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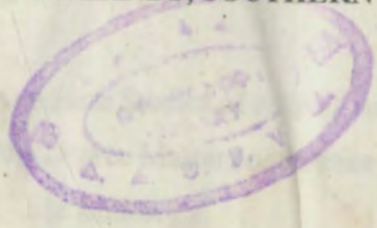
ADDIS ABABA UNIVERSITY

FACULTY OF VETERINARY MEDICINE

SEROPREVALENCE OF CONTAGIOUS CAPRINE PLEUROPNEUMONIA IN BORANA AND GUJI LOWLANDS, SOUTHERN ETHIOPIA



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TESFAYE BEKELE DINSA

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DEBRE ZEIT, ETHIOPIA

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A thesis submitted to the School of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the Degree Masters of Science in Tropical Veterinary Epidemiology

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TABLE OF CONTENTS

ACKNOWLEDGEMENT I

TABLE OF CONTENTS III

LIST OF TABLES VII

LIST OF FIGURES VIII

LIST OF ANNEXES IX

ABBREVIATIONS AND ACRONYMS X

ABSTRACT XII

1. INTRODUCTION 1

2. LITERATURE REVIEW 4

2.1. The disease 4

2. 2. Epidemiology 5

2. 2.1. Etiology 5

2.2.2. Host range 6

2.2. 3. Geographic distribution 6

2.2. 4. Source of infection and mode of transmission 8

2.3. Factors related to the epidemiology of CCPP 8

2.3.1. Type of husbandry system 8

2.3.2. Climate and season 9

2.3.3. Other factors 9

2.4. Molecular epidemiology **10**

2.5. Pathogenesis and pathology **10**

2.6. Clinical signs **11**

2.7. Immunology **12**

2.8. Diagnosis **13**

2.8.1. Clinical signs and postmortem examination 13

2.8.2. Isolation of the organism 14

2.8.3. Identification of *Mycoplasma* 14

2.8.4. Serological tests 15

2.8.5. Molecular diagnosis 17

2.8.6. Participatory Disease Search (PDS) 17

2.9. Economic importance of CCPP **18**

2.10. Prevention and control **18**

3. CCPP IN ETHIOPIA **19**

4. MATERIALS AND METHODS **20**

4.1. Description of the study area **20**

4. 2. Description of study population and study design **23**

4.3. Sampling strategy **23**

4.4. Sample size determination for the test sera **24**

4.5. Study methodology **24**

4.5.1. Sample collection 24

4.5.2. Questionnaire survey 25

4.5.3. Participatory appraisal of goat diseases 26

4.5.3. Secondary data collection 28

4.5.4. Categorization of study variables 28

4.6. Data management and analysis 29

5. RESULT 31

5.1. Seroprevalence 31

5.1.1. Overall seroprevalence 31

5.1.2. Seroprevalence by assumed risk factors 33

5.1.3. Major risk factors 37

5.2. Questionnaire survey 38

5.2.1. Comparative importance of goats 38

5.2.2. Major goat diseases in the study area 38

5.2.3. Major factors for the occurrence and spread of CCPP 40

5.2.4. Age and sex groups affected by CCPP 41

5.3. Participatory Disease Appraisal 42

5.3.1. Matrix scoring 42

5.3.2. Seasonal calendars 44

5.3.3. Triangulation of the perception of the informant groups 46

6. DISCUSSION 48

6.1. Seroprevalence 48

6.1.1. Overall seroprevalence 48

6.1.2. Seroprevalence by assumed risk factors 49

6.1.3. Major risk factors 51

6.2. Questionnaire survey 52

6.3. Participatory appraisal 53

7. CONCLUSIONS AND RECOMMENDATIONS 56

8. REFERENCES 58

9. ANNEXES 67

10. CURRICULUM VITAE 81

11. SIGNED DECLARATION SHEET 84

LIST OF TABLES

Table 1. Relationship within the Mycoides cluster 5

Table 2. Distribution of CCPP 7

Table 3. Overall seroprevalence of CCPP with CI and OR in the study areas 31

Table 4. Flock level seroprevalence of CCPP in the study districts 32

Table 5. Seroprevalence of CCPP by sex categories and the Odds rations for association 33

Table 6. Seroprevalence of CCPP by age categories and the OR for association 34

Table 7. Seroprevalence of CCPP by flock size categories the OR for association 35

Table 8. Seroprevalence of CCPP by distance categories from the veterinary service centre and the OR for association 36

Table 9. Multivariate logistic regression analysis for the major risk factors 37

Table 10. Summery of major goat diseases recorded in the study area (n=69) 39

Table 11. Summarized matrix scoring of major goat disease signs (n=12) 42

Table 12. Summarized seasonal calendar of major goat diseases (n=12) 44

Table 13.Summary of clinical and serological findings in participatory appraisal (n=8) 46

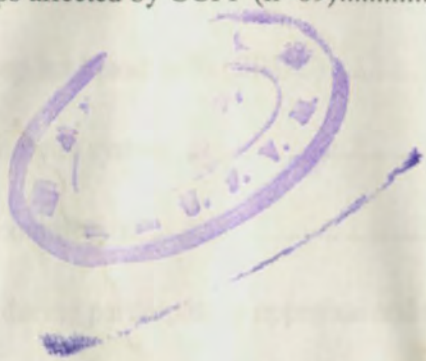
LIST OF FIGURES

Figure 1 . Map of Oromia region showing the study areas..... 22

Figure 2. Comparative importance of goats in Borana and Guji lowlands (n=69)..... 38

Figure 3. Factors responsible for the occurrence and spread of CCPP (n=69)..... 40

Figure 4. Age and sex groups affected by CCPP (n=69)..... 41



LIST OF ANNEXES

Annex 1. Questionnaire for seroprevalence study in Borana and Guji lowlands 67

Annex 2. Record format 69

Annex 3. Summery of seroprevalence of CCPP by pastoralist associations 70

Annex 4. Complement Fixation Test 71

Annex 5. Preparation of sheep red blood cells (SRBC) 73

Annex 6. Preparation of hemolytic system 73

Annex 7. Evaluation of the complement 74

Annex 8. Different pictures during participatory appraisal and sample collection 75

Annex 9. Annual outbreak of CCPP in Ethiopia (1998-2007) 77

Annex 10. Outbreak of CCPP in Ethiopia by Regions (1998-2007) 78

Annex 11. Serological studies on CCPP in different parts of Ethiopia 79

Annex 12. Determination of age of goats according to Mike, (1996) 80

ABBREVIATIONS AND ACRONYMS

CBPP	Contagious bovine pleuropneumonia
CCPP	Contagious caprine pleuropneumonia
B-ELISA	Blocking Enzyme Linked Immunosorbant Assay
C-ELISA	Competitive Enzyme Linked Immunosorbant Assay
CFT	Complement Fixation Test
CI	Confidence Interval
CIRAD-EMVT	Centre de cooperation Internationale en recherché Agronomique pour le Development de'partment d'Elevage et de me'decine v'ete'rinaire
CAHWs	Community Animal Health Workers
CSA	Central Statistics Authority
DNA	Deoxyribonucleic Acid
FAO	Food and Agricultural Organization
FMD	Foot and Mouth Disease
IHA	Indirect Hemagglutionation Test
ILRI	International Livestock Research Institute
ITDG	Intermediate Technology Development Group
KDa	Kilo Dalton
LAT	Latex Agglutination Test
LC	Large colony

Mccp	*Mycoplasma capricolum subsp. capripneumoniae*
Mmc	*Mycoplasma mycoides subsp. capri*
MmmLC	*Mycoplasma mycoides subsp. mycoides Large colony*
MmmSC	*Mycoplasma mycoides subsp. mycoides Small colony*
MoARD	Ministry of Agriculture and Rural Development
OIE	Office International des Epizooties
OR	Odds Ratio
PCR	Polymerase Chain Reaction
PDS	Participatory Disease Search
RNA	Ribonucleic Acid
rpm	revolution per minute
rRNA	ribosomal RNA
SC	Small colony
SPSS	Statistical Package for Social Sciences
SRBC	Sheep Red Blood Cells
subsp.	subspecies
VCM	Veronal buffer solution in Calcium and Magnesium
VFG	Viande foie goat

ABSTRACT

A multistage cross sectional serological study, questionnaire survey and participatory appraisal were conducted on contagious caprine pleuropneumonia (CCPP) from October, 2007 to April, 2008 in Borana and Guji lowlands, Southern Ethiopia, to determine the prevalence of the disease, to identify the risk factors for the occurrence of the disease and to assess the perception of the community on CCPP in particular and other goat diseases in general. A total of 951 serum samples (900 from goats and 51 from sheep) were collected and tested using Complement Fixation Test (CFT). Questionnaire surveys were conducted with 69 randomly selected households. Participatory disease appraisal was done with 12 informant groups in 12 different villages, the group size varying from 5-12 informants and with a total of 120 informants. Out of the 900 goat sera samples tested, 119 (13.2%) were seropositive for CCPP, giving an overall seroprevalence of 13.2 % (95%CI=11.0%-15.4%) in the study areas. A seroprevalence of 18.3% (95% CI=14.3%-22.7%), 11.6% (95% CI=8%-15.2%) and 9.6% (95% CI=6.3%-12.6%) were recorded in Liban, Teltale and Moyale Districts, respectively. The seroprevalence recorded among the districts was significantly different ($p<0.05$). The seroprevalence recorded in Liban district was significantly different from that of Moyale District ($p<0.05$). Moreover, out of 51 sheep samples tested, 3 (5.9%) were seropositive. Statistical analysis on the assumed risk factors showed that the seroprevalence observed in age groups, flock size groups and distance from veterinary service centre were found to be significantly different ($p<0.05$). Multivariate logistic regression analysis on the assumed risk factors showed that age, flock size and distance from veterinary service centre were the major risk factors for the occurrence of the disease in the area with Odds ratios of 2.18 (95% CI=1.64-2.91), 1.59 (95% CI=1.11-2.29) and 1.43 (95% CI=1.03-1.98), respectively. Contact at watering points, restocking, lack of veterinary service, contact at grazing and large flock size were identified to be the major factors for the spread and occurrence of the disease in the area. Participatory disease appraisal has indicated that the community has good knowledge about contagious caprine pleuropneumonia and other goat diseases, implying that the indigenous knowledge of the pastoral community could be used complementarily with the conventional disease investigation technique in the area. In conclusion, the serological findings, questionnaire survey and participatory appraisal have indicated that contagious caprine

pleuropneumonia was the top major goat health problem in the area which warrants appropriate measures to be in place towards the prevention and control of the disease in the study areas.

***Key words**: Borana and Guji lowlands/CCPP/Ethiopia/Participatory Appraisal/Risk factors/Seroprevalence.*

1. INTRODUCTION

In tropical African countries, livestock production plays a crucial role both in the national economy and livelihood of the people. Specifically, this sector contributes to drought power, high quality food for human beings, clothing, transportation and soil fertility. Goat production, being an important component of livestock production, plays a significant role in generating cash income, provision of meat and milk for the small holders. They are widely distributed in all types of environment, ranging from arid to humid zones. They do better than cattle and sheep well in the drier tropics, where their ability to withstand dehydration and their browsing habit enables them to survive (Mike, 1996).

There are a number of factors which affect the health of goats. The major and the most important factors are feeding and general management. Other factors which affect the health of goats are intensity of production, age of the animals, weather or climate, contact with other animals and breed (Mike, 1996).

Contagious caprine pleuropneumonia (CCPP) is one of the major goat health problems that have high economic importance in Africa and Asia. The economic importance of the disease is due to direct loss which result from its high mortality, reduced milk yield, cost of treatment and vaccination of the disease. Moreover, the disease also causes an indirect loss due to the imposition of trade restrictions (Nicholas, 2002).

CCPP, being one of the most important respiratory *Mycoplasma* infections of goats is caused by *Mycoplasma capricolum subsp. capripneumoniae* (*Mccp*). It is a highly contagious, infectious fibrinous pleuropneumonia of goats characterized by fever, respiratory distress with coughing, nasal discharge and high morbidity and mortality rates (Radostitis *et al.*, 2000). It has been reported from more than 35 countries most of which are in Africa. However, the exact

distribution of the disease is not yet known mainly due to the lack of sensitivity and specificity of the diagnostic tests and difficulty of identification of the organism causing the disease (Bolske *et al*., 1996).

In Ethiopia, the disease was first diagnosed in regions bordering Kenya and the Sudan. Since then, it has been recorded in different parts of the country where extensive type goat production system is practiced including Borana, Ogaden, Wello, Arsi, Gojam, East Shoa, South Omo and North Omo zones (Thiaucourt *et al*, 1992; Roger and Bereket, 1996). Monthly disease outbreak reports at Ministry of Agriculture and Rural Development (MoARD) shows that from 1998 to 2007, about 3308 outbreaks and 50933 cases of CCPP have occurred in different parts of the country. During this period, most of the reports of the disease were from Oromia and Southern Nation, Nationalities and Peoples Regional State indicating the widespread nature of the disease in these two regions (MoARD, 2007).

Moreover, seroepidemiological studies conducted in different parts of the country from 1995-2006 by Masters and Extern students of Faculty of Veterinary Medicine, Addis Ababa University, show seroprevalences ranging from 6% to 36%. Nevertheless, almost all investigations have indicated that the epidemiological picture and the distribution of the disease in different agro ecological zones of the country have not yet been well established. Therefore, these workers have emphasized the need to study the epidemiology and risk factors for the spread of the disease in different agro ecological zones of the country (Dawit, 1996; Solomon, 2005; Gezahegn, 2006).

In case of Borana and Guji lowlands of Southern Ethiopia, which is one of the pastoral areas of the country, there have been many outbreaks of CCPP during the past years, especially during drought periods. The disease is becoming one of the major killer diseases of goats in many districts of the lowland. The area is characterized by poor veterinary infrastructure development, and hence poor veterinary service delivery system. In an effort to bridge this gap, the pastoralists

have been using locally available antibiotics and their indigenous knowledge to treat sick goats by themselves (personal observation).

Preliminary information from the local community and field observations by the researcher has indicated the existence of factors that are assumed to be cause for the widespread occurrence of the disease in the area. Some of the assumed factors are mixing of goats at watering points and grazing areas, restocking, lack of access to animal health service, large flock size and high stock movement for marketing from neighbouring country and regions. Different workers have also indicated the importance of some of the above mentioned factors in the occurrence and spread of CCPP from other parts of the country (Gezahegn, 2006; Gelagay *et al.*, 2007). Most of the previous reports of CCPP from Borana and Guji lowland areas focus on disease outbreak investigation. However, information on the magnitude of the problem, epidemiology and risk factors associated with the disease were scanty. Therefore, the objectives of this study were to determine the seroprevalence of CCPP in the area, to identify the risk factors responsible for the occurrence of the disease and to assess the perception of the local community in the study area about CCPP in particular and goat diseases in general.

2. LITERATURE REVIEW

2.1. The disease

Contagious caprine pleuropneumonia (CCPP) was first described in 1873 in Algeria by Thomas and known under the local name of "bou frida" because, in the majority of the goats, only one lung was affected. Its contagiousness was not initially recognized because the disease was endemic in most areas under examination; however, a major outbreak in South Africa in 1881, following the introduction of goats from Turkey led the colonial veterinary surgeon, Duncan Hutcheon, to conclude that the disease was highly infectious (Seifert, 1996; Nicholas, 2002).

Research into the control of CCPP was initially hampered by confusion over the exact cause of the disease. Two *Mycoplasmas*, *Mycoplasma mycoides subsp. mycoides LC (Mmm LC)* and *Mycoplasma mycoides subsp. capri (Mmc)*, were for some time implicated in the etiology of the disease because they caused a pleuropneumonia in small ruminants that resembled CCPP. However, after 1976 a highly fastidious *Mycoplasma* designated as F-38, later named *Mycoplasma capricolum subsp. capripneumoniae (Mccp),* has been isolated for the first time in vitro by MacOwen and Minette. They had developed a suitable medium for the *Mycoplasma.* Moreover, they also have carried out experimental infections as a result of which its role as the primary cause of classical CCPP was confirmed. A classical CCPP should only be termed when the following criteria have been satisfied: *Mccp* is isolated or there is strong serological evidence of the *Mycoplasma,* lesions are restricted to lung and pleura and consist of a pleuropneumonia, the condition is highly infectious with high level of morbidity or mortality and there is no enlargement of the interlobular septa of the lung (Nicholas, 2002).

2. 2. Epidemiology

2. 2.1. Etiology

The primary causative agent of CCPP is a *Mycoplasma* recently classified as *Mccp.* It belongs to the so called *Mycoplasma mycoides* cluster. The cluster is made up of six important ruminant *Mycoplasmas* (Table 1) including *Mycoplasma mycoides subsp. mycoides SC (MmmSC)*, the causative agent of contagious bovine pleuropneumonia (CBPP), *Mycoplasma mycoides subsp. mycoides LC* and *Mycoplasma mycoides subsp. capri.* Members of the cluster have many biochemical and serological properties in common which makes the diagnosis a problem (Bascunana *et al.*, 1994; Kokotovic *et al.*, 2000; Nicholas, 2002).

Table 1. Relationship within the Mycoides cluster

***Mycoides* subgroup**	***Capricolum* subgroup**
M. mycoides subsp. mycoides SC	*M. capricolum subsp. capricolum*
M. mycoides subsp. mycoides LC	*M. capricolum subsp. capripneumoniae*
M. mycoides subsp. capri	*M. species group 7 of Leach*

Source: Thiaucourt and Bolske, (1996)

2.2.2. Host range

Under natural conditions, *Mccp* infects only goats. The disease affects goats of all age and sex groups. However, young animals are very susceptible to the infection and generally develop more severe disease than adults (Aiello and Mays, 1998; OIE, 2004).

Moreover, no clinical cases have been reported from sheep and cattle. However, report of isolation of *Mccp* from nasal cavity and lung of normal sheep in contact with infected goat flocks suggests the potential of sheep to be the reservoir host for the infection (Mekonen, 1996; Gelagay *et al.*, 2007). Similarly, antibodies to *Mccp* have been detected in buffalo, camels and antelopes in East Africa, though the susceptibility of these animals to CCPP is yet not known (Palling *et al.*, 1978).

2.2. 3. Geographic distribution

Contagious caprine pleuropneumonia is a severe disease of goats occurring in many countries in Africa and in some Asian countries where the total goat population is more than 500 million (OIE, 2004a). The organism was first isolated and shown to cause CCPP in Kenya. Subsequently, it has been isolated in the Sudan, Tunisia, Oman, Turkey, Chad, Uganda, Ethiopia, Niger, Tanzania, Eritrea and the United Arab Emirates. As shown in Table 2, the disease has been suspected and reported from many countries of Africa and Asia (Nicholas, 2000; Thiaucourt *et al.*, 2000).

In Europe, the only report of the disease dates back to the 1920s, when an outbreak occurred in Greece following the seizure of goats from Turkey. Although there were report of disease resembling CCPP in Portugal and England in 1980 and 1996, respectively, the diseases were finally confirmed to be not CCPP. Moreover, there has been no report of the disease in the

American continent, although other members of the clusters have been described (Nicholas, 2002).

Table 2. Distribution of CCPP

Continent	**Confirmed by Isolation**	**Clinical disease reported or suspected**
Africa	Chad, Eritrea, Ethiopia, Kenya, Niger, Sudan, Tunisia, Uganda	Algeria, Burkina Faso, Benin, Cameroon, Central African Republic, Djibouti, Egypt, Libya, Mali, Nigeria, Somalia, Zaire
Asia	Nepal, Oman, United Arab Emirates, Turkey, Yemen,	Afghanistan, Bangladesh, India, Iran, Iraq, Israel Jordan, Kuwait, Lebanon, Pakistan, Saudi Arabia, Syria

Source: Nicholas, (2000)

2.2. 4. Source of infection and mode of transmission

Mycoplasmas are fragile microorganisms and they do not survive more than 24 hours outside the host. This phenomenon suggests that close contact between infected and healthy susceptible animals play an important role in the transmission of the disease (Lefevre *et al.,* 1987). Clinically sick animals are the primary source of infection, however, the existence of symptomless carriers of the disease, which could serve as a source of infection to susceptible flocks is also reported (Seifert, 1996). The possibility of treatment to lead to carrier state and further transmission of the disease has been also indicated (Thiaucourt *et al.*, 1996). On the other hand, it was shown that although the pathogenecity yet remains to be determined, the isolation of *Mccp* in sheep suggests the potential of sheep to be the source of infection of *Mccp* for goat (Mekonen, 1996).

2.3. Factors related to the epidemiology of CCPP

2.3.1. Type of husbandry system

The economic impact of CCPP is serious under intensive husbandry production system because of the fact that overcrowding and confinement in this type of production system favors contact of the hosts and circulation of the agent. It has been also shown that the prevalence of CCPP was higher in mixed farming practice where goats are relatively confined as compared to pastoral production system (Solomon, 2006). In extensive husbandry system; however, mixing of goats at watering points, grazing areas and sheltering places play a great role in the spread of infection (Lefevre *et al.,* 1987). Similarly, Gelagay *et al.*, (2007), has also emphasized the role of regular mixing of flocks at watering points and communal gazing areas in the spread of infection between the flocks in pastoral areas where extensive goat husbandry is practiced.

2.3.2. Climate and season

The occurrence and severity of CCPP varies with season. It is observed that the incidence of the disease is higher during the wet season mainly due to the close contact of goats during wet and humid climatic conditions and the survival of the causative agent in the aerosols during wet climatic conditions (Seifert, 1996). On the other hand, the incidence of the disease was found to be lower in dry climate as the dry condition causes infective aerosols to evaporate and inactivate the pathogen (Lefe'vre *et al.*, 1987; Seifert, 1996). However, it has been shown that the prevalence of the disease was found to be high in arid climate as compared to the semi arid climate mainly due to shortage of feed in arid areas (Gezahegn, 2006)

2.3.3. Other factors

It is believed that any biological stress factors like viruses, bacteria, and parasites lower the non-specific defense mechanism of the host and render it vulnerable to *Mycoplasma* infections, which could in turn enhances the pathogenecity of the organism. Among these biological stress factors, viruses occupy central role. The known viruses that are encountered as concurrent infections along with *Mycoplasma* include *Parainfluenza virus type* 3 (*PI3*) and Adenovirus. However, in case of Africa the most frequently encountered and incriminated viruses are the virus of "Peste des Petits Ruminants" and *Capri poxvirus* (Lefe'vre *et al.*, 1987; Seifert, 1996).

Similarly, stress induced by factors such as heat, overcrowding, large flock size exposure to harsh weather condition, poor ventilation and poor handling are found to be the major predisposing factors to *Mycoplasmal* infections (Shiferaw *et al.*, 2005). Moreover, it has been shown that in areas where there has been a seasonal movement of flocks, the risk for the occurrence of the disease is found to be high due to the high contact challenge. Specially, in pastoral areas where such movement has been adopted as an efficient means of feed and water utilization, the chance of introduction of the disease to disease free flock is high. Furthermore, factors such as constant

movement of animals, availability and quality of feed and water may also predispose to *Mycoplasma* respiratory pathogens (Lefe'vre *et al.*, 1987; Gelagay *et al.*, 2007).

2.4. Molecular epidemiology

All members of the *Mycoplasma mycoides* cluster have two rRNA operons. Unlike other members of the cluster, *MccP* shows high degree of heterogeneity particularly in the sequence of the two rRNA operons each of them containing the genes for 16S rRNA. Phylogenetic analysis of the mollicutes based on 16S rRNA sequence has resulted in a revised taxonomy of this class. Accordingly, sequencing the 16S rRNA gene of African strains of *Mccp* has identified two distinct lines, I and II both of which were represented in central, North and East Africa; isolates from the Middle East were of the line II (Bertil *et al.*, 1998; Nicholas, 2002). Sequencing the amplified products of different genes, the H2 locus has divided strains into 4 major groups in which lineag A occurred exclusively in East Africa, lineage B mostly in North Africa and the Middle East, Lineage in central Africa and lineage D found in United Arab Emirates (Lorenzon *et al.*, 2002). This phylogenetic analysis of 16S rRNA shows that, the strain specific polymorphism pattern of 16S rRNA gene of *Mccp* may be used as epidemiological markers for CCPP in smaller geographical areas and to study the molecular evolution of this species (Heldtander *et al.*, 2001).

2.5. Pathogenesis and pathology

Mycoplasma adheres to host cells, an attribute essential for pathogenesis. This close contact facilitates toxic damages to the host cells by soluble factors produced by the pathogen. The modulation and activation of the host immune response is critical for the pathogenesis of *Mycoplasma* diseases. Pneumonia produced due to CCPP also induces ciliostasis, loss of cilia and cytopathic changes (Quinn *et al.*, 1994).

The gross pathological lesions are localized exclusively to the lung and pleura and are often unilateral. Affected lungs can be totally hepatized, and have a port wine color (Thiaucourt and Bolske, 1996). A lung section shows a fine granular texture with various colors, but usually without any thickening of the interlobular septa. There are often an abundant pleural exudates and conspicuous pleuritis. The pleural exudates can solidify and form a gelatinous covering sometimes over the whole lung. In acute cases, the pleural cavity contains a fluid with an excess of yellowish colored pleural exudates and with fibrin flocculation and there is swelling of bronchial and mediastinal lymph nodes (Wesonga *et al.*, 1993; Gelagay *et al.*, 2007). In chronic cases, there is a black discoloration of the lung tissue and sequestration of the necrotic lung areas. Chronic pleuritis causes commonly visceral and pleural thickening and adhesion to the chest (Seifert, 1996).

Histological examination of the lung tissues may show acute serofibrinous to chronic fibrino-necrotic pleuropneumonia with infiltrates of serofibrinous fluid and inflammatory cells, mainly neutrophils, in the alveoli, bronchioles, interstitial septae and sub pleural connective tissue. Intralobular edema is more prominent but interlobular edema has also been reported. Peribronchial and peribronchiolar lymphoid hyperplasia with mononuclear cell infiltration is also present (Wesong *et al.*, 1998). Moreover, it was shown that ultra structural examination of the lungs from goats infected with *Mccp* revealed extensive hyperplasia of type II pneumocytes, typically containing abundant number of osmiophilic lamellar bodies that had lost most of their characteristic lamellar ultra structure (Johnson *et al.*, 2002).

2.6. Clinical signs

After an incubation period of 8-20 days, the animals may show different courses of the disease. Acute cases can be observed in regions where CCPP is introduced for the first time into naive populations. In animals with primary infection, the illness lasts for about two days and death ensues, while in other cases it may last several days (Seifert, 1996; Nicholas, 2002). The primary clinical signs are weakness, cough, hyperpnoea and nasal discharge accompanied by fever of

106^0F (41^0C), with animals tending to lie down or lag behind the flock. Affected animals continue to graze for some time but eventually become anorexic; breathing becomes labored. Gradually, the respiratory symptoms become prominent, respiration is accelerated and painful, and is followed by violent coughing (Seifert, 1996; Aiello and Mays, 1998).

In the terminal stages, the animals are unable to move. They stand with their legs abducted, the neck is stiff and extended downward, saliva continuously drips from their mouth and their nose is obstructed by mucopurulent discharge. In fully susceptible flocks that encounter an outbreak, morbidity is usually 100% and mortality is 60%-100% (Aiello and Mays, 1998). In endemic areas sub acute and chronic cases are common and the symptoms are milder, dominated by intermittent coughing. Characteristically, the animals recover from this form of the disease almost completely and do not show symptoms or lesions after recovery. Sequestra like in CBPP do not appear, but many of the animals remain carriers (Mekonen, 1996; Seifert, 1996; Aiello and Mays, 1998).

2.7. Immunology

Little is known about the immunology of CCPP despite a large number of experimental infections reported. More recently (March *et al.*, 2002) monitored the humoral response of goats infected with a multiple passage of *Mccp* strain 19/2 with several serological tests and PCR. Indirect evidences showed that there are mechanisms other than (or in addition to) humoral response, that are important in the immunity to CCPP. This evidence was suggested based on the observation made on the growth inhibition activity of anti serum from goats vaccinated against *Mccp* did not correlate with protection against subsequent infectious challenge in these animals. Moreover, the relative contribution of cellular or humoral responses in protective immunity is unknown (March *et al.*, 2002). Despite the little evidence on what is going on within the body post infection as far as immunity is concerned, the immune response were detected by latex agglutination test and competitive ELISA (c-ELISA). Immunoglobulin G immunodominant band of 23, 40 and 44kDa were seen by immunoblotting in all experimentally infected animals as well

as in some sera from a natural outbreaks of CCPP in Eritrea which additionally showed bands of 62, 70 and 108kDa (Nicholas, 2002).

2.8. Diagnosis

The definitive diagnosis of CCPP is difficult and confusing because the changes evoked by *Mccp* are not sufficiently pathognomonic and other *Mmc* and *Mmm LC* can also induce pleuropneumonic diseases resembling the classical CCPP. Moreover, there is a problem in the transport of the sample over long distance to specialized laboratory which often results in the inactivation of the fragile *Mycoplasma* and difficulty in isolation and correctly identifying it (Bolske *et al.,* 1996; Houshaymi *et al.,* 2002). However, evidences from epidemiological studies, clinical signs and pathological lesions can assist in achieving a diagnosis of the disease (Aiello and Mays, 1998).

2.8.1. Clinical signs and postmortem examination

In case of an active outbreak, the clinical signs and lesions observed may give rise to a strong suspect of the disease. Weaknesses, anorexia, cough, hyperpnoea, nasal discharge accompanied by fever of 40^0C are often found. Exercise intolerance and eventually respiratory distress develop. Pathological lesions like thorax containing an excess of straw colored fluid, acute fibrinous pleuropneumonia with overlaying fibrinous pleurisy are also suggestive of CCPP. Consolidation is some times confined to one lung (Seifert, 1996; Aiello and Mays, 1998). The affected lung is enlarged, firm and edematous, varying in color forming a mosaic. Evolving lesions are characterized by round foci of hepatization with gray pinpoint center of necrotization and dark red hyperemic margins, which contrasts markedly with the pink unaffected lung (Thiaucourt *et al.*, 1996).

2.8.2. Isolation of the organism

Lung lesions and pleuritic fluids are the samples of choice for the isolation of *Mccp.* Similarly, nasal swabs are also useful for cultivation and isolation of the organism. Isolation of the organism can be done in *Mycoplasma* media such as "Viande foie goat" (VFG), Modified Hay flick's and Newing's tryptose (OIE, 2004). *Mycoplasma* in broth culture is recognized by color change and the appearance of follicular material. On agar plate, many *Mycoplasma* species including *Mccp* produce colonies of bizarre morphology often small, colorless and of irregular shape in early passages. In subsequent ones, such isolates demonstrate conventional "fried egg" colony, except *Mycoplasma ovipneumoniae* (Quinn *et al.,* 1994; OIE, 2004).

2.8.3. Identification of *Mycoplasma*

Biochemical identification

Biochemical tests cannot identify and isolate *Mycoplasma* equivocally, which at present can only be done by serological or genetic means. Interspecies variations in some biochemical reactions are often considerable, but some tests perform a useful function both as a preliminary screening system and in providing supportive data for serological findings (Houshaymi *et al.,* 2002; Nicholas, 2002).

The tests most commonly used in biochemical identification of *Mycoplasma* are glucose breakdown, arginine hydrolysis, film and spots formation, reduction of tetrazolium chloride, phosphatase activity, serum digestion and digitonin sensitivity (Quinn *et al.*, 1994; Nicholas, 2002).

2.8.4. Serological tests

Serological identification of CCPP has not widely been applied for the individual diagnosis of pleuropneumonia in goats or sheep. Such tests are best used on herd basis rather than for diagnosis in individual animals. Some of the serological tests used are Complement Fixation Test (CFT), Latex Agglutination Test (LAT), Competitive Enzyme Linked Immunosorbant Assay (c-ELISA) and Indirect Hemagglutination Test (IHA) (OIE, 2004).

Complement Fixation Test (CFT)

The complement Fixation Test remains the most widely used serological test for contagious caprine pleuropneumonia, except in Kenya where latex agglutination has been used. It is one of the tests recommended by OIE for international trade. It is less specific as compared to other serological tests and detects recent infections and antibodies which are short persistent in the body (Thiaucourt *et al.*, 1996). Its main draw backs are the high level of technical expertise required to perform the test and the cumbersome of the test procedures (OIE, 2004).

Latex agglutination Test (LAT)

Latex beads sensitized with the polysaccharides produced by *Mccp* and present in culture supernatant have been used in a slide agglutination test (Houshaymi *et al.*, 2002; OIE, 2004). The test is presently used routinely in Kenya. It is a very useful test in outbreaks because it can be performed at the pen side using a drop of whole blood (OIE, 2004). It is highly sensitive test than CFT (Houshaymi *et al.*, 2002). Moreover, it has been shown that in field sera from goats with CCPP, the result exhibited by LAT exhibited a 67% correlation with the result of CFT (March *et al.*, 2002).

Competitive Enzyme Linked Immunosorbant Assay (c-ELISA)

This test is based on the specificity of the monoclonal antibody for CCPP epitope and the ability of *Mccp* infected goats to make antibodies to this epitope. The two antibodies are made to compete for the *Mccp* epitope coated on the plate. The test has been described to be specific and detect antibodies for long period after infection. However, as with other serological tests, it does not detect all reactors (it detects between 30% to 60% in an infected herd). As compared to other tests, it is easier to perform. However, the test is not widely available (OIE, 2004)

Indirect Hemagglutination Test (IHA)

The Indirect Hemagglutination Test (IHA) is most commonly performed with red blood cells that are either fresh and treated or not treated with gluteraldehyde. The former is more sensitive but show greater variability between tests and require sensitization with antigen each time the test is performed. Gluteraldehyde treatment reduces sensitivity but produce much more useful diagnostic tests as sensitized red blood cells remain effective for one year or more if kept refrigerated, and require little further manipulation before use in the test. However, as compared to other serological tests it is less sensitive (OIE, 2004).

2.8.5. Molecular diagnosis

Mycoplasma capricolum subsp. capripneumoniae (Mccp) is difficult to isolate and to correctly identify it. Moreover, members of the mycoides cluster share genomic and antigenic features which results in common biochemical and serological properties, complicating species identification. Considering these constraints, a specific PCR has been developed (Woubit *et al.*, 2004). The diagnostic system is based on Polymerase Chain Reaction (PCR) in which a segment of 16S rRNA gene from all *Mycoplasma* of the *Mycoplasma mycoides* cluster can be amplified. The PCR product is then analyzed by restriction enzyme cleavage for the identification of *Mccp* DNA. The PCR is applied to clinical samples from the nose, ear, pharynx, pleural fluid and lung tissue containing *Mccp* and other *Mycoplasma* organisms (Bolske *et al.*, 1996).

2.8.6. Participatory Disease Search (PDS)

The most common epidemiological applications of participatory rural appraisal are to gain a rapid overview of the range of community's animal health problems. The method is very ideal for remote and pastoral areas where conventional ways of disease investigation approaches cannot be performed. Different workers have utilized and appreciate the importance of this approach in the diagnosis and investigation of CCPP in different parts of the country (Solomon, 2005; Gezahegn, 2006).

The method is achieved by directly asking and involving the livestock owners about the health problems they have in their goat flocks. In the process of participatory disease search, the disease search team is interested in information on specific disease but takes precautions not to communicate this interest to respondents. Questions are asked about general goat health concerns. If the target disease is identified as a problem, probing questions can be asked about the target disease in combination with other subjects. The investigation seeks to establish the history of the disease in a community and trace reports of the disease in the area. In this approach,

livestock owners guide the disease search team to active cases of CCPP that can then be confirmed by laboratory diagnostic methods (Cately *et al.*, 2002; Cately *et al.*, 2005).

2.9. Economic importance of CCPP

CCPP is a highly contagious respiratory disease of goats characterized by severe fibrinous pleuropneumonia with a morbidity of 100% and mortality of 60% to 100% (Aiello and Mays, 1998), imposing significant constraint on goat production owing to its high mortality and production losses. Although the treatment of clinical case is possible, due to the recurrent and highly contagious nature of the disease and presence of the potential carriers, it is very expensive and consequently beyond the budget of many poor pastoralists to whom the goat belongs. But there is no economic impact study, which indicates the annual loss due to CCPP in Ethiopia. However, a preliminary study by Mekonen, (1996), on the economic significance of the disease around Arbaminch area, Southern Nations and Nationalities People's Regional State indicated an average economic loss of up to 665.00 Ethiopian birr per household and loss of one third of the goat population in the affected village during the outbreak.

2.10. Prevention and control

Protection against CCPP was shown to be possible more than a century ago when Hutcheon subcutaneously inoculated goats with lung extract from affected animals (Nicholas, 2002). Further more goats vaccinated with an attenuated broth culture of F-38 did not succumb to contact infection. This clearly demonstrated prevention and control was possible. Since then, a number of different preparations have been produced which are reported to produce solid immunity even after one year. These include a vaccine composed of sonicated antigens emulsified with incomplete Freud's adjuvant and another in which lyophilized F-38 is inactivated with saponin immediately before immunization. The latter vaccine has been in use in Kenya (Thiaucourt *et al.*, 1996) for the last few years but has been modified so that the *Mycoplasma* is

inactivated with saponin for at least 12 hours at $+4^0$C. Kids older than 10 weeks of age are vaccinated to avoid interference by maternal antibody (Seifert, 1996; Nicholas, 2002).

In other countries where vaccination is not practiced, other control measures are used. Antibiotics such as the tetracyclines, fluroquinolones and macrolide families are generally effective clinically if used earlier enough. However, the complete elimination of the *Mycoplasma* is rarely achieved and treated animals should always be considered as potential carriers (Thiaucourt *et al.*, 1996).

Moreover, it is shown that especially in pastoral areas self imposed quarantine restriction measures are believed to be important for the prevention and control of the diseases (Shiferaw *et al.*, 2005). In newly infected countries, slaughtering of infected and in contact animals is recommended (Nicholas, 2002).

3. CCPP IN ETHIOPIA

In Ethiopia, the presence of the disease has been suspected for long period, especially in areas in the immediate vicinity of endemic regions of Kenya and the Sudan. It has been confirmed to be present in Ethiopia since 1980s (Thiaucourt *et al.*, 2000). Although exact epidemiological distribution of the disease is not known, monthly outbreak reports of the disease to MoARD from different regions of the country (Annex 9 and 10) and different serological studies so far conducted shows the importance of the disease especially in areas where extensive goat production is practiced (Annex 11).

4. MATERIALS AND METHODS

4.1. Description of the study area

The study areas comprises of Borana and Guji lowland of Southern Oromia (Figure 1) and Ethiopia covering an area of 95000km2. The Borana plateau gently slopes from the high mountain massif in the North 1650metres above sea level to the South bordering Kenya at 1000metres above sea level with slight variation due to central mountain ranges and scattered volcanic cones and craters (Coppock, 1994). It borders Kenya to the South, Somali region to the East, the high land parts of Borana and Guji to the North, and Southern Nations and Nationalities People's Regional State to the West.

The study was conducted in three selected districts in the lowland, namely Teltale, Moyale and Liban (Figure 1). Teltale District borders the Southern Nations and Nationalities People's Regional State to the North and North West, Kenya to the South and Yabalo District to the West. The district has a secondary market centre. There is a constant movement of goat flocks from Konso, Hammer and Arbore district of the neighboring region to Teltale District for marketing. According to the information from the district, there is also a cross border movement of goats to and from Kenya to the district. The district has an annual mean rainfall that ranges from 200mm to 300mm.

Moyale district borders Somali Regional state to the East and Kenya to the South, Das Borbor District to the North and some parts of Miyo District from the West. The district also has a secondary market centre at Moyale. There are cross-border movements of goats to and from this district to Kenya and Somali Regional State for marketing, grazing and watering. The district has an annual mean rainfall that ranges from 300mm to 400mm.

Liban District borders Bale zone of Oromia Regional State and Somali region to the East and South respectively, Wadera District to the North and Arero District to the West. Similar to the other districts, the district has a secondary market at Negele Borana. The district has relatively many watering points and a good access to market services. Thus there is a relatively high stock movement from the neighboring region, zone and districts as compared to the other districts in the lowlands. The district is relatively moist lowland as compared to the other two (MoARD, 2003). The district has an annual mean rainfall that ranges between 500mm and 900mm.

In general, the Borana and Guji lowland areas have an annual average rainfall ranging from 300mm in the South to over 700mm in the North. The rainfall pattern is bimodal with the main rainy season, locally called "Ganna" extending from March to May, and accounts for 65% of the total annual rainfall in the area. The short rainy season, locally called "Hagayya" extends from mid September to mid November and it accounts for 35% of the total annual rainfall. Annual mean daily temperature varies from 19^0C to 24^0C with moderate seasonal variations. The other two seasons in the study area are the cool dry season known as "Adooleessa" extending from June to August and warm dry season known as "Bona" extending from December to February. Seasons affect herding strategies and disease patterns due to their effect on forage and water resource availability. But herd-splitting is practiced to cope up with these shortages of resources (Coppock, 1994; Desta, 2000).

The predominant vegetation is the savannah type containing mixture of perennial and woody plants. The savannah varies from open grassland to bush encroached areas. There are shifts in response to heavy grazing, browsing and drought periods. Several plant species in the area are valuable livestock forage. Acacia is the dominant bush species in the area (Coppock, 1994; Desta, 2000).

Surface water is a serious problem in the study area. The sources of water for human and animals in the areas are traditional deep wells; "Eelaa", ponds, perennial springs, the permanent river

Dawa and Genale, seasonal sources such as streams, ephemeral ponds and shallow wells. Deep wells and large ponds are used in the dry season while seasonal streams, ephemeral ponds and shallow wells are used in wet seasons. Animal husbandry is characterized by extensive pastoral production system with seasonal mobility. Cattle are the dominant animal species followed by goats, sheep and camels. The areas are endowed with large number of small ruminants that play great role for export market (Desta, 2000).

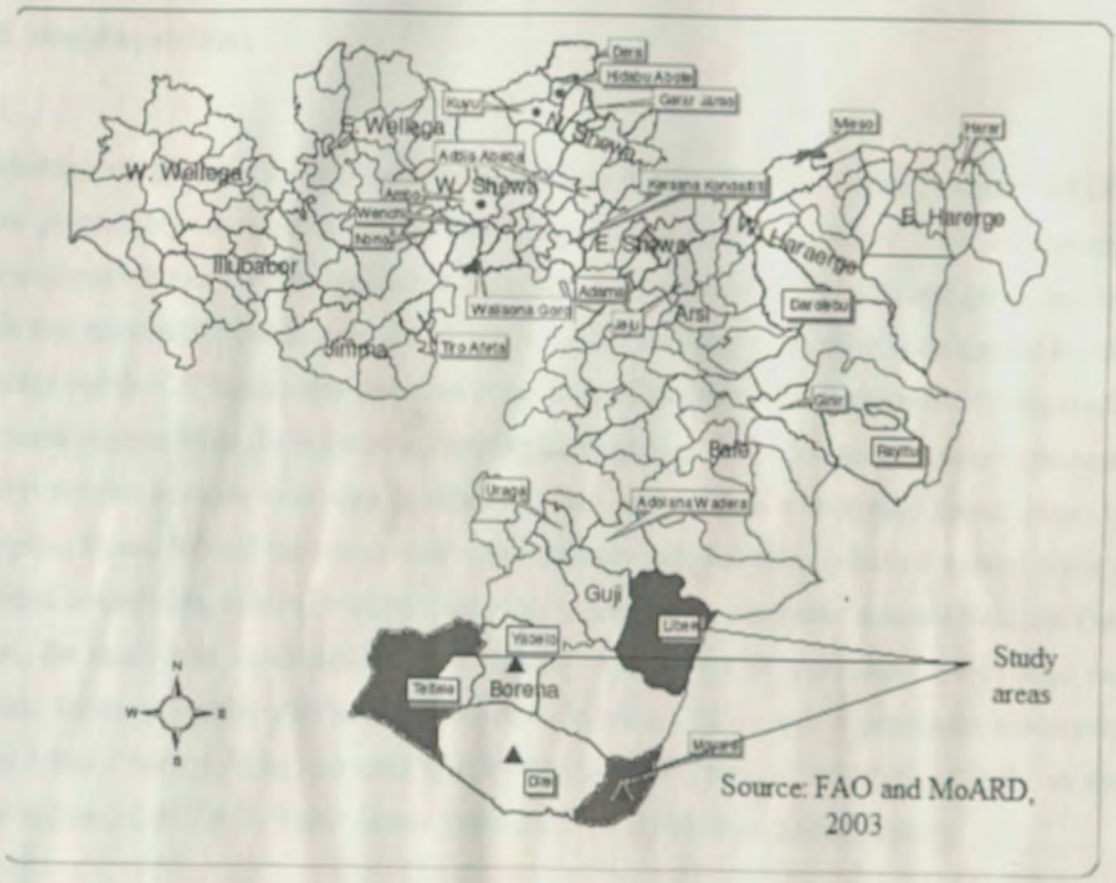


Figure 1 .Map of Oromia region showing the study areas

4. 2. Description of study population and study design

There are about 643,796 goat populations in the selected study districts CSA, (2003). Therefore, the study population considered was 643,796. The study designed was a cross sectional survey of all age and sex groups of goats in the study districts.

4.3. Sampling strategy

Multistage sampling technique was employed. Three districts namely, Teltale, Moyale and Liban were purposively selected based on their geographical locations. About 20% of pastoralist associations were conveniently selected, based on the number of households and goat population such that pastoralist associations in which households and goat population were greater than the average number of households and goat population of the district were selected. Using disease outbreak reports from the selected pastoralist associations, list of households who experienced CCPP for the last one year was established. This was used as a sampling frame. From this sampling frame, 10% of the households were randomly sampled using a lottery system. From the selected households, a fixed proportion of 10% of goats were randomly selected from the flock. Thus, the study was conducted in 13 pastoralist associations (4 pastoralist associations from Teltale District, 3 pastoralist associations from Moyale District and 6 pastoralist associations from Liban District). Blood samples were collected from a total of 117 flocks (39 flocks from Teltale District, 41 flocks from Moyale District and 37 flocks from Liban District).

4.4. Sample size determination for the test sera

The sample size for this study was is determined using the formula for simple random sampling given by Thrusfield, (2005).

$$n = \frac{1.96^2 \times P_{expected}(1 - P_{expected})}{d^2}$$

where n was the sample size, d the absolute precision at 95% confidence interval, ($P_{expected}$) was the expected prevalence. In this case the absolute precision assumed was 5%. The expected prevalence was estimated from the previous work in the neighboring area with similar agro-ecological characteristics by Solomon, (2006). He found prevalence of 16.5%. Using these values, the sample size required for this study was estimated at 212. However to increase the precision, 300 samples were taken from each district, thus a total of 900 goat sera samples and 51 sheep sera were collected.

4.5. Study methodology

4.5.1. Sample collection

An amount of 5-10ml of blood sample was collected from the jugular vein of each selected goat using plain vaccutainer tubes. Blood samples were allowed to clot at room temperature over night. Serum was separated from clotted blood by decanting into a tube. All sera were stored at -20^{0}C in a local veterinary clinic and finally transported to the National Veterinary Institute, Debre Zeit, Ethiopia where Complement Fixation Test (CFT) test was performed.

Complement Fixation Test

The OIE standard test procedure was followed for the test (OIE, 2000). Test sera including positive and negative control were decomplemented in hot water bath at 60^0C for 30 minutes. 45 µl VCM was dispensed to the wells of columns number 1, 5 and 9 of the test plate. 25 µl of VCM was dispensed in the other wells. 5 µl test sera was added to wells of column number 1, 5 and 9 giving the dilution of 1:10 in these wells. 25 µl of the diluted sera was serially transferred from column 1 to 4, column 5 to 8 and from column 9 to 12. 25 µl of antigen at working dilution were dispensed to each well, except in the wells of column number 4, 8 and 11, which were used to check for anti complementarity activity of the serum. Then the mixture was incubated for 30 minutes at 37^0C. 25µl of titrated complement were added into the wells of the test sera. It was incubated at 37^0C under constant agitation for 30 minutes. 2% one day old SRBC was prepared by washing three times with VCM and centrifuged at 2500rpm for 5 minutes for each washing. An equal volume of diluted Amboceptor (SRBC antisera) (1:1000) was added to sensitize the SRBC which brings the hemolytic system to 1% instead of 2%. 25µl sensitized SRBC (Indicator) was pippeted into each well and the plates were sealed to avoid evaporation and incubated at 37^0C for 30 minutes with constant agitation. The plates were examined for sedimentation and hemolysis. Then the plates were kept in the refrigerator at $+4^0$C over night in order to allow non lysed cells to settle. The detailed procedures and interpretation of the test are given in Annex 4.

4.5.2. Questionnaire survey

A pre-tested questionnaire was administered to the owners of the study animals. The questionnaire was administered randomly to 69 households of the 117 visited households during the survey in the study districts (Annex 1). The questionnaire had two portions: The first portion dealt with general information such as address of the owner, comparative importance of goats relative to other animals, distance from veterinary service centre, flock size, major goat disease, market value of healthy goats, accessibility to veterinary service center, source of veterinary service and intensity of flock movement in the study areas. The second portion dealt with specific

information related to CCPP such as presence of the disease in the flock during the last one year, check up for the status of CCPP during restocking, factors responsible for the occurrence of the disease, age and sex groups affected, measures taken during outbreaks, types of drugs used to treat sick animals, seasonal occurrence of the disease and health check ups for CCPP during recruitment.

4.5.3. Participatory appraisal of goat diseases

As a supplement to the questionnaire survey, the perception of the pastoral community about CCPP in particular and other goat diseases in general was assessed using matrix scoring and seasonal calendar using the guideline descriptions (Cately *et al.*, 2002; Cately *et al.*, 2005). Triangulation of the knowledge of the pastoralists about contagious caprine pleuropneumonia was assessed through comparison with text book description of the disease, clinical and serological examinations.

Matrix scoring

The informant groups identified major goat diseases in their areas from which, the first five were selected for matrix scoring. Pair wise comparisons of the five goat diseases were conducted. During the pair wise comparison, list of reasons known as "indicators" in participatory methods were established. The identified indicators were locally perceived clinical signs of the diseases. The five diseases placed along the x-axis in the matrix were scored against the list of clinical signs of the disease which were placed along the y-axis of the matrix. The diseases and clinical signs were represented by locally known objects so that the informants could easily identify them during scoring. For each clinical signs, informants were asked to score each disease by dividing piles of 25 stones (five for each disease). The informants were given the chance to change the score if they wished. The final score was recorded. The matrix scoring was conducted among 12 informant community groups (3 community groups in Teltale District, 4 community groups in

Moyale District, and 5 community groups in Liban District). In all of the cases, the community group size varied from 5-12. The level of agreement among the informant groups were determined by methods of Siegel and Castellan (1994).

Seasonal calendar

Local names of seasons in Borana and Guji lowlands were identified as long rainy ("Ganna"), short rainy ("Hagayya"), cold dry ("Adoolessa") and long dry ("Bonaa"). The seasons were represented by local materials on the top x-axis and the indicators to be scored against the season were placed along the y-axis. The diseases, rainfall and seasons were represented using locally known objects. Rainfall was chosen as the first event to be scored during the seasonal calendar scoring. The annual objective rainfall data of the study area from September, 2006 to September, 2007 were collected from former Southern Rangeland Development Project Office. The informant groups were given a pile of 30 stones and were asked to divide the stones against the seasons to show the patterns of the indicators. The informants were given the chance to change the score if they wished. The final score was recorded. The seasonal calendar was conducted among 12 informant community groups (3 community groups in Teltale, 4 community groups in Moyale, and 5 community groups in Liban). Similar to the case of matrix scoring, the informant group size varied from 5-12. The level of agreement among the groups was determined by methods of Siegel and Castellan (1994).

Triangulation of the perception of the informant groups

Clinical examinations were conducted and blood samples were taken for serology from 9 goats which were considered to be infected with CCPP according to the perception of the informant groups. The 9 cases were taken from 8 different community informant groups.

4.5.3. Secondary data collection

Secondary data such as outbreak reports, general animal health service problems in the area, vaccination and treatment services for contagious caprine pleuropneumonia and socioeconomic data were collected from the districts. National CCPP outbreak report was collected from the Federal Ministry of Agriculture and Rural Development (Annex 9 and 10) serological study data were compiled from FVM library (Annex 11).

4.5.4. Categorization of study variables

The ages of individual goats were determined according to Mike, (1996) (Annex 12) and were categorized into three groups as age group <=2 years (young), age group >2 years-<=5 years (adult) and age group >5 years (old).

Goat flock sizes were categorized as <=50 goats (small flock size), >=51-<=160 goats (medium flock size) and >=161 goats (large flock size).

The distance from veterinary service centre was categorized into three groups based on previous studies by MoARD, (2003) in the area, questionnaire survey and interview with the district veterinary officials. Accordingly, areas <=10kms way from veterinary service centre (accessible), areas >10kms-<=30kms way from veterinary service centre (moderately accessible) and areas >30kms way from veterinary service centre (inaccessible).

4.6. Data management and analysis

Data from individual animals; participatory disease investigation and questionnaire data were stored in Microsoft Excel spreadsheet (Microsoft Corp.1985-2001) as databases. Data were screened for proper coding and error and corrected prior to statistical analyses. The seroprevalence was calculated based on the result of CFT by dividing the number of reactors by the total number of animals tested. The associations of the individual risk factors with out come of interest were analyzed using Pearson's Chi-square, in SPSS version 11.50. The significant risk factors associated with the outcome of interest were further subjected to multivariable stepwise logistic regression analysis to determine the major risk factors and adjust for confounders. The major risk factors were used for the model construction to predict the occurrence of the disease in the study area. Logistic regression model for the multiple predictor variables was based on the formula;

$$\text{Log} \quad \frac{P(X1, X2, \ldots Xn)}{1-P(X1, X2, \ldots Xn)} = \beta 0 + \beta 1 X1 + \beta 2\, X2 + \ldots\, \beta n Xn$$

The strength of association between the risk factors and the occurrence of the disease was assessed using Odds Ratio (OR) at the 95% confidence level.

In case of participatory disease appraisal and questionnaire survey, the data were analyzed by computing descriptive statistics using Ms-excel version 2000. Descriptive statistics used for questionnaire survey were frequency, proportions, graphs and pie charts. While in case of participatory appraisals, medians, minimum, and maximum values were used. The level of agreement among the groups were assessed using Kendall's coefficient of concordance (W) and p value using SPSS (2000) version 11.50. The concordance (W).value ranges from 0 to 1. W values

of <=0.26, >0.26 to <=0.38 and >0.38 shows weak, moderate and good agreement between the informant groups, respectively.

5. RESULT

5.1. Seroprevalence

5.1.1. Overall seroprevalence

An over all seroprevalence of 13.2% (95% CI= 11.0%-15.4%) was observed in the study areas (Table 3). Seroprevalence of 11.7% (95% CI= 8.1%-15.3%), 9.7% (95 CI= 6.4%-13.0%) and 18.3% (95% CI= 14.0%-22.6%) were observed in Teltale, Moyale and Liban districts, respectively. The differences in seroprevalences among the districts were statistically significant ($p<0.05$). Pair wise comparisons showed significant difference existed between Liban and Moyale Districts ($p<0.05$).

Table 3. Overall seroprevalence of CCPP with CI and OR in the study areas

District	Sample Tested	Sample Positive	Prevalence (%) (95% CI)	p value	OR (95% CI)
Teltale	300	35	11.7 (8.1-15.3)	0.43	0.81 (0.48-1.36) *
Moyale	300	29	9.7 (6.4-13.0)		
Liban	300	55	18.3 (14.0-22.6)	0.002	2.09 (1.29-3.39) **
Overall total	**900**	**119**	**13.2 (11.0-15.4)**		

Pearson's Chi-square(X^2) (2) =10.768, p=0.005; * Teltale vs. Moyale, ** Liban vs. Moyale.

Out of the total 117 flocks examined during the study, 62 flocks were found to be infected with CCPP, giving an over all flock (herd) level seroprevalence of 53% (95% CI=44%-62%) in the study area. Flock level seroprevalence of 53.8% (95% CI=37.9%-69.7%), 43.9% (95% CI=28.8%-59%), and 64% (95% CI=47%-78.2%) were recorded in Teltale, Moyale, Liban Districts, respectively (Table 4). Although high flock level seroprevalence was recorded in Liban district, the difference in flock level seroprevalence among the districts was not significant ($p>0.05$).

Table 4. Flock level seroprevalence of CCPP in the study districts

District	Flock Tested	Flock positive	Prevalence (%) (95% CI)	p value	OR 95%CI for OR
Teltale	39	21	53.8 (28.8 -59.0)	0.374	1.49 (0.62-3.55) *
Moyale	41	18	43.9 (37.9 - 69.7)		
Liban	37	23	62.6 (47.0 - 78.2)	0.064	2.36 (0.94-5.87) **
Overall total	**117**	**62**	**53 (44.0-62.0)**		

Pearson's Chi-square (X^2) (2) =3.44, p=0.179; * Teltale vs. Moyale, ** Liban vs. Moyale.

Although sheep are naturally not affected by contagious caprine pleuropneumonia, there is an assumption that sheep reared along with infected goat flocks could be affected. In the study area it was observed that, goats and sheep have been reared together. In this study 51 serum samples were collected from sheep, which were reared along with goats, out of which 3 sheep (5.9%) were seropositive.

5.1.2. Seroprevalence by assumed risk factors

The seroprevalence recorded in females was 14% (95% CI=11.3%-16.7%), while it was 11.6 % (95% CI=8.0%-15.4%) in males (Table 5). The seroprevalence between the two sexes was not significantly different ($p>0.05$).

Table 5. Seroprevalence of CCPP by sex categories and the Odds rations for association

Sex categories	**Sample Tested**	**Sample positive**	**Prevalence (%) (95%CI)**	**OR 95%CI for OR**
Female	599	84	14.0 (11.3-16.7)	0.807(0.529-1.229)
Male	301	35	11.6 (8.0-15.2)	
Overall total	**900**	**119**	**13.2 (11.0-15.4)**	

Pearson's Chi-square($X^{2)}$ (1) = 1.020, p =0.313.

A seroprevalence of 9.2% (95% CI=6.3%-12.0%), 11.0% (95% CI=8.0%-14.0%) and 34.8% (95% CI=26%-42.8%) were recorded in <=2years (young age), >2years-<=5years (adult age) and >5years (old age) groups, respectively (Table 6). The differences in seroprevalence among the age groups were significant ($p<0.05$). Old age has (>5years) has showed significantly different seroprevalence as compared to the other two age groups ($p<0.05$). The likelihood of the disease in old age group was 5.27 (95%CI=3.13-8.87) times more likely to occur as compared to the young age group, while it was 4.31 (95%CI=2.62-7.08) times more likely to occur as compared to the adult age group.

Table 6. Seroprevalence of CCPP by age categories and the OR for association

Age categories	Sample Tested	Sample positive	Prevalence (%) (95% CI)	p value	OR (95% CI for OR)
<=2years	380	35	9.2 (6.3-12.0)		
>2 years-<=5years	408	45	11.0 (8.0-14.0)	0.398	1.22 (0.767-1.94)*
>5years	112	39	34.8(26.0-42.8)	0.000	4.31 (2.62-7.08) **
				0.000	5.27 (3.13-8.87) ***
Overall total	**900**	**119**	**13.2 (11.0-15.4)**		

Pearson's Chi-square (2) =52.579, p=0.000; * > 2years-<=5years vs. <=2years, ** >5years, vs.> 2years -<=5years, *** >5years vs.<=2years.

Seroprevalence of 9.6% (95% CI=5.5%-13.5%), 12% (95% CI=9.6%-14.5%) and 25% (95% CI=17.3%-32.7%) was observed in <=50 goats (small flock size), >=51-<=160 goats (medium flock size) and >=161 goats (large flock size) groups, respectively (Table 7). The difference in seroprevalence among the three flock size groups was significant ($p<0.05$). Large flock size (>=161 goats) has shown significantly different ($p<0.05$) seroprevalence as compared to the other two flock groups. The likelihood of the disease in large flock size group was 3.14 (95%CI=1.66-5.96) times more likely to occur as compared to the small flock size and 2.45(95%CI=1.5-3.96) times more likely to occur when compared to the medium flock size.

Table 7. Seroprevalence of CCPP by flock size categories and the OR for association

Flock size Categories	Sample Tested	Sample positive	Prevalence (%) (95% CI)	p value	OR (95% CI for OR)
<=50	188	18	9.6 (5.5-13.5)		
>=51-<=160	592	71	12.0 (9.6-14.5)	0.363	1.29 (0.746-2.22) *
>=161	120	30	25.0 (17.3-32.7)	0.000	2.45 (1.5-3.96) **
				0.000	3.14 (1.66-5.95) ***
Overall total	**900**	**119**	**13.2 (11.0-15.4)**		

Pearson's Chi-square(X^2) (2) =17.467, p=0.000; * >=51-<=160 vs. <=50, ** >=161 vs. >=51-<=160, *** >=161 vs. <=50.

A seroprevalence of 10.6% (95% CI=6.6%-14.6%), 11.4% (95% CI=8.7%-14.6%) and 21.9% (95% CI=15.9%-27.9%) was observed in areas located <=10kms (accessible), >10kms-<=30kms (moderately accessible) and >30kms (inaccessible) away from veterinary service centre, respectively (Table 8). The difference in seroprevalence among the three distance groups was significant ($p<0.05$). Distance group >30kms (inaccessible) has shown significant difference ($p<0.05$) seroprevalence as compared to the other two distance groups. The likelihood of the disease in distance group >30kms (inaccessible) was 2.36 (95% CI=1.31-4.25) times more likely to occur as compared to the distance group <=10kms (accessible) and 2.17 (95% CI= 1.39-3.14) times more likely to occur as compared to the distance group >10kms-<=30kms (moderately accessible).

Table 8. Seroprevalence of CCPP by distance categories from veterinary service centre and the OR for association

Distance from Veterinary service Centre	Sample Tested	Sample positive	Prevalence (%) (95% CI)	p value	OR (95% CI)
<=10kms	188	20	10.6 (6.6-14.6)		
>10kms-<=30kms	543	62	11.4 (8.7-14.6)	0.77	1.08 (0.63-1.85)*
>30kms	169	37	21.9 (15.9-27.9)	0.001	2.17 (1.39-3.41) **
				0.004	2.36 (1.31-4.25) ***
Overall total	**900**	**119**	**13.2 (11.0-15.4)**		

Pearson's Chi-square(X^2) (2) =13.709, p=0.001; * >10kms-<=30kms vs. <=10kms, ** >30kms vs. >10kms-<=30kms, *** >30kms vs. <=10kms.

5.1.3. Major risk factors

All the assumed risk factors such as age, sex, flock size, distance from the service centre were subjected to step wise multivariable logistic regression analysis to determine the major risk factors for the occurrence of the disease in the study area. From the analysis, it was noted that age group, and flock size and distance from veterinary service centre were found to be statistically significant major risk factors ($p<0.05$) responsible for the occurrence of the disease in the study area (Table 9).

Therefore, as there is no interaction among these factors they can be used to construct regression model to predict the occurrence of the disease. The multivariate logistic regression analysis on the three variables indicate the odds ration of 2.18 (95% CI=1.64-2.91), 1.59 (95% CI=1.11-2.29) and 1.43 (95% CI=1.03-1.98) in age groups, flock size groups and distance from the veterinary service centre, respectively. The regression coefficients for the identified major risk factors were 0.781, 0.466 and 0.355 for age groups, flock size groups and distance from veterinary service centre, respectively. Hence the regression model for the occurrence of CCPP in the study area based on the major risk factors identified would be Log (p) = 0.781 Age + 0.466 Flock size + 0.355 Distance from veterinary service centre - 4.973.

Table 9. Multivariate logistic regression analysis for the major risk factors

Variables	Coefficient of regression (B)	p value	OR (95% CI)
Age	0.781	0.000	2.18 (1.64-2.91)
Flock size	0.466	0.011	1.59 (1.11-2.29)
Distance	0.355	0.034	1.43 (1.03-1.98)
Constant	-4.973	0.000	0.007

5.2. Questionnaire survey

5.2.1. Comparative importance of goats

The questionnaire survey collected from 69 households indicated that the ability of goats to resist drought (73.9%), its high market preference (66.7%) and its preference for meat use (58%) were identified to be the major comparative importance of goats compared to cattle and sheep (Figure 2).

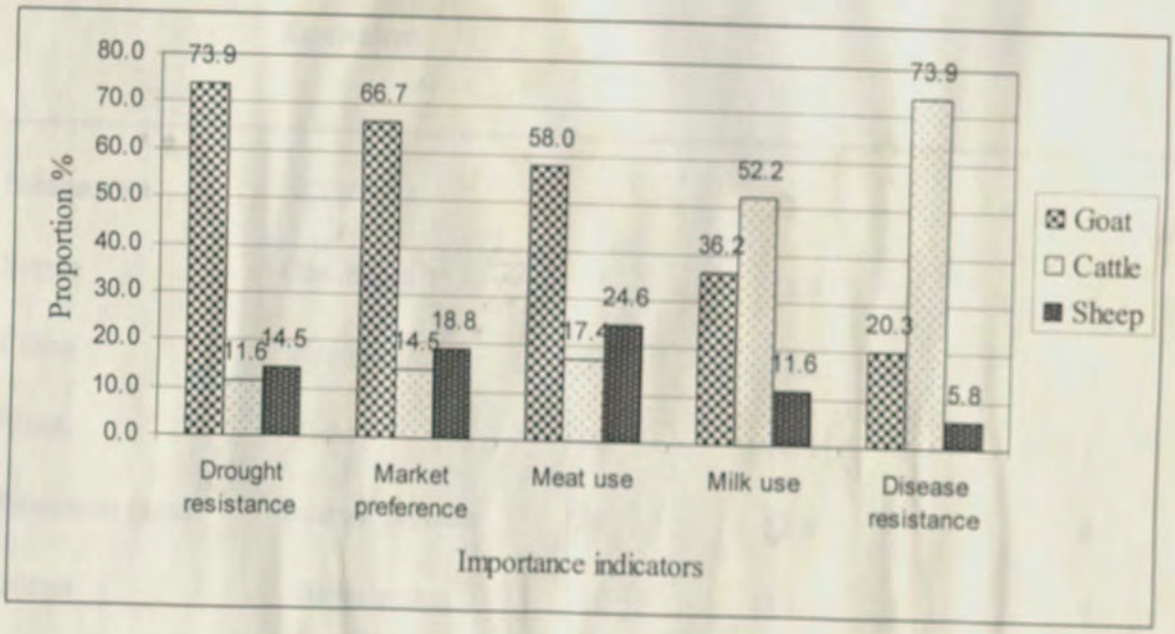


Figure 2. Comparative importance of goats in Borana and Guji lowlands (n=69)

5.2.2. Major goat diseases in the study area

A total of 10 major goat diseases were complained by the community as major goat health problems in the study area. Among these major diseases, CCPP locally known as "Sombessaa" ranked first with relative proportion of (22%) followed by coenurus cerebralis locally known as

"Sirgoo" (18.9%). Similarly, the survey showed that, mange mite infestation (18.2%), internal parasites (12.8%) and tick infestation (10.8%) ranked from third to fifth (Table 10).

Table 10. Summery of major goat diseases recorded in the study area (n=69)

Local name	Veterinary Equivalent	Frequency	Proportion	Rank
Sombeessaa	CCPP	65	22	1
Sirgoo	Coenurosis	56	18.9	2
Cittoo	Mange mite	54	18.2	3
Silmii	Ticks	32	10.8	5
Raammoo garaa	Internal parasite	38	12.8	4
Biirtee	Babesiosis	10	3.4	7
Cirmalee	Anthrax	4	1.4	10
Oyyalee	FMD	6	2	9
Okkolchiisaa	Fotrot	7	2.4	8
Mararebbaa	PPR	13	4.4	6

5.2.3. Major factors for the occurrence and spread of CCPP

As depicted in Figure 3, contact at watering point, restocking, lack of veterinary service, contact at marketing points, large flock size and contact at grazing were identified as the major factors responsible for the occurrence and spread of the disease in the area. Accordingly, contact of goats at watering (24%), restocking (19%) and lack of veterinary service in the area (18%) were identified to be the first three most important factors for the spread and occurrence of CCPP disease in the area in descending order.

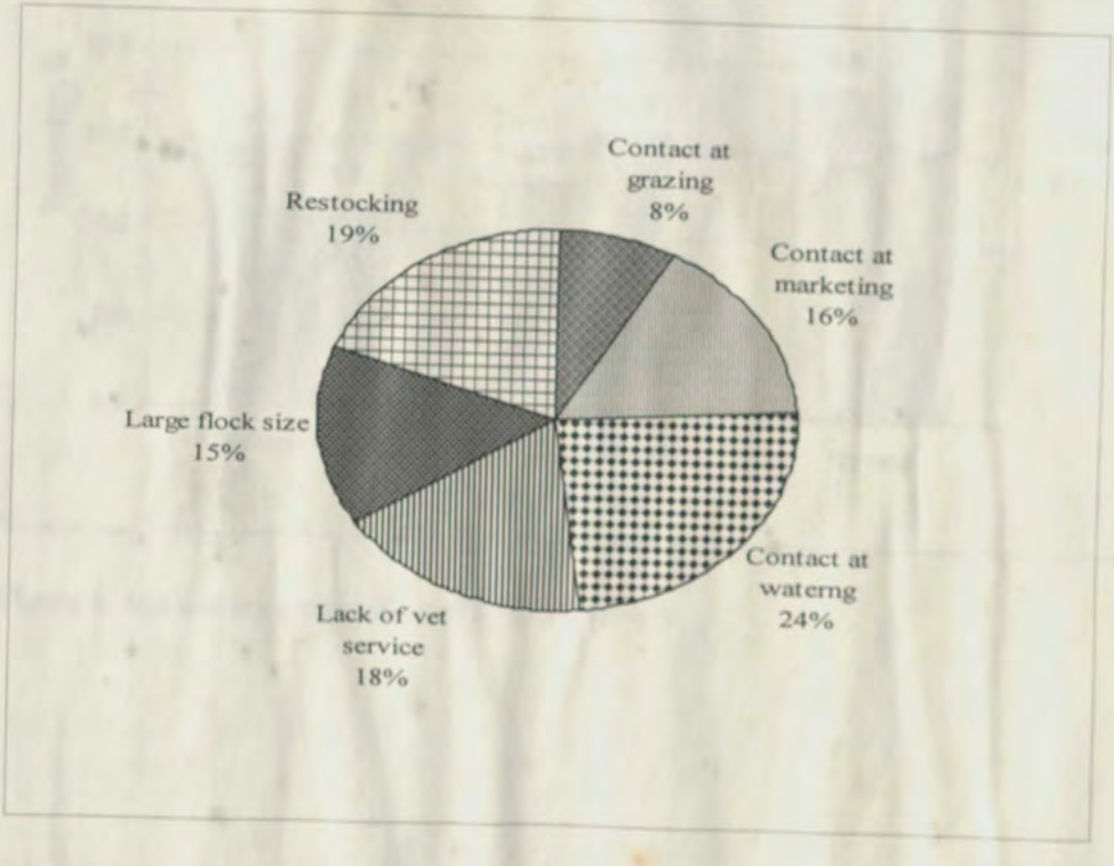


Figure 3. Factors responsible for the occurrence and spread of CCPP (n=69)

5.2.4. Age and sex groups affected by CCPP

As depicted in Figure 4, the questionnaire survey indicated that both sexes are equally affected with minor differences. However, it was shown that the disease affects older age groups as compared to the young groups.

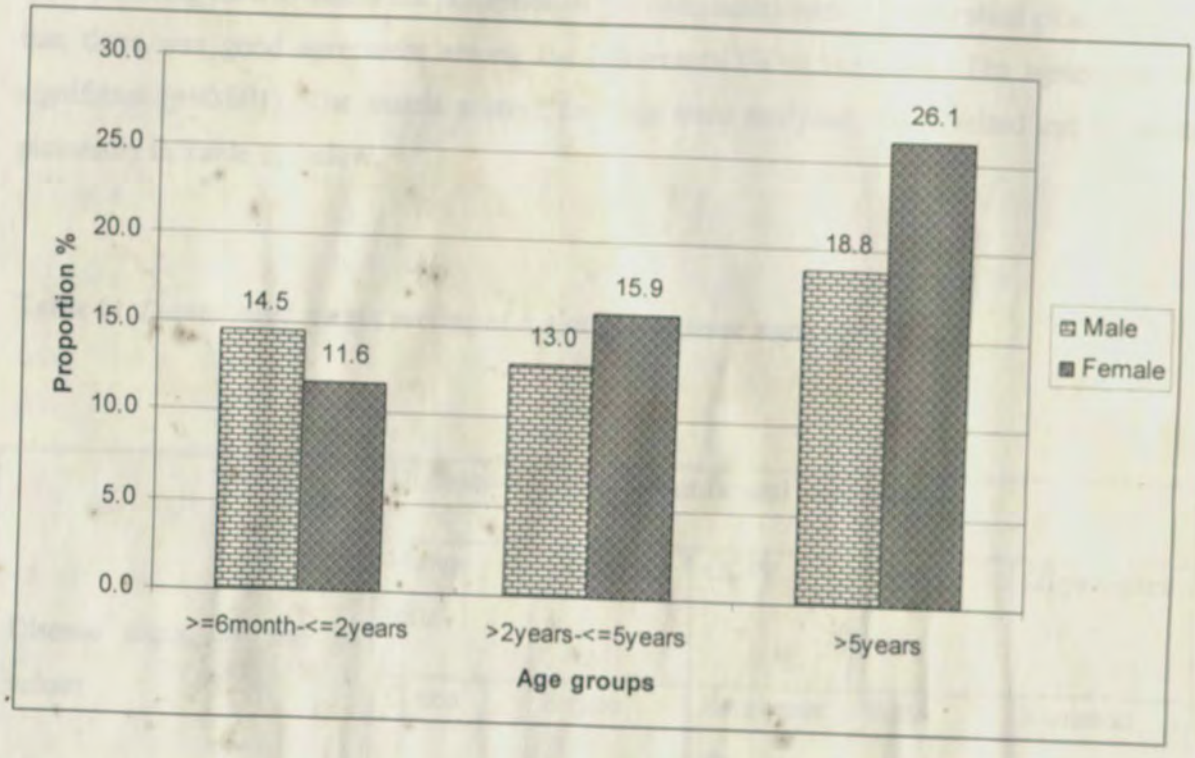


Figure 4. Age and sex groups affected by CCPP (n=69)

5.3. Participatory Disease Appraisal

5.3.1. Matrix scoring

Matrix scoring used to assess the perception of the community with 12 informant groups showed that there was good agreement among the informants (W=0.546-1.00). The agreement was significant ($p<0.001$). The matrix scoring findings were analyzed, summarized and presented pictorially in Table 11 below.

Table 11. Summarized matrix scoring of major goat disease signs (n=12)

Disease signs, W and p-values	Diseases with their scientific and local names				
	Mange mite	Coenurosis	CCPP	Ticks	GI parasites
	Cittoo	Sirgoo	Sombeessaa	Silmii	Rammoo garaa
High morbidity, W=0.786*	5.5(4-7)	3(2-4)	9(7-12)	3(2-5)	5(2-7)
Circular movement, W=1.00*	0(0-0)	25(25-25)	0(0-0)	0(0-0)	0(0-0)
Coughing and nasal discharge, W=1.00*	0(0-0)	0(0-0)	25(25-25)	0(0-0)	0(0-0)
High mortality, W=0.773*	3.5(2-6)	5(3-6)	11(10-15)	2(1-4)	3(2-6)
Has drugs, W=0.846*	6(4-7)	0(0-0)	3(2-5)	8.5(4-12)	7(5-15)

Disease signs, W and p-values	Diseases with their scientific and local names				
	Mange mite	Coenurosis	CCPP	Ticks	GI parasites)
	Cittoo	Sirgoo	Sombeessaa	Silmii	Rammoo garaa
Loss of weight, W=0.898*	8.7(7-11)	2(0-5)	3(0-4)	5(4-7)	6(5-9)
Diarrhea, W=0.880*	0(0-2)	0(0-0)	0(0-1)	0(0-7)	25(22-25)
Skin damage, W=0.960*	15(12-19)	0(0-0)	0(0-0)	8.5(6-10)	0(0-4)
Loss of milk yield, W=0.824*	11.5(10-14)	1.5(0-4)	2.5(1-4)	4.5(3-6)	4.5(3-6)
Chronic disease, W=0.922*	8.5(8-10)	3(1-5)	0(0-1)	8(5-8)	6(2-7)
Seasonal disease, W=0.918*	3.5(3-5)	0.5(0-2)	9(8-10)	5(4-6)	7(4-9)
Has vaccine, W=1.00*	0(0-0)	0(0-0)	25(25-25)	0(0-0)	0(0-0)
Affects both goat and sheep, W=0.546*	5(2-8)	6(3-11)	0(0-0)	6(4-9)	5.5(2-8)

W=Kendall's coefficient of concordance), * shows = good agreement among the informant groups at $p<0.001$. The median score is outside the parentheses. The minimum and maximum scores are shown in the parentheses.

5.3.2. Seasonal calendars

Seasonal calendar with the informant groups showed that there were good agreement among the informants (W= 0.912-0.981). The agreement among the informant groups was significant ($p<0.001$). However, in case of coenurosis, the agreement was weak ($W<0.26$) and statistically not significant ($p>0.05$). The matrix scoring findings were analyzed, summarized and presented pictorially in Table 12 below.

Table 12. Summarized seasonal calendar of major goat diseases (n=12)

Indicators, W and p values	Scientific and local Borana and Guji seasons			
	Long rainy season	Cool dry season	Short rainy season	Long dry season
	Ganna	Adoolessa	Hagayya	Bona
	Months in Gregorian calendar			
	March – May	June-August	September-November	December-February
Mean seasonal rain fall(mm)	175.5mm	21.4mm	82.7mm	11.6mm
Rain fall , W=0.946*	17(15-19)	2(0-3)	10(8-13)	1(0-3)
Mange mite infestation, W=0.964*	1(0-4)	14.5(9-20)	4.5(3-7)	10(6-13)
Coenuruses , W=0.013**	8(5-9)	8(7-12)	8(5-8)	7(5-10)

Indicators, W and p values	Scientific and local Borana and Guji seasons			
	Long rainy season	Cool dry season	Short rainy season	Long dry season
	Ganna	Adoolessa	Hagayya	Bona
	Months in Gregorian calendar			
	March – May	June-August	September-November	December-February
CCPP , W=0.910*	3(0-6)	9(6-12)	4(2-7)	12(10-17)
Tick infestation, W=0.981*	16.5(10-20)	8(0-4)	3.5(2-8)	2(0-5)
Internal parasite, W=0.912*	14.5(10-20)	4.5(1-6)	8(6-10)	3(0-7)
Livestock movement ,W=0.968*	1(0-4)	8(5-12)	6(2-8)	14(10-23)
Fly infestation ,W=0.912*	13(10-18)	6.5(4-9)	8(5-9)	2.5(0-6)

W=Kendall's coefficient of concordance), * shows= good agreement among the informant groups at $p<0.001$, ** shows= weak agreement among the informant groups at $p>0.05$.The median scores written outside of the parentheses. The minimum and maximum scores are shown in the parentheses.

5.3.3. Triangulation of the perception of the informant groups

The knowledge of the informant groups involved in participatory CCPP appraisal were triangulated by clinical and serological examinations on 9 cases, which the informant groups considered as clinical cases of the disease. The cases were clinically examined and blood samples were taken for further serological test. About 66.6% (6 out of 9) of the goats identified by the community as clinical cases of the disease were positive serologically. The summary of the clinical and serological finding were presented in Table 13.

Table 13 Summary of clinical and serological findings in participatory appraisal (n=8)

Description	Case number								
	1	2	3	4	5	6	7	8	9
Clinical examination									
Coughing	+	-	-	+	+	+	+	-	+
Nasal discharge	+	+	+	-	-	+	+	+	-
Poor body condition	+	+	+	-	+	+	+	-	-
Diarrhea	-	+	+	+	+	+	-	+	+
Age in years	1	2	2	4	5	6	6	7	3
Sex	M	M	F	M	F	M	M	F	F
Rectal temperature in ^{0}C	39.5	39	40	39.5	41	39.5	40	40.5	41
Respiration(Breaths/minute	45	38	50	40	52	54	42	50	51

Descriptions	Case number								
	1	2	3	4	5	6	7	8	9
Serum sample									
C F T result	+	-	+	-	+	+	-	+	+

+= Positive. - =Negative

6. DISCUSSION

6.1. Seroprevalence

6.1.1. Overall seroprevalence

The overall seroprevalence of CCPP in the study areas was 13.2% (CI=11.0%-15.5%). The finding in the present study is about similar to the work of Solomon, (2006) who reported seroprevalence of 16.5% in South Omo and Arbaminch areas. However, the finding in the present study was higher than that of Beyene, (2003) and lower than that of Gezahegn, (2006) who reported 6% and 29.08% seroprevalence respectively. Moreover, Gelagay *et al.*, (2007), have also reported prevalence of 20.12% from selected districts of Borana pastoral areas. Sharew *et al.*, (2005), have reported a seroprevalence of 52%-100% in acute outbreak areas using serological tests such as CFT and B-ELISA. The wide variation in the seroprevalence could be attributed to a number of reasons. For instance some studies focus on disease outbreak investigation findings (Gelagay *et al.*, 2007), while other works dealt with evaluating the sensitivity and specificity of different serological assays and relative advantage (Sharew *et al.*, 2005) and still others have different sampling technique and sample size as compared to the present study (Beyene, 2003; Gezahegn, 2006).

The seroprevalence difference among the districts was significant ($p<0.05$). Particularly, the seroprevalence observed in Liban was significantly different ($p<0.05$) from that of Moyale District. Secondary data collected from respective districts showed that Liban District has high intensity of flock movement due to marketing and moist climatic condition which might have contributed to the highest prevalence recorded in this district.

Considering infected flock as a flock which has at least one positive animal to *Mccp* infection, an over all flock level prevalence of 53% (95% CI=44%-62%) was recorded in the study areas. Higher flock level seroprevalence was recorded in Liban district; although, the difference among the districts was not statistically significant. However, Solomon (2006) has reported flock level seroprevalence of 93.15% which is higher than the result obtained in this study. The difference in flock level seroprevalence could be attributed to the difference in husbandry and management practices among the different flocks in the districts. Moreover, the difference in the awareness of the flock owners to take necessary measures against the disease could be an important factor in causing this difference. Some of the methods practiced in the study area against CCPP were antibiotic treatment, isolation and application of herbal medicines.

As sheep were kept and reared with goats, they were included in the sample just to evaluate if they could be affected by CCPP. The prevalence found in sheep was 5.9%. Similarly, Gelagay *et al.*, (2007) has reported a seroprevalence of 7.14% in sheep. On the other hand, Solomon, (2005) and Gezahegn, (2006) have reported higher prevalence of 55% and 20% in sheep respectively. The recorded small seroprevalence in this study may be attributed to the sample size. Previously, bacteriological and serological studies on sheep have indicated the presence of sub clinical infection and have been shown to harbor *Mccp* in the lung and the nares (Litamoie *et al.*, 1990). In Ethiopia, sheep were found to be resistant to clinical CCPP. The isolation of *Mccp*; however, proves the role of sheep as a reservoir of infection (Laikemariam *et al.*, 2004). However, the pathogencity of the isolate to goats and the role of sheep in the epidemiology of CCPP are not yet determined (Mekonen, 1996). The seroconversion in sheep could be due to the possibility of horizontal transmission of the infection to sheep.

6.1.2. Seroprevalence by assumed risk factors

Higher seroprevalence was recorded in females than males in this study. However, the difference observed was not significant. Other studies have also shown that significant difference in seroprevalence between female and male was not observed (Dawit, 1996; Teshome, 1997;

Beyene, 2003; Solomon, 2005). This can be explained by the fact that CCPP is highly contagious and fatal to susceptible goats of both sexes (Aiello, and Mays, 1998; OIE, 2004).

The difference in seroprevalence in the age categories was found to be significant. It was observed that the prevalence of the diseased as animals gets older. The observation of the community as shown in the questionnaire survey also agrees with the result of the serological findings in such a way that the occurrence of the disease increases with increasing age with a proportion of 26.61%, 28.90% and 44.9% for young (<=2years), adult (>2years-<=5years) and old age (>5years) categories, respectively.

The findings of this study agrees with the works of Solomon, (2006) and Daniel, (2006), but contradicts with the reports of Dawit, (1996), Teshome, (1997) and Gezahegn, (2006) who observed the presence of significant variation among age groups. However, different authors have indicated that as the goats get older; they are more susceptible to diseases than young once (Mike, 1996). More over, from the questionnaire survey it was observed that, as age increases, they are often frequently exposed to different stress conditions which make them more susceptible to infection increases. Moreover, they also tend to be infected repeatedly. Therefore, the probability to be seropositive in older ages for CCPP would be high as compared to young and adult goats.

The large flocks were found to be more affected with the disease than the medium and smaller flocks. The difference in seroprevalence among the various flock sizes categories was significant ($p<0.05$). Similar findings were reported by Solomon, (200) and Gezahegn, (2006). The questionnaire survey also identified that large flock size was a factors in the spread and occurrence of the disease. This may be explained by the fact that the infection needs proximity to source of infection and increasing number of susceptible population (Lef'evre *et al*., 1987). The aggregation of goat flocks during watering, grazing and rest times would favor the spread of the infection within the flock.

In pastoral areas, the users of the static clinical service and veterinary extension system are mostly those communities residing within the distance of 10kms to 15kms from veterinary service centers. Therefore, most areas beyond this radius do not have access to the service. Therefore, the extension of veterinary service to such and inaccessible corners is very limited (MoARD, 2003). In this study the seroprevalence observed among the distance categories was significant and the prevalence of CCPP was higher in distant communities. Previous study by Teshale, (1999) in the area, has indicated that an impact of insufficient veterinary service in mobile livestock production system increases the spread of diseases. The higher seroprevalence of CCPP recorded in areas more than 30kms way from veterinary service centre may be due to the inaccessibility of such areas to veterinary services. Particularly, the vaccination, treatment and extension services targeted to CCPP were observed to be mainly restricted to around veterinary service centers and not accessible to remote areas of the lowland. Hence, being far way from veterinary service centre, as in this case >30kms away, could contribute to the high spread and occurrence of CCPP.

6.1.3. Major risk factors

In this study it was observed that age, flock size and distance from veterinary service centre were the major risk factors which could be responsible for the occurrence of the disease. This could be explained by the fact that as goats get older, they are more susceptible to different stress conditions and repeated exposure to the infection than their young and adult counter parts. Inaccessibility to veterinary service due to further location from the service centre leads to insufficient animal health service which could in turn contribute to increase in occurrence of the disease. On the other hand, the association of the disease with flock size may be attributable to the fact that large flock could have large number of susceptible animals. Therefore, once the infection is introduced to the flock, then it would circulate in that specific flock by infecting many goats which could lead to higher seroprevalence.

6.2. Questionnaire survey

Goats have ability to do well in drier tropics and fragile environment as compared to cattle and sheep (Mike, 1996). The comparative importance of goats as compared to the other ruminants in the area has shown that goats are relatively more drought tolerant. This observation is similar to the observation by Coppock, (1994) who has reported that goats and sheep are less affected by drought as compared to cattle. According to CSA, (2003), about 75% of goat population in the country is found in the lowland areas. These areas are the resource base of small ruminant for export market. The author has observed that the demand for small ruminants, especially goats for export market has been well known among the pastoral communities. Hence, goats have high market preference as they are immediately marketable commodities as compared to sheep and cattle. Similar findings were reported by Peacock, (1996) which indicated that goats are easily marketable for immediate needs. Moreover, Workneh and Rowlands, (2004) have reported that pastoralists preference to sell small ruminants to cattle. In most of the cases, the communities in the study area do not usually sell cattle; rather they keep them as a source of milk for the household.

Major diseases of goats in the area were identified by the communities interviewed. It has been shown that CCPP ranked first among other goats diseases in the area. It was indicated that the disease was known in the area since 15 to 20 years ago. All of the interviewed households have experienced the disease at least once for the last one year. Their knowledge about the disease was reflected by the fact that they were able to describe the clinical and post mortem signs of the disease. It was also shown that coenurus cerebralis ranked second next to CCPP. The author observed that almost all household interviewed had one to two dogs, which were considered to be the source of the infection. The majority of the households; however, do not know that coenurus cerebralis locally known as "Sirgoo" circulates between dogs and goat/sheep. The observation on the major goat diseases in this study was similar with the reports by Workneh and Rowland, (2004) and MoARD, (2003). Similarly, Coppock, (1994) has shown that CCPP was the pervasive disease of goats in Borana Plateau. The occurrence and spread of CCPP in the area was shown to be related mainly to contact at watering (24%), followed by restocking (19%), lack of veterinary

service (18%) and large flock size (15%). It was explained that, many goats from the neighboring villages and pastoralist associations congregate at watering points especially during dry seasons. This congregation has favored the spread and occurrence of the disease. On the other hand, the area has been known to be affected by recurrent drought which led to loss of many livestock species. Restocking activity has been carried out since long by different NGOs and other institutions in an effort to rehabilitate affected households. In such circumstances, the health status of the goats, especially for CCPP was not checked. Hence, such activity was incriminated to be the factor for the spread of the disease in the lowlands. The area was found to be inaccessible to veterinary services and the mechanism to control and prevent the spread and occurrence of the disease were not in place. Questionnaire survey indicated that to compensate for the lack of veterinary service in the study areas, the pastoralists have been using human tetracycline antibiotic locally known as "Kaapsuusii" to treat cases of CCPP. It was observed that about 92% of the interviewed households treat cases of CCPP by their own. A similar situation was observed by Gezahegn, (2006) in Afar pastoralist areas.

6.3. Participatory appraisal

Participatory appraisal methods have been used by veterinarians in Africa since late 1980s and examples of field research includes the use of matrix scoring to characterize cattle diseases in Southern Sudan and seasonal calendars to depict seasonal variations in disease incidence and vector population (Catley *et al.*, 2004).

The participatory matrix scoring method has shown that there are many diseases affecting goat population in Borana and Guji lowlands and the pastoralists were able to describe, identify and prioritize those diseases. In this study, the pastoralists have identified CCPP as the major goat health problem. The clinical signs of CCPP such as high morbidity, high mortality, coughing and nasal discharge, abortion, availability of vaccine for the disease and others described by the informant groups were almost similar to the text book descriptions of the disease (Seifert, 1996; Radostitis *et al.*, 2000). Similarly, the descriptions of the other major goat diseases in the area

such as coenurus cerebralis, mange mite, ticks and internal parasites were similar to the text book descriptions of these diseases. Similar observations were reported by Solomon, (2006) from South Omo.

The seasonal calendar has identified the season of the year when the incidence of CCPP is high. It is shown that the disease can occur at any season of the year; however, the incidence of the disease were found to be high during the cool dry season locally known as "Adoolessaa" and during long dry season locally known as "Bona". It was explained that the cold climate during the cool dry season and the frequent meeting at watering point and shortage of feed during the long dry season, were the major contributing factors for the high incidence of the disease during these seasons. The seasonal calendar description for other diseases is also found to be similar to the text book descriptions.

In both seasonal calendar and matrix scoring methods, it was indicated that the scoring has achieved high level of group agreement among the informants. They appear to enjoy the problem solving aspect of the scoring such as how many stones to use for each disease and relating scores for different diseases to each other. During the scoring, the informants were seen to carefully count the stones allocated to each indicator. The scoring has showed that the community can prioritize goat disease and score factors which they consider to be of relevant when distinguishing between the diseases. Similar observations were reported by Solomon, (2005) and Gezahegn, (2006).

Although matrix scoring was considered to be a useful method, its use should be combined and triangulated with other methods. Basic veterinary investigation methods such as clinical and post mortem examinations are feasible in resource poor settings and when used can validate local diagnosis for some diseases (Catley *et al*., 2002). In this study, the knowledge of the communities were triangulated with clinical and laboratory examinations. Accordingly, in this study it has been observed that of cases identified by the communities as cases of CCPP 66.6% were found to

be serologically positive using CFT. Hence, the serological finding has indicated the validity and the potential importance of the knowledge of the pastoral community in the diagnosis and surveillance of CCPP.

7. CONCLUSIONS AND RECOMMENDATIONS

The serological findings, questionnaire survey and the participatory disease appraisal agreed and they showed that contagious caprine pleuropneumonia was one of the major goat health problems in Borana and Guji lowlands.

Despite the absence of outbreaks of CCPP in the study areas during the study period, the findings in the serological study have indicated that the disease is endemic, exists in the sub clinical level and has wide occurrence and distribution.

Moreover, the seroconversion in sheep observed in this study indicates that this species could be a potential source of infection for CCPP.

In this study, it was identified that age, flock size and distance from the vet service centre have contributed to the occurrence and distribution of the disease. These variables are responsible for predicting, the disease outcomes and hence to be included in the final model construction.

Questionnaire survey and participatory appraisal have indicated that CCPP, coenuruses, mange mite and internal parasite were the major causes of morbidity and mortality of goats in the study area. The survey also showed that contact at watering points, grazing points, restocking, lack of veterinary service and large flock size are the factors responsible for the spread and occurrence of the disease.

Participatory appraisal of goat diseases showed that the community has good knowledge about CCPP and other goat diseases.

Based on the findings of this study the following recommendations were made:

- Contagious caprine pleuropneumonia was found to be one of the most economically important diseases in Borana and Guji lowlands. Therefore, control measures focusing on routine vaccination programs have to be implemented in the study areas.

- The pastoral communities which are found at far distance from vet service centers should have access to veterinary service through veterinary infrastructure development and community based animal health service so that they get immediate service near their vicinity.

- The identified major risk factors need to be further studied to be included in the disease prevention and control scheme.

- The role of sheep in the epidemiology of CCPP has to be further studied. Moreover, sheep has to be included in the CCPP control and prevention programs.

- The participatory disease appraisal is shown to be a useful tool in the investigation of CCPP in the study area. Therefore, it could be used in complementarily with modern ways of disease investigation in pastoral production system.

8. REFERENCES

Aiello, E. and Mays, A. (1998): The Merck Veterinary Manual. 8th Edition, MERCK & Co. INC., New Jersey, Pp 1109-1110.

Bascunana, C. R., Mattasson, J. G., Bolske, G. and Johansson, K. E. (1994): Characterization of the 16S rRNA genes for *Mycoplasma species strain* F-38 and development of an identification system based on the polymerase chain reaction. *Journal of Bacteriology*, **176**: 2577-2586.

Bereket, Z. (1995): Contagious Caprine Pleuropneumonia: Prevalence in Konso, Southern Ethiopia. Study on the Effects of Antibiotic Treatment. DVM Thesis, AAU, FVM, Debre Zeit, Ethiopia.

Bertil, P., Bolske, G., Thiaucourt, F., Uhlen, M. and Johansson, K. (1998): Molecular evolution of *Mycoplasma capricolum subsp. capripneumoniae* strains, based on polymorphism in the 16S rRNA genes. *Journal of Bacteriology*, **180**: 2350-2358.

Beyene, N. (2003): Epidemiology and Serosurveillance of Contagious Caprine Pleuropneumonia in Dire Dawa Administrative Region. DVM Thesis, AAU, FVM, Debre Zeit, Ethiopia.

Bolske, G., Mattson, J. G., Bascunana, C. R., Bergstrom, K., Wesonga, H., Johansson, K. E. (1996): Diagnosis of contagious caprine pleuropneumonia by detection and identification of *Mycoplasma capricolum subsp. capripneumoniae* by PCR and restriction enzyme analysis. *Journal of Clinical Microbiology*, **34**: 785-791.

Cately, A. (2005): Participatory Epidemiology: A Guide for Trainers, African Union Inter African Bureau for Animal Resources, Nairobi, Pp 1-42.

Cately, A., Chibunda, R. T., Ranger, E., Makungu, S., Magayana, F. T., Magoma, G., Madege, M. J., Vosloo, W. (2004): Participatory diagnosis of a heat tolerance syndrome in cattle in Tanzania and association with Foot and Mouth Disease. *Preventive Veterinary Medicine*, **65**: 17-30.

Cately, A., Blackways, S. and Leland, T. (2002): Community Based Animal Health Care; A Practical Guide to Improving Primary Veterinary Services. 1st Edition, ITDG, London, Pp 23-34.

Coppock, D. L. (1994): The Borana Plateau of Southern Ethiopia: Synthesis of Pastoral Research, Development and Change. Synthesis study No 5. Addis Ababa, Ethiopia, International Livestock Centre for Africa, Pp 1980-1991.

CSA (2003): Statistical Report on Livestock and Farm Implements. In: Federal Democratic Republic of Ethiopia, Central Agricultural Census commission, Ethiopian Agricultural Sample Enumeration, 2001/2002, Addis Ababa, Ethiopia.

Daniel, G. (2006): Serological, Pathological and Bacteriological Investigation of *Mycoplasma* Infection in Goats Slaughtered at Elfora Export Abattoir, Debre Zeit. MSc Thesis, AAU, FVM, Debre Zeit, Ethiopia.

Dawit, K. (1996): Serological and Microbiological Studies on Major Respiratory Mycoplasmosis of Goats in Yabelo. DVM Thesis, AAU, FVM, Debre Zeit, Ethiopia.

Desta, S. (2000): Pastoralism and natural resource management: the case of pastoral Borana in Southern Ethiopia. In: Proceedings of the Ethiopian Society of Animal production, August, 2000, Addis Ababa, Ethiopia, Pp 17-25.

Gelagay, A., Teshale, S., Amsalu, W. and Esayas, G. (2007): Prevalence of contagious caprine pleuropneumonia in the Borana pastoral areas of Ethiopia. *Small Ruminant Research* **70**: 131-135.

Gezahegn, E. (2006): Serological and Participatory Epidemiological Survey of Contagious Caprine Pleuropneumonia in Afar Pastoral areas of North East Ethiopia. MSc Thesis, AAU, FVM, Debre Zeit, Ethiopia.

Heldtander, M., Wesonga, H., Bolske, G., Pettersson, B., Johansson, K. E. (2001): Genetic diversity and evolution of *Mycoplasma capricolum subsp. capripneumoniae* strain from Eastern Africa assessed by 16S rRNA sequence analysis. *Veterinary Microbiology*, **78**:13-28.

Houshaymi, B., Tekleghiorghis, T., Worth, D. R., Miles, R. J., Nicholas, R. A. J. (2002): Studies on strains of *Mycoplasma capricolum subsp .capripneumoniae* isolated from outbreaks of contagious caprine pleuropneumonia in Eritrea. *Small Ruminant Research*, **45**: 139-140.

Johnson, E. H., Muirhead, D. E., King, and G. J. (2002): Ultra structural changes in caprine lungs infected with *Mycoplasma capricolum subsp. capripneumoniae*. *Journal of Veterinary Medicine*, **49**: 206-208.

Kokotonic, B., Bolske, G., Aherns, P., Johansson, K. E. (2000): Genomic variations of *Mycoplasma capricolum subsp. capripneumoniae* detected by amplified fragment length polymorphism (analysis). Federation of European Microbiological Societies. *Microbiology Letters*, **184**: 63-68.

Laikemeriam, Y., Selam, T., Gelagay, A., Roger, F. (2004): Respiratory Mycoplasmosis of small ruminants in Ethiopia. *Ethiopian Veterinary Journal*, **8**: 67-74.

Litamoi, J. K., Wanyangu, S. W. and Sima, P. X. (1990): Isolation of *Mycoplasma* F-38 from sheep in Kenya. *Tropical Animal Health and Production*, **8**: 91-95.

Lefevre, P. C., Bread, A., Farouk, I. and Buron, S. (1987): *Mycoplasma* species F-38 isolated in Chad. *Veterinary Record*, **121**: 575-576.

Lorenzon, S., Wesonga, H., Yegezu, L., Tekleghihorgis, T., Maikono, Y., Angreya, M., Hendri, K. X, P., Thiaucourt, F. (2002): Genetic evolution of *Mycoplasma capricolum subsp. capripneumoniae* strain and molecular epidemiology of contagious caprine pleuropneumonia by sequencing of locus H_2. *Veterinary Microbiology*, **85**:111-123.

March, J. B., Gammack, C., Nicholas, R. (2002): Rapid detection of contagious caprine pleuropneumonia using *Mycoplasma capricolum subsp. capripneumoniae* capsular polysaccharides specific antigen detection latex agglutination test. *Journal of Clinical Microbiology*, **38**: 4192.

Mekonen, L. (1996): Contagious Caprine Pleuropneumonia: Study on Economic Significance and Vaccine Trial. DVM Thesis, AAU, FVM, Debre Zeit, Ethiopia.

Mike, S. (1996): Goats: In the Tropical Agriculturalist. 1st Edition, Macmillan, Malaysia, Pp 1-152.

MoARD (2007): Monthly disease outbreak report: In: National Animal Health Department Reports: Addis Ababa, Ethiopia.

MoARD (2003): Pastoral Areas Development Study (PADS). Animal Health Thematic Report Number 4, Rome and Addis Ababa, Pp 1-114.

Nicholas, R. A. J. (2000): Improvement in the diagnosis and control of disease of small ruminant caused by *Mycoplsama*. *Small Ruminant Research*, **45:** 145-149.

Nicholas, R. A. J. (2002): Contagious caprine pleuropneumonia. In: Recent Advances in Goat Disease. International Veterinary Information Service. UK. Ithaca. NY. (www.ivis.org),2002, A0907-0802.

OIE (2004): Contagious Caprine Pleuropneumonia. Manual of Diagnostic Tests and Vaccine for Terrestrial Animals, Web: http//www.oie.int/eng/norms/manual/A-00072htm.

OIE (2000): Contagious Caprine Pleuropneumonia. In: Office International des Epizooties (OIE). Manual of Diagnostic Tests and Vaccine for Terrestrial Animals. 3rd Edition, OIE, Paris, Pp 503-513.

Peacock, Z. (1996): Improving goat production in the tropics. A Manual for Development Workers. Oxfam and Farm Africa, UK and Ireland, Pp 1-37.

Palling, R. W. J., MacOwn, K. J., Karstax, L. (1978): The prevalence of antibodies to CCPP (M. strain F-38) in some wild herbivores and camels in Kenya. *Journal of wildlife disease*, **14**: 305-308.

Quinn, P. J., Carter, M. E., Markey, B., Carter, G. R. (1994): Mollicutes. In: Clinical Veterinary Microbiology. Wolfe publishing year book, Europe Limited, Spain, Pp 320-326.

Radostitis, O. M., Blood, D. C. and Gay, C. C. (2000): Diseases caused by *Mycoplasma*. In: Veterinary Medicine. Text Book of the Disease of Cattle, Sheep, Pigs, Goats and Horses. 9th Edition, Harcourt, China, Pp 1004-1005.

Roger, F and Bereket, Z. (1996): Contagious caprine pleuropneumonia in Ethiopia: Laboratory investigation, station and field studies, (1994-1995). Preliminary report, CIRAD-EMVT, Pp 191-198.

Seifert, H. S. H. (1996): Contagious Caprine Pleuropneumonia. In: Tropical Animal Health. 2nd Edition, Kluwer Academic Publisher, Dordrecht, Pp 339-341.

Seigel, S. and Castellan, N. J. (1994): Non- parametric Statistics for Behavioral Sciences. 2nd Editions, McGrew-Hill, New York, Pp 1-399.

Sharew, A. D., Staak, C., Thiacourt, F., and Roger, F. (2005): A Serological investigation into contagious caprine pleuropneumonia in Ethiopia. *Tropical Animal Health and Production*, **37**: 11-18.

Shiferaw, G., Tariku, S., Ayelet, G., Abebe, Z. (2005): Contagious caprine pleuropneumonia and *Mannheimia haemolytca* associated acute respiratory disease of goats and sheep in Afar region. *Revue Scientifique et Technique –office International des epizooties*, **25**: 1153-1163.

Solomon, M. (2005): Epidemiological Survey of Contagious Caprine Pleuropneumonia in South Omo and Gamo Gofa zones, Southern Ethiopia. MSc Thesis, AAU, FVM, Debre Zeit, Ethiopia.

SPSS (2000): Statistical Package for Social Sciences. Version 11.3, SPSS Inc, 1989-2002, USA.

Teshale, S. (1999): Ethno Veterinary Practice of the Borana Rangeland Pastoral System. DVM Thesis, AAU, FVM, Debre Zeit, Ethiopia.

Teshome, F. Y. (1997): Epidemiological Survey of Peste des Petits Ruminants (PPR) and Contagious Caprine Pleuropneumonia in Selected Areas of Ethiopia. DVM Thesis, AAU, FVM, Debre Zeit, Ethiopia.

Thiaucourt, F., Bread, A., Lefevre, P. C., Meberatu, G. Y. (1992): Contagious caprine pleuropneumonia in Ethiopia. *Veterinary Record*, **131**: 585.

Thiaucourt, F., Bolske, G., Leneguersh, B., Smith, D. and Wesonga, H. (1996): Diagnosis and control of contagious caprine pleuropneumonia. *Revue Scientifique et Techniques-Office International des epizooties*, **15**: 1415-1429.

Thiaucourt, F. and Bolske, G. (1996): Contagious caprine pleuropneumonia and other pulmonary *Mycoplasmoses* of sheep and goats. Revue *Scientifique et Technique-Office International des epizooties*, **15**: 1307-1414.

Thiaucourt, F., Lorenzon, S., David, A. and Bread, A. (2000): Phylogeny of the *Mycoplasma mycoides* cluster shown by sequencing of putative membrane protein gene. *Veterinary Microbiology*, **72**: 251-268.

Thrusfield, M. (2005): Veterinary Epidemiology. 3rd Edition, Blackwell, United Kingdom science Ltd, Pp 233.

Workneh, A. and Rowlands, J. (2004): Design, execution and analysis of the livestock breed survey in Oromia Regional State, Oromia Rural and Agricultural Development Bureau and ILRI, Nairobi, Kenya, Pp 260.

Wesonga, H. O., Litamoi, J. K., Kagumba, M., Wakhusama, E. (1993): Relationship between clinical signs and early lesions of contagious caprine pleuropneumonia caused by *Mycoplasma strain F38. Small Ruminant Research*, **10**: 45-54.

Wesonga, H. O., Linberg, R., Litamoi, J. K. and Bolske, G. (1998): Late lesions of experimental contagious caprine pleuropneumonia caused by *Mycoplasma capricolum subsp. capripneumoniae*. *Zentralbl Veterinamed*, **45**: 105-114.

Woubit, S., Lorenzon, S., Peyraud, A., Manso-Silvan, L., Thiaucourt, F. (2004): A specific PCR for the identification of *Mycoplasma capricolum subsp. capripneumoniae*, *Veterinary Microbiology*, **104**: 125-132.

9. ANNEXES

Annex 1. Questionnaire for seroprevalence study in Borana and Guji lowlands

I. Address and general information

1. Address: District----------PA----------Village----------

Date----------, Name of the owner----------sex-------age

Distance from vet service centre in kms -------- flock size----------

2. What is the comparative importance of keeping goat relative to cattle and sheep?

	Cattle	Goats	Sheep
• Disease resistance			
• Drought resistance			
• Market preference			
• Milk use			
• Meat use			

3. What are the top major goat diseases in the area?

---

4. What is the intensity of flock movement in your area?

High 2) Low

Why? ----------

5. What is the price of healthy goat in your area?

a. Male ------1) <=2yrs ; ---------- 2) >2- <=5yrs ; ---------- 3) >5yrs;----------

b. Female ------1) <=2yrs;--------- 2) >2- <=5yrs;---------- 3) >5yrs;----------

6. How do you judge your accessibility to animal health service?

   1. Accessible
   2. Moderately accessible
   3. Inaccessible

7. Where do you get veterinary service in your area?

   Public (1) CAHWs (2) Traditional (3) No services

II. Specific questions related to CCPP

1. Is CCPP present in your herd/neighboring herds during the last one year?

   Yes (1); No (2)

2. Describe the major clinical and post mortem signs of CCPP----------
   ----

3. Which age and sex groups are more affected by CCPP?

- Less than 2-year (young) (1) Female (2) Male
- Between 2-5 years (adult) (1) Female (2) Male
- Greater than 5 years (old) (1) Female (2) Male

4. What are the possible causes for the occurrence of CCPP in your area?

Contact at watering points (1) Contact at grazing points (2), Contact at marketing sites (3), lack of veterinary service (4), Large flock size (5), Restocking (6), Drought (7), Other (8), mention;---

5. What the measures do you take to combat the disease during the outbreak?

Vaccination (1), Treatment (2), Slaughter (3), Segregation (4), other----------

If you treat sick goats yourself, mention the type of drugs and dose you use----------

---

Annex 2. Record format

SN	District	PA	Owners name	Flock Number	Animal number	Age	Sex	Flock size	Distance from the veterinary clinic	CFT test result
1										
2										
3										

Annex 3. Summery of seroprevalence of CCPP by pastoralist associations

District	Pastoralist association	No of flocks tested	No of animals tested	No positive		Seroprevalence %	
				Flock	Individual animal	Flock level	Animal level
Teltale	Bule korma	8	35	3	5	32.5	14.2
	Kulcha	13	57	6	10	46	17.5
	Mekenisa	13	143	10	17	76.92	11.8
	Hado	5	65	2	3	40.07	4.6
Sub total		39	300	21	35	53.8	11.6
Moyale	Meleb	14	105	6	8	42.9	7.6
	Arbale	13	90	7	8	53.8	8.8
	Dambi	14	105	5	13	35.7	12.3
Sub total		41	300	18	29	43.9	9.6
Liban	Genale	4	46	4	14	100	30
	Bitata	6	46	4	9	66.6	19.5
	Boba	5	47	4	11	80	23.4
	Adadi	5	53	5	7	100	13.2
	Kobadi	7	64	4	11	57.1	17
	Deka kala	10	46	3	3	30	6.5
Sub total		37	300	23	55	62.2	18.3
Over all total		117	900	62	119	53	13.2

Annex 4. Complement Fixation Test

The Office Internationale des Epizootics (OIE) standard test procedure was followed for the test (OIE, 2000)

Materials

Test sera, U-bottom micro plates, multi channel micropipette, pipette tips, Guinea pigs complement, complement diluents, *Mccp* antigen, Veronal buffer solution in Calcium and Magnesium at PH 7.2, Water bath, Incubator with agitator, Alsever's solution, male sheep red blood cells, Amboceptor (rabbit anti sheep red blood cells), trough, syringe, Arranged test sera, positive control, negative control, distilled water, sheet of plate layout for record, flasks.

Complement Fixation Test proper

1. The test sera including the positive and negative controls were decomplemented in hot water bath at 60^0c for 30 minutes.

2. 45 µl VCM was dispensed to columns number 1, 5 and 9. But 25 µl of VCM was dispensed in the other wells.

3. 5 µl test sera were added to column number 1, 5 and 9 giving dilution of 1:10.

4. 25 µl of the diluted sera was serially transferred from column 1 to 4, column 5 to 8 and from column 9 to 12.

5. 25 µl of antigen at working dilution were dispensed to each well, except in the column number 4, 8 and 11, which were used to check for anti complementary activity of the serum.

6. The plates were incubated in the incubator with agitator at 37^0c for 30minutes.

7. 25 µl of complement at working dilution (1:1000) were added to each well.

8. The plates were incubated at 37^0c for 30minutes under continuous agitation.

9. 25 µl of the hemolytic system was dispensed into each well.

10. The plates were sealed to avoid evaporation and incubated at 37^0c for 30minutes under constant agitation.

11. The positive and negative controls were diluted; complement and hemolytic systems were added on other plate. Following same procedure mentioned above. Similarly, complement and hemolytic system controls were prepared accordingly.

12. Before reading, the plates were left in the refrigerator at $+4^0$c for some time in order to allow non- lysed cells to settle.

13. The plates were examined for sedimentation and hemolysis.

Interpretation:

Sedimentation of the SRBC indicates positive results and hemolysis indicate negative results. The results were ranked according to the extent of SRBC sedimentation. Accordingly, hemolysis (-), weak (+), moderate (++), and strong (+++). When the sedimentation in test sera and control sera of anticomplemetary (without *Mccp* antigen) were equal, the test serum was taken as negative.

Annex 5. Preparation of sheep red blood cells (SRBC)

1. Using a syringe, 75 ml of male sheep blood was drawn from a jugular vein into 125ml Alsever's solution
2. The blood was kept at $+4^0$C until used.
3. A day old sheep blood was used for the test

Annex 6. Preparation of hemolytic system

1. The sheep blood was washed three times at a dilution of 1:10 by adding Veronal buffer (VCM) at PH 7.2 and centrifugation at 2500rpm for 5 minutes
2. The supernatant was discarded
3. The SRBC was resuspended in VCM, mixed gently and centrifuged at 2500rpm for 5 minutes. This procedure was repeated three times

4. A tube of an identical size was taken and held next to the centrifuged tube and packed cell volume of the SRBC was measured

5. Water was added to a tube and related to the tube containing SRBC until the meniscus of the SRBC (volume of SRBC in ml) was reached

6. The SRBC in VCM was diluted to 2%

7. The freeze dried Amboceptor was reconstituted with 1ml distilled water. The working dilution of the Amboceptor is 1: 1000

8. Equal volume of the diluted Amboceptor and 2% SRBC v/v was mixed with constant and gentle agitation during incubation for 30 minutes at room temperature so that it could be ready for work.

Annex 7. Evaluation of the complement

1. 25 µl VCM was dispensed to each well of the U-shaped micro plate

2. 25 µl of the complement at a working dilution of 1:2 was added to wells of row A1, B1, C1 and D1

3. Two fold dilutions was made by transferring 25 microlitre of the complement to the other wells until A12, B12, C12 and D12

4. 25 µl of the hemolytic system was added per well and incubated at 37^0C with constant agitation for 30 minutes

5. The last dilution's column showing complete hemolysis and 50% hemolysis of SRBC was read and recorded

Annex 8. Different pictures during participatory appraisal and sample collection

Picture 1. Goats identified by the community as cases of CCPP (Boba PA-Liban), with nasal discharge coughing and serologically positive.

Picture 2. A laboratory technician, Diid Galgaloo, collecting blood sample (Ganale PA- Liban)

Picture 3. About to start participatory appraisal (Adaadii PA)

Annex 9. Annual outbreak of CCPP in Ethiopia (1998-2007)

Year	No of outbreaks	No of cases	No of deaths
1998	36	771	453
1999	22	530	172
2000	17	346	222
2001	29	5863	800
2002	55	12,383	2546
2003	42	2447	980
2004	5	271	102
2005	34	4089	206
2006	56	5461	1027
2007	3007	18762	6904
Total	**3308**	**50923**	**13412**

Source: MoARD (2007), Monthly disease outbreak report

Annex 10. Outbreak of CCPP in Ethiopia by Regions (1998-2007)

Region	No of outbreaks	No of cases	No of deaths
SNNP	850	18330	5495
Afar	49	7487	409
Amhara	480	4781	313
Oromia	1888	8770	4141
Benishaugul	16	4975	2436
Dire Dawa	11	595	426
Somali	14	5985	192
Total	**3308**	**50923**	**13412**

Source: MoARD (2007), Monthly disease outbreak report

Annex 11. Serological studies on CCPP in different parts of Ethiopia

Source	Study areas	No of goats Examined (=n)	Prevalence reported (%)
Bereket, Z. 1995	Konso	122	35%
Dawit, K .1996	Yabelo	273	24%
Mekonen, L. 1996	Konso	254	36%
Teshome, F. Y. 1997	Arsi, North Omo Somali, Welo, Dire Dawa	375	17.9%
Solomon, M. 2005	South Omo, Gamo Gofa	1033	16.5%
Gezahegn, E. 2006	Afar	1183	29.08%

Source: AAU, FVM, compiled from DVM and Masters Theses.

Annex 12. Determination of age of goats according to Mike, (1996)

Age group	Teeth condition
1. Kid under one year	eight sharp scissor teeth
2. Yearling (1-2) years	central pair of baby teeth replaced by permanent
3. Adult (3-5) years	8 permanent teeth
4. Old (> 5) years	worn teeth and some missing

10. CURRICULUM VITAE

1. Personal data

- Name: Tesfaye Bekele Dinsa
- Place of birth: Ambo, West Shoa
- Date of birth: February, 20, 1974
- Sex: Male
- Martial status: Married
- Nationality: Ethiopian
- Address: Oromia Pastoralist Area Development Commission
- P. O. Box 11120, Addis Ababa, Ethiopia

  Telephone 091-1-842156

  E-mail: tesfa_me@yahoo.com

2. Academic background:

- Primary school: Bola junior secondary school, 1981-1987
- Secondary school: Ambo senior secondary school; 1988-1991
- University education: Addis Ababa University, Faculty of veterinary Medicine, 1992-1997.
- Post graduate program study: Addis Ababa University, Faculty of veterinary Medicine, department of Veterinary Epidemiology, 2005-2008.

3. Research back ground

- DVM Thesis, 1997: Comparative study on the pathogenic effects of Diminazine aceturate resistant and sensitive isolates of *T. congolense* in goats.
- MSc Thesis, 2008: Seroprevalence of contagious caprine pleuropneumonia in Borana and Guji lowlands.

4. Certificates awarded

- Training on Integrated use of data base management and Geographical Information System technique organized by FAO and Ministry of Agriculture and Rural Development, May 8-23, 2006.
- Training of trainers on Community Animal Health Workers and Participatory Rural appraisals organized by PACE program of MoARD, October 18-November 3, 2003.
- Training on sustainable livelihoods Approaches and Managing Reform Processes organized by Oromia pastoralist Development Commission and Pastoralist Community Initiatives, Ethiopia, August 10-14, 2004.
- Training on vaccine quality control and disease management organized by PANVAC and MoARD, March 14-18, 2006

5. Work experience

Livestock disease surveillance and monitoring performer, Oromia Pastoralist Area Development Commission, February, 2008- to date

- Livestock Production and Veterinary Service Department Head, Oromia Pastoralist Area Development Commission, July, 2007-January, 2008.
- Regional Animal Health Team leader, Oromia Pastoralist Area Development Commission, January, 2007-June 2007.
- Senior Regional Veterinary epidemiologist, Oromia Pastoralist Area Development Commission, June 2003- December, 2006.
- District Agricultural Development Head; Arsi zone, Lemu Bilbilo district, July, 2002-May, 2003.
- District veterinarian and animal health team leader; Southern Nations, Nationalities, People's Regional State, Kembata Alaba Tembaro zone, Omo Sheleko district; Oromia Regional Sate, Arsi zone, Merti and Lemu Bilbilo districts: August 1997- June, 2002.

6. Computer skill

- Microsoft Word, Excel, Advanced Excel, Access, Power point, and Statistical soft wares such as STATA and SPSS.

7. Language skill

- Afaan Oromo, Amharic, English

8. Reference

- Dr. Yilkal Asfaw (DVM, MSc, Assistant Professor, AAU/FVM, Debre Zeit)

11. SIGNED DECLARATION SHEET

"I under sign, declare that the thesis is my original work and has not been presented for degree in any University and that all sources of materials used for the theses have been duly acknowledged".

Name: Tesfaye Bekele

Signature: _____

Date of submission: 24/06/2008

This thesis has been submitted for examination with my approval as University advisor

Dr. Yilkal Asfaw (Assistant Professor)

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