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Using Participatory Epidemiology Tools to Investigate Contagious Caprine Pleuropneumonia (CCPP) in Maasai Flocks, Northern Tanzania

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Abstract: Participatory Epidemiology (PE) was applied on the Maasai rangeland of northern Tanzania to understand pastoralist's perceptions of the clinical and epidemiological features of Contagious Caprine Pleuropneumonia (CCPP). The study was conducted during the period of April 2008 and caprine disease event was directed during the period of July 2006 to June 2007. Participatory methods such as Focus Group Discussion (FGD), proportional piling and matrix scoring were used to characterize pastoralist perceived clinical signs and risk factors for CCPP. The estimated mean incidence and case mortality rate of CCPP was 31.6 and 61.4%, respectively. Matrix scoring showed moderate to good agreement between informant groups on the clinical signs and risk factors. It was concluded that PE complimented with local knowledge could generally be used to generate disease information at low cost and therefore assist the design of feasible disease surveillance systems and control programmes at local and national level.

Key words: Contagious caprine pleuropneumonia, focus group discussion, goats, matrix scoring, pastoral system, proportional piling, Tanzania

INTRODUCTION

Contagious caprine pleuropneumonia (CCPP), an Office Internationale des Epizooties (OIE) listed disease, caused by Mycoplasma capricolum *subspecies capripneumoniae* (Mccp), is a severe disease of goats that causes significant socio-economic losses especially in many countries in West and East Africa, Middle East, as well as in Pakistan and India, where its endemic (Jones, 1992; Kusiluka *et al*., 2000; Kusiluka *et al*., 2007). The disease was officially confirmed in Tanzania in 1998 and since then it has spread widely through out the country causing tremendous losses in the goat industry (Msami *et al*., 1998; Msami *et al*., 2001a). In pastoral and non-pastoral areas of Tanzania, outbreaks of CCPP are reported frequently but the disease remains largely un-contained using conventional methods (Kusiluka *et al*., 2007). In part, deficit of disease control strategies was due to weak veterinary services in most pastoralists areas including poor diagnostic facilities, surveillance and the lack of an effective vaccination program (Leyland *et al*., 1998; Allport *et al*., 2005). Opinions on the importance of CCPP in pastoral flocks varied (Kusiluka and Kambarage, 1996). Given the low production of pastoral flocks compared to commercial dairy units, some experts including policy makers assume CCPP is a relative minor disease in pastoral areas. However, at certain times of year pastoralists rely heavily on small stock (goats and sheep) as an important livelihoods asset and therefore, they often prioritize CCPP due to its impact on food and income (Kamau, 2004). From the international perspective, CCPP is often perceived as a major hindrance to international trade. To reverse this attitude and to enhance external export opportunities, understanding CCPP status is a priority need. Furthermore, amongst the members of South African Development Community (SADC), it is only Tanzania that has confirmed CCPP, and given the indications that there is threat of a southward flow of this disease, our national and international obligations compel us to urgently undertake rigorous control programs (MoLD&F, 2006).

In many developing countries, investigating diseases and maintaining nationwide animal surveillance system is a major challenge. Important constraints include the need to access remote and often large areas characterized by poor infrastructure and communications and the need to conduct adequate disease search with limited, yet less-motivated personnel and financial resources (Allport *et al*., 2005).

One useful approach for improving disease investigation and surveillance in rural marginalized areas of developing countries such as Tanzania is to use Participatory Epidemiology (PE) techniques (Catley, 2005; Thrusfield, 2005). Participatory Epidemiology is a proven technique which overcomes

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many of the limitations of conventional epidemiological methods, and has been used to solve a number of animal health surveillance and research problems (Catley, 2006; Jost *et al*., 2007).

This study describes the use of PE to collect information on the basic epidemiology of CCPP in Maasai pastoral flocks in northern Tanzania.

MATERIALS AND METHODS

Study area: This study was conducted in three districts of the Maasai pastoral system, northern Tanzania during the period of April 2008. The 3 districts were Ngorongoro, Monduli and Longido of Arusha region, and they were located between 02°11′ to 06°14′ S and 35°11′ to 38°26′ E. Arusha Region is a semi-arid rangeland area in the Rift Valley just to the south of the Kenyan-Tanzanian border. This area normally experiences two rainy seasons: a short rainy season between October and December, and a long rainy season between March and May. The annual precipitation averages between 500 and 1000 mm. The vegetation mainly consists of various shrubs and acacia bushes, and livestock species kept are primarily cattle, goats, sheep and donkeys.

Data collection: The participatory epidemiological studies consisted of focal group discussions with pastoralist livestock keepers, for which villages were the unit of analysis, and key informant interviews. The focal group discussions took place in 18 villages, comprising of an average of 14 informant groups. In each village, focal groups were convened which consisted of between seven and 20 people, most of whom were men and all of whom were ethnically Masaai. Livestock production system and socio-economic conditions were similar in the 3 districts. The focal group participants relied primarily on extensive rearing of livestock and eco-tourism for their livelihoods, supplemented with limited cultivation of crops.

During the focal group discussions, a variety of participatory epidemiological tools, previously described in the literature (Catley, 2005, 2006; Mariner and Paskin, 2003) were utilized to encourage participation of each member in the groups. Due to time constraints, however, not all tools were applied in every village. These PE tools were complimented by direct observation of the flock and their environment. However, due to logistics constraints, clinical examination of sick goats and sample collection from clinical cases of CCPP-like disease could not be undertaken.

Semi-structured interviews: These were used to collect general information about the livestock owners, types of livestock kept, use of livestock and livestock diseases encountered. The interviews were guided by a pre-tested and adjusted prior to the initiation of the study checklist of open-ended questions. Interviews were conducted using the national Swahili and local Maasai languages with the help of a translator. The interviews also collected descriptions of the clinical presentation of CCPP in goats.

Proportional piling: This tool was used to rank livestock species by numbers and relative contribution to livelihoods, using the method described in the literature (Catley, 2006). For this, participants first listed the livestock species kept. A circle was drawn on the ground representing each species. Participants allocated 100 counters (beans or maize seeds) to the circles according to the relative numbers of each species. The exercise was then repeated, except this time participants were asked to allocate the counters in proportion to the relative contribution each species made to their livelihoods. Follow-up questioning explored the range of benefits that each livestock species provided.

Relative annual incidence of CCPP: This was assessed using two methods adapted from the method described in the literature (Catley, 2005, 2006). First, participants were asked to list all the diseases that had affected goats in the past year (July 2006 to June 2007). Discussions were then initiated on the clinical signs of CCPP, as well as its incidence relative to other diseases. Participants were then asked to focus on one CCPP outbreak and to divide the individual piles of counters previously used to rank the livestock species by numbers into two sub-groups: those that developed CCPP and those that did not. For those that had CCPP, the counters were further subdivided into the proportion that died and the proportion that recovered. This method provided an estimate of the incidence of CCPP, as well as the outbreak case fatality rates during the outbreak.

To assess the relative incidence of CCPP compared to that of other caprine diseases, participants were asked to consider each diseases in turn. Taking 100 counters, they were asked to allocate these into two groups: the proportion that got sick in the past one year (between July 2006 and June 2007), and the proportion that remained healthy. For the counters allocated to the 'got sick' category, participants next subdivided the counters amongst the various diseases that they had listed earlier. For each disease, the counters were finally subdivided in proportion to those animals that survived and those that died.

Perceived association between diseases and clinical signs and risk factors: Informal interviews with pastoralists were used to identify five most important goat diseases to be used in the matrix scoring along with CCPP (local Maasai name *orkipie*) using the proportional piling technique (Catley, 2005, 2006). These five diseases and their local names were CCPP (*orkipie*), Mange (*emukuji*), Heart water (*ormilo*), anthrax (*engeeya nairowa*) and Pox

Table 1: Mean proportions (%) indicating the relative populations of the livestock species kept by the Maasai pastoralist as determined through proportional piling exercises

Livestock species	Ngorongoro(n = 8) Mean±SD	Monduli (n = 5) Mean±SD	Longido(n = 5) Mean±SD	Overall (= 18) Mean±SD
Cattle	29.1±7.1	31.2±4.1	35.5±6.5	31.9±11.2
Sheep	34.1±9.2	35.5±4.9	33.1±8.7	34.3±13.2
Goat	26.6±9.3	20.8±5.9	24.3±6.9	23.9±7.8
Other[a]	10.3±7.5	11.3±4.8	7.9±6.7	9.9±6.4

[a]: Other livestock species mentioned by participant were chicken, ducks, dogs and donkeys
n : The number of villages involved in the proportional piling exercises

Table 2: The mean (%) relative importance of livestock species as scored by Maasai pastoralist based on livelihood derived from each species

Livestock species	Ngorongoro (n = 8) Mean ±SD	Monduli (n = 4) Mean±SD	Longido (n = 4) Mean±SD	Overall (n = 16) Mean±SD
Cattle	46.9±4.3	47.8±6.5	48.5±7.3	47.7±12.1
Sheep	21.9±7.6	20.8±12.4	19.7±5.9	20.8±10.0
Goat	26.2± 5.1	14.6±5.4	16.4±8.2	19.06±8.3
Other[a]	8.0 ±6.7	15.7±12.8	13.6±9.8	12.4±10.7

[a]: Other livestock species mentioned by participant were chicken, ducks, dogs and donkeys
SD = Standard deviation
n : The number of villages involved in the proportional piling exercises

(*elomoroj*). Simple matrices were constructed on the ground. Various clinical signs formed the y-axis and five diseases, one of which was CCPP, formed the x-axis. Likewise, risk factors formed the y-axis and diseases formed the x-axis. Twenty-five counters were allocated for each disease and the participants were asked to divide the counter in relation to the relative importance of each symptoms/clinical signs or risk factors played in the disease.

Disease impact matrix score: Participants were asked at the beginning of interview to give a list of benefit that were perceived and score them based on number and importance to their livelihood using matrix scoring described in the literature (Catley, 2005, 2006; Mariner and Paskin, 2003). A matrix was constructed on the ground, with benefits along the y-axis and diseases on the x-axis. Participants were given 25 counters, and allocated them to the benefits according to the relative importance of each benefit, with the most important benefit receiving the highest number of counters. The counters for each benefit were then sub-allocated to each disease to show the relative negative impact of each disease on a family's ability to achieve that benefit, with the disease having the greatest impact receiving the highest number of counters. The number of counters allocated for each disease was totaled: this was a measure of the overall impact of that disease on livestock-derived livelihoods.

Key-informant interviews: These were conducted with various officials who had been involved in the management of the diseases, such as local government officers with responsibility for veterinary issues, along with community-based animal health workers (CAHWs) and village leaders.

Data management and statistical analysis: A database was constructed in Microsoft Excel® to store the data. Descriptive analyses were conducted using queries executed in Excel, and other statistical analyses were conducted in SPSS 11.0. The level of agreement between informant groups was determined using the Kendal coefficient of concordance (*W*) in the SPSS 11.0 (SPSS, 2002). Agreement was termed 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 (Siegal and Castellan, 1998).

RESULTS

Relative livestock herd structure, benefits and importance of each livestock species: Sheep constitute the largest proportion of livestock species (Table 1) kept in Ngorongoro, Monduli and Longido districts. Cattle population comes second to sheep while goats are the third in population size. Other livestock kept, however in small numbers, were donkeys, dogs and chicken.

In all surveyed villages, livelihoods depended largely on livestock (Table 2). Cattle were the livestock species that made by far the greatest contribution to livelihoods. On average, cattle were considered to be about as important for livelihoods as both sheep and goats combined. For all livestock species, the main benefit derived from livestock was reported to be food, which included meat, milk, ghee and fat (32%).The second most important benefit was income from sales of surplus animals or produce (23%).Other lesser benefits include skins for sheep and socio-cultural roles (14%) for various species, such as conflict resolution and payment of dowry with cattle or goats. Goats were often exchanged (16%) for cattle in the process of herd building; twelve goats or sheep can be exchanged for one heifer or a young bull. In some districts, hides for clothing (9%) and manure (6%) were also mentioned as an important livestock-derived benefit.

Table 3: Mean scores (out of a total of 25 per clinical sign) derived from simple matrices constructed with Maasai pastoralists for five diseases of goats according to the level to which they manifest selected clinical signs

		Assigned score[a], Mean±SD				
Clinical sign (n)	*W*	Mange	CCPP	Pox	Anthrax	Heart-water
Salivation (11)	*W* = 0.62*	1.3±4.2	11.4±7.4	5.4±8.2	4.4±5.4	2.5±4.6
Kids death (14)	*W*= 0.36*	2.0±3.0	8.2±4.4	5.8±6.3	5.0±3.6	4.0±3.5
Adult sudden death (13)	*W* =0.68*	0.3±1.1	6.5±4.2	1.5±2.2	12.5±6.3	4.2±3.5
Diarrhea (14)	*W* =0.72**	0.9±3.2	17.7±9.0	2.9±6.6	3.5±7.1	0
Abortions (14)	*W* = 0.35*	5.8±3.9	7.1±3.3	6.7±3.1	0	5.4±2.6
Purulent nasal mucous (12)	*W* =0.78**	1.1±3.8	13.8±9.6	4.8±8.3	3.8±6.8	1.5±3.3
Circling (14)	*W* =0.75***	0	0	0	2.2±4.3	22.8±4.3
Labored breathing(13)	*W* =0.65**	0	17.3±7.3	5.3±7.6	0	2.4±4.3
Coughing (13)	*W* =0.80***	0.9±3.3	23.8±3.4	0	0.3±1.1	0
Skin lesion (13)	*W* =0.83***	12.0±2.4	0	13.0±1.4	0	0

SD = Standard deviation,
n: The number of groups involved in the matrix scoring exercises which considered that this clinical sign was associated with at least one of the five diseases
[a]: The higher the score, the more strongly pastoralists associated that clinical sign with the given disease
W: Kendal coefficient of concordance (*: p<0.05; **: p<0.01; ***: p<0.001); CCPP- Contagious caprine pleuropneumonia

Table 4: Mean scores (out of a total of 25 per risk factor) derived from simple matrices constructed with Maasai pastoralists in showing five goat diseases with respect to their perceived strength of association with predetermined risk factors

		Assigned score[a], Mean±SD				
Risk factor (n)	*W*	Mange	CCPP	Pox	Anthrax	Heart-water
Sharing pasture (13)	*W* = 0.54*	3.4±4.6	11.1±3.2	7.1±4.8	2.9±3.4	0.5±1.9
Floods (6)	*W* = 0.33*	0.8±1.3	7.4±6.0	7.7±9.4	4.3±6.2	4.8±10.0
Tsetse (4)	*W* = 0.38*	4.8±3.5	0	2.8±3.5	2.5±5.0	14.9±7.5
Contact (4)	*W* = 0.62**	6.8±4.6	8.1±6.8	7.2±6.7	0.5±3.0	2.5±3.5
Heavy rains (11)	*W* = 0.58*	2.6±2.8	4.3±4.5	6.4±8.7	5.5±7.4	6.2±5.8
Ticks (13)	*W* = 0.78***	0	0.7±2.4	0.9±3.0	0.9±3.0	22.5±5.9
Sharing water point (13)	*W* = 0.68**	1.8±3.7	11.2±2.4	7.4±5.0	3.7±4.9	0.9±1.8

SD = Standard deviation
n: The number of groups involved in the matrix scoring exercises which considered this risk factor as being associated with at least one of the 5 diseases
[a]: The higher the score, the more strongly pastoralists associated that risk factor with the given disease
W: Kendal coefficient of concordance (*: p<0.05; **: p< 0.01; ***: p<0.001); CCPP- Contagious caprine pleuropneumonia

General livestock diseases: Key informants and pastoralists reported that high proportions (61, 56 and 56%) of their goats (n = 13), sheep (n = 13) and cattle (n = 12) had been sick during the 12 month period July 2006-June 2007, with CCPP been cited as one of the most prevalent disease in goats. Although the range of livestock diseases that pastoralists reported varied somewhat between the three districts under study, CCPP featured prominently for goats in all three areas.

Local characterization of CCPP: The Maasai pastoralists proved to be knowledgeable at recognizing symptoms of CCPP in their goat stock, and also in identifying risk factors associated with the disease. The Maasai pastoralists consistently and correctly listed symptoms such as laboured breathing, coughing, diarrhea and purulent nasal mucous emanating from the nose as being indicative of CCPP, and also correctly associated the disease with contact, sharing water and pasture. In addition, they correctly thought that vectors (tsetse and ticks) were not a major risk factors associated with CCPP. However, it should be noted that the same communities consistently and strongly associated appropriate risk factors with other diseases; for example ticks with heartwater. The results of matrix scoring for CCPP and other diseases are shown in Table 3 and 4. There was moderate to good agreement between the 14 informant group for the 10, 7 disease signs and risk factors, respectively (W = 0.33 to 0.83; $p<0.05$)

CCPP disease incidence: The relative morbidity of CCPP and case mortality was explored through proportional piling to ascertain the perceived morbidity and mortality associated with the disease (Table 5). The result shows the relative mean annual morbidity and case mortality rate due to CCPP, with 10th and 90th percentile range, to be 31.6% (24.4, 46.7) and 61.4% (48.1, 82.3), respectively. With respect to the 3 districts under study, these relative proportions were, however, not significant different ($p>0.05$).

Impact of CCPP on flock owner's livelihood: Ranking diseases of goats by impact using matrix scoring revealed that pox (34.3%) was ranked as the most prevalent disease over the period under study. Pre-determined impact factors were deaths, lowered value of infected animals,treatment costs rated to be high, abortion induced by the disease and stress exerted on animal owner. Other

Table 5: The mean annual relative incidence and case mortality rates due to CCPP in goats as scored by flock keepers involved in the study (n =13)

District	Interviewed groups	Mean annual relative incidence, (with 10th and 90th percentile range)	
		Morbidity (%)	Case mortality (%)*
Ngorongoro	Group 5(n = 72)	34 (27.1, 46.7)	62.2(52.3,78.5)
Monduli	Group 4(n = 46)	32(25.4, 39.6)	66.3(54.1,76.3)
Longido	Group 4(n = 34)	29(19.5, 38.8)	55.8(42.7, 68.3)
	Overall 13(n =152)	31.6 (24.4,46.7)	61.4(48.1,82.3)

n: The number of participants involved in the proportional piling exercises

*: Case mortality represents the animals scored as having died from the pile of those that got CCPP

diseases and their scores in descending order were anthrax (19.2%), heartwater (18.5%), CCPP (17.6%) and mange (10.4%).

DISCUSSION

In Tanzania, the factors responsible for mortalities and low productivity in the extensive small ruminant production sector are not fully known. It is well established that serological confirmation and isolation of Mycoplasma capricolum *subspecies capripneumoniae* (Mccp) from clinical sick animal, reflect animal exposure to virulent Mycoplasma pathogen. This useful laboratory support service was not undertaken due to logistic reasons. This information would have been valuable for supporting the finding of this PE study and developing disease control strategies.

The study showed that Maasai pastoralists described clinical and epidemiological features of CCPP according to the typical descriptions of the disease in veterinary descriptions and textbooks. Results of this present study is also in agreement with other work carried elsewhere in Tanzania of which results were based on clinical and post-mortem features (Msami *et al*., 2001a). Perceptions of the clinical signs, risk factors were all consistent with veterinary thinking (Radostits *et al*., 1994).

Relative annual incidence and mortality estimates indicated CCPP was endemic in the three districts under study, which represented typical Maasai pastoral system. CCPP was first reported and confirmed in one of the three districts 10 years ago (Kusiluka *et al*., 2007), signifying the long term presence of the disease. Compared to other caprine diseases investigated in this study, CCPP was ranked number 4 in terms of perceived socio-economic impact to pastoral livelihoods. It was clear that pastoralists were more concerned most with diseases such as pox, anthrax and heartwater as compared to CCPP or mange. Failure to pastoralist to rank CCPP highly may be explained by masking of the lesions (i.e., pox), signs (circling for heartwater) and sudden death (anthrax), which seem to be somewhat more expressive to pastoralists.

In this study, it is noted that different Maasai pastoralists interviewed had different levels of traditional knowledge concerning caprine diseases in general and CCPP in particular (Mariner and Paskin, 2003). Diseases like pox, mange, which can be easily confused with dermatophilosis and Orf (Msami, 1991; Msami *et al*., 2001b) (common diseases in goats in Tanzania) and heartwater were detailed and accurately described both clinically and an appreciation of the clinical signs and risk factors associated with the diseases was demonstrated. The fact that the difference in knowledge levels was noted to relate to all disease suggests that recall bias due to differences in elapsed time between the disease occurrence and the study in the three study district was not the principal source of differences in CCPP knowledge. It has been suggested that the superior knowledge of the Maasai pastoralist on CCPP may be due to the fact that they have to be self-reliant with regard to animal health as they are very poorly served by conventional animal health services. However, it is also possible that their knowledge had been enhanced by exposure to a range of CCPP awareness-raising activities undertaken in the area by various actors.

Although CCPP was found to be prevalent disease in the 3 districts under study from July 2006 to June 2007, it proved to be the disease that had the lowest impact on benefit derived from goats for Maasai pastoralists in the area. The lower livelihood impacts reported by the Maasai did not match with the perceived morbidity (32%) and mortality (61%) rate detected in this study. This may suggest that at least in Maasai community, other un-investigated factors, beyond the scope of the present pre determined factors in this study were more important in determining the impact of CCPP in this pastoral system.

This study points out the important role that flock owners can play in veterinary surveillance (Allport *et al*., 2005; Mariner and Paskin, 2003; Miaron *et al*., 2004). Proportional piling and matrix scoring results showed that the pastoralists in this study could associate heartwater and ticks as well as CCPP and sharing contaminated pasture or water and contact with infected animals. These facts were common knowledge among flock owners well in advance of the detection of CCPP by veterinary service surveillance systems.

The potential limitation of this study is the inability to collect relevant sample for laboratory diagnosis

consistent to CCPP confirmation. In addition, due to time constraints, constructing disease calendar and timeliness was not made, useful information which could have explain the disease occurrence over time for better targeting disease control interventions.

CONCLUSION

In conclusion, CCPP was identified and perceived to be one of the important goat disease, wide spread and endemic in northern Tanzania and possibly other parts of Tanzania. This widespread is partly attributed to the lack of disease control programme; poor veterinary service delivery in the marginalized rural areas and uncontrolled animal movement. Matrix scoring between groups revealed that CCPP clinical signs and causes showed moderate to good agreement consistently with veterinary thinking. PE complimented with local knowledge could generate disease information with least laboratory support service and therefore assisting the designing of disease surveillance and control program in under served rural pastoral and non-pastoral areas.

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