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ORIGINAL PAPER

Participatory investigation of Contagious Caprine Pleuropneumonia (CCPP) in goats in the Hammer and Benna-Tsemay districts of southern Ethiopia

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Abstract The study was conducted in two selected districts of Southern Omo zones of Ethiopia, namely Hammer and Benna-Tsemay, during November 2004 and May 2005 to determine the status of contagious caprine pleuropneumonia (CCPP). Participatory disease investigation was conducted in the goat flocks owned by pastoralists of the districts. Participatory methods such as proportionate piling and matrix scoring of diseases were used to characterise major diseases of goats. Clinical and post-mortem examinations and isolation of the causative agent of CCPP were done. Serological tests were conducted using CFT. CCPP (locally termed *Sompo*) ranked as the first important disease of goats in the study area. Local perception of causes and signs of CCPP were described. Matrix scoring between groups revealed that disease signs and causes showed weak, moderate and good agreement by Kendall's coefficient concordance (W=0.21–0.99). The overall sero-prevalence of CCPP was 15.5%. The causative agent was isolated from sick animals in the lab. The characteristic clinical signs, gross lesions, bacteriological isolation of the causative agent supported by participatory epidemiological disease investigation revealed that CCPP is a major disease of goats in the study districts. Participatory epidemiology using indigenous knowledge could efficiently be used to generate sufficient information with minimum cost, local materials and within reasonably short period of time, assisting the designing of feasible disease control programme in developing countries.

Keywords CCPP · Participatory epidemiology · Disease surveillance · Goats, Pastoralists · Ethiopia

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Introduction

Ethiopia hosts 23.33 million goats (CSA 2004). Goats contribute to livelihoods as a source of milk, meat, skin, income, risk mitigation, property security, monetary savings, and other socio-economic and socio-cultural functions. The integration and full utilization of goats, however, is constrained by

various factors including diseases, feed scarcity, inadequate utilisation of indigenous genetic resources, poor management, inadequate marketing infrastructure, and unimproved management systems. Of these factors, diseases are widespread and have a significant impact on the performance of goats in Ethiopia.

Contagious caprine pleuropneumonia (CCPP), a contagious disease that affects commonly goats, is one the most important diseases in Ethiopia. It is caused by *Mycoplasma capricolum* subsp. *Capripneumoniae* [F38] (Mccp) (MacOwan and Minette 1976). The disease is characterized by cough, dyspnoea, lagging behind the flock, lying down, fever (40.5–41.5°C) and in the terminal stages mouth breathing (Thiaucourt and Bolske 1996). In chronic cases, animals show sporadic coughing, emaciation, and diarrhoea. Animals recovered from this form of the disease do not show signs or lesions after recovery. Even though there is no sequestera in recovered animals, the survivor goats may remain as carriers of the infection (Seifert 1996; Maré 2004).

In Ethiopia, the presence of CCPP has been suspected since 1983 and later confirmed in 1990 by isolation and identification of the causative agent Mccp. Since then the disease was identified as endemic in different parts of the country (Thiaucourt et al. 1992). To date there has not been well organized study on the disease. Reports from fragmented studies by different workers in different part of the country indicate that the sero-prevalence of CCPP could vary from 6% to 51.5%. The data compiled from 1998 to 2004 on CCPP outbreak report showed that 42.7% of 206 CCPP disease outbreaks were reported from Southern Nation Nationalities People Regional State (MoARD-Ethiopia 2004) particularly as endemic in the South Omo and Gamo Goffa zones.

Participatory disease investigation method which uses community knowledge has recently been shown to be the cheapest and fastest way to generate information as compared to conventional methods in the pastoral production systems. In this method researchers act as facilitators and technical advisers, and research methods are often based on the interviewing, visualization and scoring methods of the participatory rural appraisal (PRA) (Catley et al. 2002a). Informal interviewing, visualization and ranking or scoring described by Mariner (2001) are important participatory methods used in the participatory epidemiology. Moreover, triangulation, which refers to a process of crosschecking of reports or data provided by various independent respondents or methods, as a simple and powerful method of quality control in the analysis of the results are paramount important. Further when this is supported with laboratory confirmation, clinical signs and post-mortem examination and direct observation, are considered complete triangulation in participatory epidemiology.

Despite the high population density of goats estimated at 1.1 million (CSA 2004) in the South Omo, little attention has been given to the health problems of goats. No systematic epidemiological disease investigation was conducted so far. Pastorals indigenous knowledge about diagnosis and reporting livestock diseases were not fully exploited. This study was conducted to understand the community's perception on disease constraints in the Hammer and Benna-Tsemay districts of the South Omo zone using participatory disease investigation, triangulation and conventional methods.

Material and methods

Description of the study area

The study sites were selected purposely because CCPP outbreak report from the region during the last seven years has indicated the highest frequency of occurrence in South Omo zone and that all reports were based on suspected case only.

The Hammer and Benna-Tsemay districts, where this study was undertaken, are found in South Omo zone of southern Ethiopia. The districts are located between 04° 59.00″ and 05° 58.40″ N and 36° 12.45″ and 37° 30.25″ E. Jinka is the capital of the South Omo zone and is located at 750 km at 21° south-west of Addis Ababa. Topographically, massifs, plains, bushes, shrubs and Rivers mark the areas. The biggest rivers are Omo and Mago Rivers with a number of tributaries. Mean monthly rainfall distribution in Hammer and Benna-Tsemay districts varies from 3.9 to 276.5 mm. Rainfall distribution is erratic and usually occurs as bimodal, which occurs between September and November, and between March and May.

The area is inhabited by agro-pastoral communities, whose lifestyle is highly dependent on goats and cattle. The districts are named after the major ethnic group (i.e. Hammer, Benna and Tsemay) inhabiting

the area. All of the three major ethnic groups have seasonal movement during dry season towards Omo River in search of grazing and water for their animals.

Study design and sampling strategy

The study area and communities were identified in participatory manner and literature information was also collected. Translators with no personal bias and have respect for local people were selected. Key informants (composed of mainly traditional leaders, religious leaders, community animal health workers) were identified in a participatory manner as the study actively seeks individuals who are likely to have specialized knowledge (Mariner et al. 2001).

A cross-sectional investigation into CCPP was conducted in all age and sex groups of goats above 6 months of age from 10 selected villages of the Hammer and Benna-Tsemay districts. Sera were collected and participatory epidemiological investigation was employed.

Eight pastoral associations four from each of the two districts were selected and equal number of sample size were allocated to arrive at a 679 sample size (Table 1). Sampling frame at each stage was:

1. Primary sampling units used for random sampling were districts in the South Omo zone who did not vaccinate their goats against CCPP for the last one year. Out of the six districts from the zone, the Hammer and Benna-Tsemay districts were selected.
2. Secondary sampling units were number of peasant associations (PAs), which were randomly selected from each district. A total of eight PA's of which eight villages were selected. Animals below six months of age were excluded from sampling. Animals were selected systematically at the interval of 5 animals starting from number one until the required number of sample size in that village attained. During sampling, history of goats whether they were the member of the flock or not were asked and a newly recruited goats replaced by existing flocks to avoid the risk of including vaccinated animals.

Table 1 Serum samples collected and sample size by site from the pastoral flocks

Districts	Peasant Association	Altitude (meters above sea level)	Number of goats sampled
Hammer	Dembayte	990	88
"	Kolakeja	967	88
"	Karoduss	391	88
"	Zeldaketa	987	88
Benna/Tsemay	Alduba	1334	89
"	Sille	1250	88
"	Shabba	1449	88
"	Challi	1343	62

Participatory disease investigation

Group interviews were undertaken by participatory epidemiological disease investigation methods (Mariner 2003) to validate the knowledge of the community about the disease between November and December 2004. More than 10 different villages were covered within the study districts. Key informants were used in each site to identify cluster of communities. Sampling of the informants was based on the information of key informants.

Proportional piling

Proportional piling was used to rank major goat diseases. Different informant groups listed a numbers of diseases and the first five diseases that were frequently mentioned were used for matrix scoring. Using a pile of 100 beans more important diseases were ranked. Based on informants piling, major goat diseases identified were *Sompo* (CCPP), *Quatsi* (mange mite), *Shoko* (tick infestation), *Pirtsa* (Diarrhoeal syndrome) and "Other" diseases not mentioned frequently. The method was repeated with 12 informant groups. Median of the score and maximum and minimum response were calculated for each disease.

Matrix scoring

Matrix scoring as described by Catley et al. (2002a) was used to understand local perceptions of the main clinical signs and causes of CCPP (locally termed *Sompo*). In order to avoid exaggeration of responses to *Sompo*, and check that informants understood the matrix scoring method, list of major diseases were identified and included in the matrix to crosscheck diseases. To identify locally perceived clinical signs and causes of CCPP in goats, pair-wise ranking (Mariner 2003) of the five diseases (*Sompo, Quatsi,*

Shoko, Pirtsa and others) was conducted a group of 10 key informants. From the above exercise, 14 indicators were produced and categorized into 5 disease causes and 9 clinical signs. To confirm whether informants understood the matrix scoring *Quatsi* (mange mite) and *Shoko* (tick infestation) were used as control diseases to create agreement among informants.

Five diseases mentioned above were represented using drawing on the piece of hard paper and placed along the top 'x-axis' of a matrix drawn on the ground. Each of the five diseases was then scored against a list of clinical signs and causes of disease. The clinical signs and causes were represented using simple locally available objects that were placed along the 'y-axis' of the matrix. The clinical signs and causes were labelled using everyday objects. The arrangement of the matrix and each illustration was explained to the informants. For each disease sign or causes informants were asked to score the five diseases by dividing a pile of 30 beans. The more important a particular sign or cause, the greater the pile of beans assigned to it. After the scoring procedure was completed, informants were asked to check their scoring and confirm that as a group, they agreed that the scores were correct. The scores were then recorded and additional questions were asked to crosscheck and probe the responses, more importantly to elicit additional information from those, which had highest scores.

Matrix scoring was repeated with 12 informants' group at various sites of two districts. Group sizes varied from 4 to 15 individuals. The level of agreement between informants groups were assessed using Kendall's coefficient of concordance (W) (SPSS standard version inc.1989–2002). Maximum, minimum and median were used to see the difference between informants.

Clinical and post-mortem examinations

During participatory investigation of CCPP, informants were asked in order to bring sick goats from their flock. Five cases showing respiratory signs were obtained at different sites. Temperature, respiratory rate, pulse rate, mucus membrane of eyes, body condition were examined and recorded. Jugular blood was sampled in aseptic procedure from vein puncture. Case history from the owners was taken before post-mortem examinations. All post-mortem examinations were conducted together with informants and they have indicated lesions what they were used for the diagnosis of CCPP. Nasal swabs, thoracic fluid, lung tissue were taken for agent isolation and lung lesion with 10% buffered formalin for histopathological examinations. Tissue samples for histopathology were processed and examined according to Leeson and Leeson (1981). Briefly, the hematoxylin-eosin stain procedures were applied which involve fixation (dehydration clearing and impregnation), embedding, sectioning, staining and mounting. Then, the stained tissue sections were examined for characteristic lesions of CCPP, which may involve 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 (Nicholas 2002).

Laboratory investigations

Serology

The randomly collected sera were de-complemented in a water bath at 60°C for 30 min before execution of the test proper. Standard complement fixation test (CFT) was used to determine the prevalence of antibodies against *Mycoplasma capricolum capripneumoniae* strain F38, as recommended by OIE (2000). Briefly, collected sera were de-complemented in a water-bath at 56°C for 30 min. Then, 25 μl of veronal buffer was dispensed to each well of a U-bottomed micro-plate, and 1/5 diluted sera were added to first column and diluted serially in two-fold dilutions (1/10, 1/20,..., 1/160). A 25-μl aliquot of antigen was added to each well with 25 μl of complement, which was agitated and incubated for 45 min at 37°C. Finally, 25 μl of sensitised sheep red blood cells (RBC + haemolysin) was added, mixed well and incubated at 37°C for 45 min, and kept at 4°C for 1 h to allow the unlysed cells to settle. More than 50% haemolysis was considered as positive (OIE 2000). Since the sensitivity and specificity of the above test is not indicated clearly by OIE, we have prepared and used the Mccp antigen (Thiaucourt et al. 1992) and followed screening test instead of the dilution test.

Isolation of the causative agent

Isolation and identification of Mycoplasma from infected lung, pleural exudates, fibrinous mass and

nasal swabs was carried out at National Veterinary Institute (NVI) according to the standard procedure Jones and wood (1988). The basal culture media used were heart infusion broth (2.5%) and modified Hayflick Bacto PPLO 2.1% containing 0.2% glucose, bactoneopeptone and bacto-casitone 0.25% (w/v). Solidification of the basal broth media was done by adding 1.4% agar (Difco). Liquid and solid basal media were sterilised by autoclaving at 121°C for 15 min. Before inoculation, the sterile basal media were enriched with 20% horse serum (NVI produced) (v/v), fresh yeast extract 10% (v/v) and kept overnight at 37°C to verify absence of any contamination. Penicillin at a final concentration of 200 IU/ml and 10% Thalous acetate 0.12% (v/v) were used as inhibitors against bacterial and fungal contaminants in the pathological samples. Finally, 4 mg/ml sodium pyruvate and 0.2% calf thymus DNA, in a proportion of 1% (v/v), were added to enhance growth of fastidious Mycoplasma, such as Mccp (Thiaucourt 1994). The seeded agar plates were incubated at 37°C in a CO2 incubator for 14 days. Evidence of micro-colonies was checked daily for growth. Typical colonies with a fried-egg appearance were taken and biochemically tested for break down of glucose, arginine hydrolysis, reduction of tetrazolium chloride, phosphates activity and digitonin sensitivity. Identities of the isolated Mycoplasma were confirmed by growth inhibition and dot blot tests (OIE 2000; Thiaucourt 1994).

Dot blot immunoassay

A 5-μl aliquot of mycoplasma culture was dropped on pieces of hybridisation transfer membrane, left to dry at 37°C for 10 min, washed three times with Tris buffer solution (TBS), incubated with blocking buffer (TBS + 10% horse serum) for 30 min and later with *Mycoplasma capricolum subsp. capripneumoniae* specific monoclonal antibody. After three washings, immuno-enzymatic antigen antibody reaction was determined using anti-mice immunoglobulin G conjugate with horseradish peroxidase (HRP, DAKO), which gave a brown staining following reaction with orthophenylenediamine (OPD) chromogen and hydrogen peroxide substrate (Thiaucourt 1994).

Data analyses

Data were transferred first into Ms-Excel spread sheet and then to SPSS (SPSS inc. 1989–2002 USA) version 11.5.0. To observe agreement between participatory group and individual discussion, Kendall's coefficient of concordance (W) procedure was used. W (Kendall's coefficient of concordance) ranges from 0 to1. The higher the value of W is the higher the agreement amongst the informants. According to critical values for Kendall's coefficient concordance (W) provided by Seigel and Castellan (1994) agreement was termed as weak, moderate and good if W=values were less than 0.26, between 0.26 and 0.38 ($p<0.05$) and greater than 0.38 ($p<0.01$ to <0.001), respectively. The prevalence rate for CCPP is defined as the proportion of the number of CFT positive animals to the total number of animals tested expressed in percent. These were generated by FREQ procedures of the Statistical Analysis System (SAS 2003) Variation of prevalence by districts and peasant association was investigated by the chi-square test. Odds ratio (OR) was computed by FREQ procedures with the option of Cochran-Mantel-Haenszel statistic to estimate the level of risk of CCPP by explanatory variables. Odds ratio (OR) is the ratio of the odds of diseases occurring among animals exposed to a factor and the odds of disease occurring among animals not exposed to a factor (Thrusfield 1995).

Results

Sero-prevalence

A total of 105 of the 679 examined serum samples were positive for Mccp F_{38} antibodies using CFT making the overall sero-prevalence of CCPP in Hammer and Benna-Tsemay districts 15.5% (Table 2). There was no significant difference ($P>0.05$) in sero-prevalence between Benna-Tsemay and Hammer districts. However, there was significant ($P<0.05$) difference in sero-prevalence by PA (Table 3). A higher prevalence rate

Table 2 Sero-prevalence of CCPP in goats in the Hammer and Benna-Tsemay districts

Districts	Goats tested	Goats positive	Sero-prevalence (%)	95% CI
Hammer	352	55	16.2	11.8–19.4
Benna-Tsemay	327	50	14.7	11.3–19.2
Total	679	105	15.5	11.5–19.3

Odds ratio=1.02; *P*=0.58

Table 3 Sero-prevalence of CCPP in goats by districts and peasant associations

Districts	Peasant Association	No. sampled	No. positive	Sero-prevalence (%)	95% CI
Hammer	Dambayte	88	12	13.6	6.4–20.8
"	Duss	88	16	18.2	10.1–26.2
"	Kolakeja	88	13	15.1	7.4–22.1
"	Zeldaketa	88	14	17.5	8.3–23.6
Benna-Tsemay	Alduba	89	13	13.1	7.3–21.9
"	Sille	88	23	26.1	16.9–35.3
"	Shabba	88	6	6.8	1.5–12.1
"	Challi	62	8	12.9	7.6–21.2

District: $\chi^2 = 0.29$, $P = 0.59$

Peasant Association: $\chi^2 = 14.4$, $P = 0.04$

(26.1%) was recorded in Sille PA, while lower rate (6.8%) was observed in Shabba, both from the Benna-Tsemay district.

Participatory disease investigation

Results from participatory epidemiology show that CCPP, mange mites, and tick infestation share the highest percentage as compared to other diseases. Among goat diseases mentioned during the participatory disease search, the first four diseases repeatedly mentioned by the communities were *Sompo* (CCPP), *Quatsi* (mange mite), *Shoko* (Tick infestation), *Pirtsa* (diarrhoeal syndrome) and others. Major goat diseases mentioned were similar among groups except that disease called *Etmma* (anthrax) was emphasized by few groups as an important goat's disease. Due to disagreement between groups about *Etmma*, it has been included in the disease group called 'others' for further research. Proportionate piling (Fig. 1) revealed the highest median with their minimum and maximum value observed was 29 (16–47) for disease *Sompo*, 27 (7–41) for *Quatsi*, 14.5 (8–24) for *Shoko*, 9.5 (4–14) for *Pirtsa* and 11 (3–21) for disease called 'others', respectively. The minimum and maximum values for disease called *Etmma* were (0–25).

Local perceptions of disease signs

Results obtained from discussions with group informants about disease signs and causes are given in Figs. 2 and 3. Agreement between informants was categorized as 'weak', 'moderate' and 'good'. According to critical values for Kendall's coefficient concordance (W) provided by Seigel and Castellan (1994). The results of matrix scoring for disease signs showed good level of agreement (W=0.39–0.99) between 12 informant groups for the disease signs (Fig. 2). The scores allocated to the control diseases indicated that informants understood the scoring method. For instance, *Quatsi* (mange mite) received high scores for itching and *Shoko* (tick) received very low scores for itching even though it is external parasite. The disease called *Pirtsa* was associated with diarrhoea & sudden death. Further probing questioning about the signs of *Pirtsa* showed that informants were able to differentiate sudden death due to *Etmma*. The informants did also mention that *Etmma* affects people if the sick goats' carcass was consumed and the spleen of the goats gets enlarged with accompanying bleeding from natural orifices.

Local perceptions of disease causes

The results of matrix scoring for disease causes showed moderate to good levels of agreement (W= 0.37–0.68) among 12 informant groups (Fig. 3). The

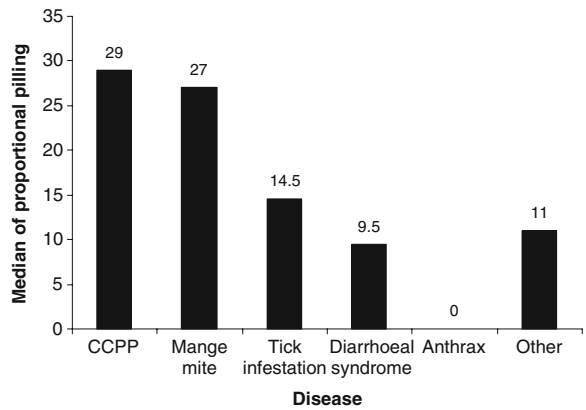

Fig. 1 Major diseases of goats using proportional piling obtained from group discussion (n=12 groups) in Hammer and Benna-Tsemay districts, South Omo zone. Numbers on the top of the histogram bars are the medians obtained from proportionate piling exercise

Disease signs	*Sompo* CCPP	*Quatsi* Mange mite	*Shoko* Ticks	*Pirtsa* Diarrhoeal syndrome	Others
Weight loss W=0.39***	6.5 (0-17)	11.5 (9-16)	3.5 (0-10)	1.5 (0-2)	6 (1-15)
Diarrhoea W= 0.78***	0 (0-11)	0 (0-6)	0 (0)	18.5 (9-30)	10 (0-16)
Coughing W=0.84***	28 (17-30)	0 (0)	0 (0-7)	0 (0)	0 (0-13)
Reduced appetite W=0.70***	17 (9-30)	0 (0-14)	0 (0-3)	1.5 (0-8)	7.5 (0-18)
Nasal discharge W=0.51***	20 (0-30)	0 (0-10)	0 (0-7)	0 (0-9)	7.5 (0-17)
Sudden death W=0.57***	15.5 (7-24)	0 (0)	0 (0-7)	7.5 (0-14)	6.5 (0-19)
Abortion W=0.64***	15.5 (7-24)	0 (0-14)	0 (0-2)	0 (0-5)	7 (0-30)
High mortality W= 0.65***	16 (10-30)	7.5 (0-14)	0 (0-6)	0 (0-10)	2.5 (0-16)
Itching W=0.99***	0 (0)	20 (15-28)	10 (2-15)	0 (0)	0 (0)

Fig. 2 Summarized matrix scoring of disease signs based on group discussion. N=12 groups (4–15 informant members participated in each group) W=Kendall's coefficient of concordance (***P<0.001). The black dots represent the median scores. The minimum and maximum scores are shown in parenthesis. Hammer-Benna words are shown in *italics*

score allocated to the control diseases indicated that informants understood the scoring method. For example, *Sompo* (CCPP), and *Quatsi* (mange mite) received high scores for 'introduction of sick goats' as cause of disease. Marketing site also received high scores as a cause of CCPP and mange mites. Further probing questioning revealed that these two diseases are transmitted by direct contact from sick animals. The informants said that grazing and watering site as contributory cause for the disease occurrence.

Seasonal factors

Seasonal calendar for goat diseases were mentioned. These results were obtained from the discussion with informant groups, and identifying seasonal calendar according to the local perceptions. Local name of the seasons and months were recorded. Seasonality mainly depends on rainfall intensity and flood retreats were informants' main factors for classification. According to responses from informants almost for all diseases scoring was highest during *Bergi* and *Gidibergi* seasons. Scoring was null at Mishi season and very small score were observed at Bonna season. Probing questions were made to classify each season with events that occur associated with different seasons, and is largely related with livestock movement for grazing and sorghum harvest. For instance, livestock move towards their settlement area during rainy season because feed is available whereas livestock are moved away from their villages during Bonna (dry season). Mean rainfall of three years (2002–2004) was 194.5 for Bergi, 37.8 for Mishi, 79.2 for Gidibergi and 67.4 for Bonna seasons. The mean monthly ambient temperature during the same period in the area was (23°C), maximum temperature was recorded in Feb (31.6°C) and minimum temperature occurred in August (11.5°C) (NMSA 2004).

Disease/Causes	*Sompo* CCPP	*Quatsi* Mange mite	*Shoko* Ticks	*Pirtsa* Diarrhoeal syndrome	Others
Introduction of sick goat	●●●●●●● ●●●●●●● ●●●●	●●●● ●●●● ●			●●●
W= 0.68***	16(11-25)	8.5(0-11)	0(0-8)	0(0-9)	2.5(0-11)
Wet season W=0.36**	●●●●● ●●	●●●● ●●●	●●● ●●	●● ●●	●●●
	11.5(0-15)	7(0-12)	5(0-11)	3.5(0-9)	2.5(0-11)
Overcrowding W=0.63***	●●●●● ●●●●● ●	●●●● ●●●	●●● ●●	●●●	●●●
	11(8-16)	7(0-13)	5(0-9)	3(0-7)	3(0-10)
Grazing and watering point W=0.62***	●●●●●●● ●●●●●●● ●●	●●●● ●●●●	●●● ●●		●●
	14(9-30)	8(0-14)	4.5(0-10)	0(0-6)	1.5(0-9)
Marketing site W= 0.68***	●●●●● ●●●●● ●●●●● ●●	●●● ●●● ●	●●		●
	16.5(10-27)	6.5(0-13)	2(0-6)	0(0-6)	0.5(0-9)

Fig. 3 Summarized matrix scoring of disease causes based on group discussion. N=12 informant groups in each group ranges of 4–15 members involved. W=Kendall's coefficient of concordance (**P<0.01; ***P<0.001). The black dots represent the median scores that were used during the matrix scoring. The minimum and maximum scores are shown in parenthesis. Hammer-Benna words are shown in *italics*

Clinical signs and post-mortem examinations

Information on case histories, clinical signs and post-mortem lesions is presented in Table 4. Frequent coughing was reported and observed in all cases, however the duration of coughing among cases varied from a week to months. Nasal discharge was reported and it was observed in almost all of the cases. Diarrhoea cases were also observed in severely sick goats. The history of respiratory distress and lagging behind from the flock were reported and also observed in all of the cases. There was sign of weakness and frequent recumbency. All cases of goat had high tick infestation. *Amblyomma* spp and *Hyalomma* spp were predominant.

All the cases presented for post-mortem examination due to *Sompo* were above one-year old and all of them were female except one male. Out of the gross pathological lesions observed, the communities' emphasized adhesion of lung with chest wall, straw coloured thoracic fluid, fibrinous tissue coverage of lung & consolidated parts of lung were commonly observed.

Microscopic examination of stained lung tissue samples revealed congested alveolar septa with the thickening of the alveolar septa an infiltration with neutrophils and fibrin deposition.

Bacteriological isolation and characterization

After 7 days of inoculation, out of the total 14 cultures, 7 (50%) broth cultures and the corresponding 7 (50%) plates had typical fried-egg colonies of Mycoplasma (Table 4) The colonies were examined by various biochemical tests and were positive for glucose fermentation and reduction of tetrazolium chloride, and negative for phosphatase activity and hydrolysis of arginine. Growth of the isolates was inhibited with Mccp hyperimmune. The isolates were further subjected to dot blot test using Mccp monoclonal antibody and were positive for Mccp with the monoclonal antibody-based dot blot test. Three broth cultures from thoracic fluids origin and broth culture from lung tissue origin were found to be positive for dot blot at different intensity. Thoracic fluid origins were strong positives and others were moderate to weak positives. But broth cultures from nasal swab origin were negative.

Discussion

Goat rearing is an important agricultural activity, especially in pastoral areas of Ethiopia where goats are major species for the livelihoods. The major health constraint of goats in the studied pastoral and agro-pastoral areas is contagious caprine pluropneumonia. Several outbreaks of CCPP have been reported from almost all regions in Ethiopia (MoARD-Ethiopia 2004), particularly from the lowland areas where 75% of the total goat population of the country are found. The 15.5% individual animal sero-prevalence obtained in this study is in close

Table 4 Case histories, clinical signs and gross-pathological lesions

Case history, clinical and post-mortem findings	Case number				
	1	2	3	4	5
Case history					
Coughing	+	+	+	+	+
Weakness	+	+	+	+	+
Lagging behind the flock	+	+	+	+	+
Nasal discharge	+	+	−	−	+
Diarrhoea	+	+	+	−	−
Clinical signs					
Coughing	+	+	+	+	+
Weight loss	+	+	+	+	+
High respiratory rate (per minutes)	56	52	60	44	48
Temperature (°C)	40.2	39.9	41	39.6	39.8
Pulse rate (per/min)	112	108	112	104	100
Nasal discharge	+	+	+	−	−
Diarrhoea	+	+	+	−	−
Post mortem examined					
Adhesion of lung with chest wall	+	+	+	+	+
Yellow nodules surrounded by congestion	+	+	+	−	−
White patches over the lung	+	+	−	−	−
Strew coloured thoracic fluid	+	+	+	+	+
Cultural growth					
Nasal swabs					
Broth	+	+	+	−	−
Plate	+	+	+	−	−
Thoracic fluids					
Broth	+	+	−	−	−
Plate	+	+	−	−	−
Lung tissue fluid					
Broth	+	−	+	−	−
Plate	+	−	+	−	−

agreement with previous reports from Ethiopia (Roger and Bereket 1996; Gelagay et al. 2007) and India (Shaheen et al. 2001). However, the current prevalence is lower than other studies in the country (Gezahegn 1993; Bereket 1995; Sharew et al. 2005). One of the reasons for this could be the low sero-prevalence of CFT, which might be related to the ability of the test to detect antibody that appear first and span short duration in the blood which could be due to the limitations of CFT as observed by March et al. (2002). March et al. (2002), did not observe significant CFT titres in infected goats 21 days post infection. Therefore, at an early stage in a field outbreak, false negative results based upon serological diagnosis are a real possibility as observed in Shabba PA where only few positive cases detected by CFT test despite the presence of clinical cases of CCPP. Another reason for the variations could arise from differences in study location, sample size, and the type of tests used to evaluate the sero-prevalence of CCPP. For example, all of the studies reporting higher prevalence of antibodies to Mccp used ELISA tests, while we used CFT.

In the present study, we have successfully employed participatory epidemiology to investigate important health problems of goats reared by the pastoralists of the two districts in southern Ethiopia. The participatory methods were valuable for understanding local characterization of goat diseases. Following the completion of matrix-scoring, probing questions could provide valuable crosschecking scores and help relate local name of the disease with the clinical signs and post-mortem findings. For example, probing questions in “Duss”, one of the sampling sites,

revealed that sudden death accompanied by diarrhoea was different from sudden death caused by *Etmma* (Anthrax). For instance, "*Sompo*" means lung and "*Piskilsa*" means coughing indicating that community did recognise that coughing is associated with lung disease. "*Quatsi*" ("mange mite") is the local name indicating the disease that causes itching; communities were able to select and show goats infected by mange mite from their flock at the spot.

CCPP was considered as major disease by the participating community in the area and this was confirmed through triangulations during the participatory investigation. The repeatability of the methods used was, analyzed by 'W' Kendall's coefficient concordance. Response agreement among groups indicates that the standardized participatory method was repeatable or reproducible (Catley et al. 2001, 2002a). Group discussions could bring ideas that is shared and agreed by groups, because discussion helped them to memorize the events or causes and signs of the diseases, so that the response given by different groups indeed had similarity.

The overall exercise has shown that indigenous knowledge about animal diseases in the area developed over generation in the pastoralist community. Further probing questions revealed that pneumonia due to pasteurellosis differ from CCPP by its clinical signs and post-mortem lesions. According to the participants "*Quappa*" means pasteurellosis the name derived from the clinical sign of throat suffocation, which means the disease signs is mainly difficulty in breathing in the upper respiratory tract. The pastoralists stressed that in cases of *Quappa*, there are no gross lesions like adhesion and yellow colour thoracic fluid and that *Sompo* kills a number of goats in flock within short period of time as opposed to *Quappa*.

Community perceptions about disease name and their signs largely related with modern disease signs. For example, findings indicated that *Sompo* with clinical signs of coughing, weight loss, sudden death, and high mortality coincides with modern CCPP clinical signs (Nicholas 2002; Bereket 1995). Itching signs was strictly allocated for "*Quatsi*" (mange mite). Assessment of disease causes shown that the disease "*Sompo*" and "*Quatsi*" were strongly associated with the introduction of sick goat, marketing site, grazing and watering site and overcrowding (direct contact). The pastoral community of Hammer and Benna districts have clearly indicated that these two diseases are their major goat health problem and that their transmission is through contact between sick and healthy goats.

The seasonal variation in the occurrence of "*Sompo*" was also noted by the community during the matrix scoring, most cases occurring during long- and short-rainy seasons, i.e. *Bergi* (March to May) and *Gidibergi* (September to November), respectively. Seasonal calendars have diagnostic value, because results can be crosschecked against other findings like "matrix scoring" which was demonstrated by associations between fasciolosis with snails in the wet season (Catley et al. 2001). This study has also shown that the occurrence of "*Sompo*" is associated with wet season as shown in matrix scoring. During the seasonal calendars description, the community could use their own definitions of seasons and such participatory disease search process helps people to feel confident about their own language and knowledge. This also strengthens the relationship between researchers and livestock keepers. Especially seasonal calendars were used to open up discussions on topics such as the best time to control livestock disease and external parasites. In seasonal calendar analysis, the informants made a remark that the seasonal pattern described is during "normal" weather conditions as during drought such pattern may not be there as also reported by previous workers (Lienhardt 1961; Evans-Pritchard 1940 cited by Catley et al. 2002b).

Clinical and post-mortem examinations on sick goats presented by the pastoralists revealed classical gross lesions and signs of CCPP (Thiaucourt et al. 1996; Maré 2004). The clinical and pathological manifestations observed in the current study were consistent with those of Radostitis et al. (2000), Kusiluka et al. (2000), Wesonga et al. (1998) and Quinn et al. (2002). The lesions were restricted to thoracic cavity with adhesion of the lungs with parietal pleura, and sero-fibrinous fluid in the pleural cavity. In addition, there were yellowish pea-sized nodules on the surface of lung surrounded by congestion. The diameter of nodules was varied in different observation; a case of one lung was fully consolidated.

Mycoplasma capricolum subsp. *capripneumoniae* isolated had a characteristic colony (dense centred and nipples like morphology) which we confirmed by using biochemical tests the isolates being glucose fermenting and arginine negative and phosphatase negative group of *Mycoplasma* (Nicholas and Bashiruddin 1995). Slow

growing characteristic of the Mccp were observed by (MacOwan and Minette 1976) and confirmed by Nicholas (2002) and Thiaucourt and Bolske (1996) that Mccp are fastidious and slow growing organisms.

In conclusion, participatory disease investigation, serological, bacteriological isolation, and clinical and post-mortem findings strongly suggest that CCPP infection has become one of the major goat health problems in pastoral area of South Omo zone in southern Ethiopia. Participatory epidemiological study shows indigenous knowledge could be used to generate more information with less cost and simple local materials within short period of time. Local description of the disease using matrix scoring shows that CCPP and mange mites were found as major causes of goats' loss in the area. This study indicates that participatory epidemiology could be used to design participatory disease control programme in similar production systems in developing countries.

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