Fleckview. Among the cattle, the total number of dairy cows is 600; bulls 130; heifers and calves 430. Among the dairy cows, lactating ones are 450(38.8%). Lactating cows are under zero grazing. They are milked thrice a day using machine at an interval of eight hours. These animals are kept in different groups. Calves less than three months old are fed using bucket feeding method.

The study was designed to test for mastitis using CMT. Twenty lactating cows were sampled for mastitis test. These animals were selected randomly from different groups.

3.2 STUDY DESIGN

A structured questionnaire with close-ended questions was used to collect data on milk practices and other farm management variables thought to influence the prevalence of mastitis in the farm. The questionnaire was designed to collect data on factors that included: - milking practices, frequency of milking, cleaning and drying methods of teats, source of water, pre and post milking teat dipping among others (Annex1).

A face to face interview was also conducted using a set of questions (Annex2). Ten personnel working in the farm participated in interviews and filling the questionnaires conducted.

Farm records were analyzed. Production, health and treatment records were used to evaluate prevalence of mastitis in the farm.

A thorough physical examination for evidence of mastitis was conducted on lactating cows that were sampled for the study. Clinical findings such as secretions, abnormalities of size and shape of the udder, its consistency and temperature were assessed by visual inspection and palpation. Environment, shelters, milking palour, milking equipment as well as milkmen were generally examined with an aim of identifying hygiene standards. A cow was considered to have clinical mastitis if it fulfilled at least two of clinical findings such as (1)pain reaction upon palpation (2) changes in colour and consistency of milk(blood tinged milk, watery secretion, clots, pus), (3) change in udder consistency.

Twenty animals were randomly selected for mastitis test. California Mastitis Test was used. Briefly, teats were washed using clean running water, wiped dry with clean dry towel and disinfected using 70% ethyl alcohol. To minimize contamination with bacteria from the skin around teat canal, the first streams of milk were discarded. Aseptically 2 mls of milk squirted from the quarters to the corresponding cups of CMT paddle. Two mls of the reagent added to milk then swirled. Colour change and gel formation observed.

Health and treatment records were analyzed to show disease prevalence. Individual cow records were analyzed to aid in determining the type and effectiveness of treatment used.

3.4 CALIFORNIA MASTITIS TEST

It is a simple indicator of the somatic cell count (SCC) of milk. It works by using a reagent which disrupts the cell membrane of somatic cell present in milk sample; a detergent lyses the somatic cells in the milk and denatures any DNA present. This reaction increases with viscosity of the mixture; the extent of which correlated to the number of somatic cells present.

It is a simple but a useful technique for detecting subclinical mastitis on farm; providing an immediate result and can be used by any member of farm staff.

A four-well plastic paddle is used; one well being used for each quarter of the cow to be tested. The foremilk is discarded and then a little milk drawn into each well. An equal volume of test reagent is added and then the sample is gently agitated.

Table 1: California Mastitis Test Reactions

Category	**Score**	**Description of reaction**
Negative	0	Mixture of milk and test fluid Stays unchanged and can be easily shaken.
Trace	1	Mixture is slightly mucous but can still be shaken.
Positive	2	With movement of mixture an unmistakable gel formation can be seen. It is still possible to tip a small portion of the mixture out.
Strong positive	3	Jelly-like Mucous consistency is formed and is difficult to shake the mixture. It is no longer possible to tip out and surplus liquid.

CHAPTER FOUR

4.0 RESULTS

4.1 Prevalence of clinical and subclinical mastitis

Fifteen cows (75%) were affected by both clinical and subclinical mastitis. Prevalence rate of clinical was 3 (15%) and subclinical mastitis at 12 (60%) (Table2).

Table 2: The CMT results on prevalence of mastitis

Animal condition	Number of cows found	Number of quarters
Healthy	5 (25%)	40 (51.95%)
Clinical	3 (15%)	12 (15.58%)
Subclinical	12 (60%)	25 (34.47%)
Total	20	77

4.2 Prevalence of mastitis in quarters

The quarter prevalence rates were 12 (15.58%) and 25 (32.47%) for both clinical and subclinical mastitis respectively. The overall quarter prevalence rate was 48.05% (Table 3).

Table 3: Forms of mastitis and prevalence of affected quarters

Form of Mastitis	**Total number of cows affected (%)**	**Total number of quarters examined**	**Number of quarters affected (%)**
Clinical	3 (15%)	77	12 (15.58%)
Subclinical	12 (60%)	77	25 (32.47%)
Total	15 (75%)	77	37 (48.05%)

4.3 Quarter prevalence for subclinical mastitis

The overall quarter prevalence was 48.05%. The prevalence rates for left fore, left rear, right fore and right rear were 50%, 60%, 42.11% and 40% respectively(Table 4).

Table 4: Quarter prevalence for subclinical mastitis

Quarter	Number examined	Positive	Prevalence (%)
Left fore (LF)	18	9	50%
Left rear (LR)	20	12	60%
Right fore (RF)	19	8	42.11%
Right rear (RR)	20	8	40%
Total	77	37	48.05%

CHAPTER FIVE

5.0 DISCUSION

The present study showed that the overall mastitis prevalence at the cow level was 75% as evidenced in examination and CMT. The prevalence rates for both clinical and subclinical forms of mastitis were 3 (15%) and 12 (60%) respectively. The prevalence is different from others. It is higher than 74.7% reported by (Zeryehun *et al*., 2003). Clinical mastitis was 19.6% and subclinical of 55.1% prevalence.

The overall quarter prevalence rate was 48.05% with clinical and subclinical prevalence rates at 15.58% and 32.47% respectively. This was higher than that of (Regassa *et al*., 2010) whose findings of overall quarter prevalence was 44.9%. The clinical form was 10% and subclinical of 34.9%.

From the CMT results, it showed that specific quarter prevalence of subclinical mastitis was; 50%, 60%, 42.11% and 40% for LF, LR, RF and RR respectively. The prevalence of subclinical mastitis was higher in the left quarters than the right quarters. The rate was higher in the left rear quarter (60%) than right rear (40%) while for left fore was (50%) and right fore at 42.11%.

Three quarters in different lactating cows were blocked. This was due to previous mastitis infection. One quarter was due to trauma to teat which predisposed it to mastitis and eventually got blocked.

In the study it is evident that subclinical mastitis is higher than clinical mastitis. This form causes a greater challenge in dairy herd as it is difficult to detect. Poor milking techniques and practices majorly contribute to the condition. In addition, mastitis is the leading disease

compared to other conditions encountered on the farm. Other diseases include anaplasmosis, lameness, and enteritis among others.

In the farm (area of study), it could be due to failure to wash udder and teats properly, use of dirty water, sharing of infected towels and inadequate hygiene of milking equipment, palour and milkmen. It is therefore advisable to take into account good management practices and proper hygiene standards to minimize mastitis incidence in the dairy farm.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 CONLUSION

The present study revealed that mastitis was a major disease affecting animals in this farm. Subclinical form of mastitis was the most prevalent and the treatment option used in the farm was effective. Low hygiene was the likely source of mastitis in this farm.

6.2 RECOMMENDATION

This study recommends the following measures in order to control and prevent mastitis in large farms:-

1. Strict hygiene measures during and after milking; proper milking technique and practices in order to reduce the factors that contribute to the mastitis in the farm.

2. Prompt treatment of the mastitis cases.

3. Institution of a herd health program to follow up on mastitis control and prevention.

REFERENCES

AhmadzadehA, **FragoF**, **ShafiiB**, **DaltonJC**, **PriceWJandMc GuireMA**, **2009**. Effect of clinical mastitis and other diseases on reproductive performance of Holstein cows. Animal Reproduction Science. 112: 273-282.

Arimi S. M., McDermott J. J., 2002. Brucellosis in sub-Saharan Africa: epidemiology, control and impact. *Veterinary Microbiology* 90, 111-134.

Blood D. C., Radostits O. M., 1989. Veterinary Medicine. A textbook of the Diseases of Cattle, Sheep, Pigs, Goats and Horses.*7th Edition*. Mastitis 500-559.

Bradley A.J., 2002. Bovine mastitis: An evolving disease. *The Vet J*. 2002, 163, 1-13.

Kiptarus J.K, **2005**. Focus on livestock sector. Supply policy framework strategies status and links with value addition.

Majiwa E.B., **Kavoi M.M.**, **Murage H.**, **2012**. Smallholder dairying in Kenya. The assessment of the technical efficiency using the stochastic production Frontier model. Smallholder Dairying in Kenya. JAGST vol. 14(2); 1-14.

Radostis M , C. Gay., Douglas C. Blood, Kenneth W. Veterinary Medicine.A textbook of diseases of cattle, sheep, pigs, goats and horses.9^{th} Edition

Regassa A., Mekebib B., Furgasa M., Abunna F., Megersa B., 2010. Bovine mastitis: prevalence, risk factors and major pathogens in dairy farms of Holeta Town, Central Ethiopia. *Research: Veterinary World*. 3 (9), 397-403.

Sharif A and Muhammad G. **2009**.Mastitis Control in Dairy Animals. Pakistan Veterinary Journal. 29(3): 145-148.

Shitandi Anakalo, Gathoni Anakalo, Tura Galgalo, Milcah Mwangi, 2002. Prevalence of bovine mastitis amongst smallholder dairy herds in Kenya. *Israel Journal of Veterinary Medicine.*

Yang FL, **Li X S**, **He BX**, **Du YL**, **Li GH**, **Yang BB**, **and Huang QH**. **2011**. Bovine Mastitis in Subtropical Dairy Farms, 2005-2009. Asian Journal of Animal and Veterinary Advances. 10: 68-72.

Zeryehun T., Aya T., Bayecha, 2013. Study on prevalence, bacterial pathogens and associated risk factors of bovine mastitis in smallholder dairy farms in and around Addis Ababa, Ethiopia.*J. Animal & Plant Science*, 23(1), 50-55.

ANNEXES

ANNEX 1: STRUCTURED QUESTIONNAIRE

Date……..

Name of the animal (ear tag no.)……..

Species…….

Breed…….

Age…….

Parity……..

Number of times…….. Quarter(s) affected ……

Was treatment done? ..... Drug used…….

Type of milking……,..

Mastitis status

Is it sick? ..... Has it been sick?

……..

Average amount of milk/day……

Milking interval……

Control measure…… Remarks ……

Month(s) with high frequencies ……

ANNEX 2: INTERVIEW

1. How many cows does the farm have? .....
2. How many lactating cows does the farm have? .....
3. Average amount of milk per day? .....
4. Which breeds of cattle do they keep in the farm? .....
5. Which method of milking are they using in the farm? …….
6. How many times in a day do they milk their cows? …….
7. Which type of breed is mostly affected? ……
8. At what age is most susceptible to mastitis? ……..
9. At what stage of lactation are they susceptible to the condition? …….
10. Parity of the animal (a number of times she has calved down) ……..
11. Frequency of mastitis occurrence in the farm ……
12. What are the clinical signs that they observe for them to conclude that the condition affecting the animal is mastitis? ……..
13. How do they manage this condition in the farm? …….
14. Response to treatment……