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Control of contagious bovine pleuropneumonia: Knowledge, attitudes, perceptions and practices in Narok district of Kenya

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ABSTRACT

CBPP is an important transboundary disease in sub-Saharan Africa whose control is urgent. Participatory data collection involving 52 focus group discussions in 37 village clusters and key informant interviews, a cross-sectional study involving 232 households and a post-vaccination follow up involving 203 households was carried out in 2006–2007 in Narok South district of Kenya. This was to investigate knowledge, attitudes, perceptions and practices (KAPP) associated with control of CBPP as well as the adverse post-vaccination reactions in animals in order to advice the control policy. The community perceived trans-boundary CBPP threat to their cattle. They had traditional disease coping mechanisms and were conversant with CBPP prevention and control with 49.8% (95%CI: 42.8–56.7%) giving priority to CBPP control. However, 12.9% (95%CI: 9.0–18.1%) of pastoralists had no knowledge of any prevention method and 10.0% (95%CI: 6.5–14.7%) would not know what to do or would do nothing in the event of an outbreak. Although 43.5% (95%CI: 37.1–50.2%) of pastoralists were treating CBPP cases with antimicrobials, 62.5% (95%CI: 52.1–71.7%) of them doubted the effectiveness of the treatments. Pastoralists perceived vaccination to be the solution to CBPP but vaccination was irregular due to unavailability of the vaccine. Vaccination was mainly to control outbreaks rather than preventive and exhibited adverse post-vaccination reactions among 70.4% (95%CI: 63.6–76.5%) of herds and 3.8% (95%CI: 3.5–4.2%) of animals. Consequently, nearly 25.2% (95%CI: 18.5–33.2%) of pastoralists may resist subsequent vaccinations against CBPP. Pastoralists preferred CBPP vaccination at certain times of the year and that it is combined with other vaccinations. In conclusion, pastoralists were not fully aware of the preventive measures and interventions and post-vaccination reactions may discourage subsequent CBPP vaccinations. Consequently there is need for monitoring and management of post vaccination reactions and awareness creation on CBPP

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prevention and interventions and their merits and demerits. CBPP vaccine was largely unavailable to the pastoralists and the preference of the pastoralists was for vaccination at specified times and vaccine combinations which makes it necessary to avail the vaccine in conformity with the pastoralists preferences. In addition, planning vaccinations should involve pastoralists and neighbouring countries. As the results cannot be generalized, further studies on CBPP control methods and their effectiveness are recommended.

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1. Introduction

Contagious bovine pleuropneumonia is an important disease of cattle caused by *Mycoplasma mycoides mycoides* Small Colony variant (*MmmSC*) (Radostits et al., 2000). The livelihoods of about 24.4 million people in 19 African countries (1.3 million in Kenya), 30–50% of who live below poverty levels, are at risk from the effects of CBPP (Thomson, 2005). In Kenya, CBPP is present in the Karamoja ecosystem bordering Uganda and Southern Sudan, the Somali ecosystem in the eastern part of the country and in the Maasai ecosystem in the south. Over a 10 year period, the incidence of CBPP in Kenya was 2.8% and 12.7% in endemic and epidemic situations respectively and up to 47% in the event of sporadic outbreaks (Wanyoike, 1999) following mass screening of animals.

The options for control of CBPP include cattle movement control and quarantine, stamping out, test and slaughter, treatment and vaccination with T1 vaccines (Radostits et al., 2000). CBPP can disappear from a country with adequate movement control (Newton and Norris, 2000). However, movement control is difficult and often impractical because of need for transhumance, trade, socio-cultural practices, civil strife and inadequate veterinary personnel (Wanyoike, 1999; Windsor, 2000). Thus levels of movement control consistent with sustainable pastoral livelihoods are unlikely to have a major impact on CBPP prevalence (Mariner et al., 2006a).

Stamping out has been termed as the simplest and surest way to control and eradicate CBPP. However, stamping out has far reaching socio-economic effects (Le Gall, 2009). Consequently, it is recommended that stamping out should be a strategy of last resort to be used in critical epidemiological situations such as in the case of outbreaks in a free area or the surveillance zone (of a sanitary cordon) or on major trade routes. It can also be introduced at a later stage of the campaign after substantial reduction of CBPP incidence such that the incidence is approaching zero (FAO, 1997).

The test and slaughter method was extensively used in the clearing of CBPP from the Kenya Maasailand. However, test and slaughter of animals can be a lengthy and difficult process in the absence of adequate quarantine (Scudamore, 1975) although there are cases in which it has been successful when backed by strict movement control to avoid re-introduction of the disease (Wanyoike et al., 2004). CBPP can be eradicated if infected animals are detected at meat inspection, the disease traced back, suspected herds tested and positives slaughtered (Santini, 1998). However, the test and slaughter method may fail in the absence of compensation (Thomson, 2005).

Treatment of affected cattle with antimicrobials has been officially discouraged on the basis that it may favour the creation of chronic carriers which are believed to be responsible for disease spread (FAO, 1967). However, the method may be of use as it reduces mortalities and bacterial burden (Huebschle et al., 2006). Unfortunately there is still not sufficient evidence that sequestra will not break down to cause clinical disease (FAO, 2007) although Huebschle et al. (2006) and Nicholas et al. (2007) have cast doubt on clinical disease emanating from such sequestra. This leaves vaccination as the most practical control option (Tulasne et al., 1996).[4]

The OIE recommends T1 vaccine strain for vaccination against CBPP. It is generally accepted that the protection offered by the vaccine wanes after 12 months (Wesonga and Thiaucourt, 2000) but may last for more than one year (Nkando et al., 2011). However, to reach a herd immunity level of 80% and above for adequate CBPP control, there is a need for biannual vaccination as primal vaccination leads to only 67% protection rate at three months while revaccination at six months leads to 95.5% protection rate (Wesonga and Thiaucourt, 2000). The vaccine is sufficiently avirulent but can cause severe post-vaccinal adverse reactions in some breeds (Teshale, 2005).

The measurement of knowledge, attitudes, perceptions, and practices in control of a disease is important for generating information that can be used in policy advice (Thomson, 2005; McLeod and Rushton, 2007; Heffernan et al., 2008). Although CBPP is known to be an important disease in sub-Saharan Africa, information on pastoralist knowledge, attitudes, perceptions and practices in CBPP control is scanty. This study, which was part of a wider study which explored the use of a modified vaccine in CBPP control (Mtui-Malamsha, 2009; Wanyoike, 2009) was undertaken to close these gaps.

2. Materials and methods

2.1. Selection of the study area

The Mara and Loita divisions of Narok South district (Fig. 1) were chosen as the study sites firstly because, of the 16 CBPP outbreaks recorded in the infected area in Kenya in the period preceding the study, 11 (68.8%) were in Narok district; principally in Mara and Loita divisions (Wanyoike, 2009). Secondly, the knowledge base of the Maasai (the

[4] This however, is for countries whose policy is largely control at present as opposed to those in the process of eradication where the control methods of stamping out and movement control may be more appropriate (OIE, 2008).

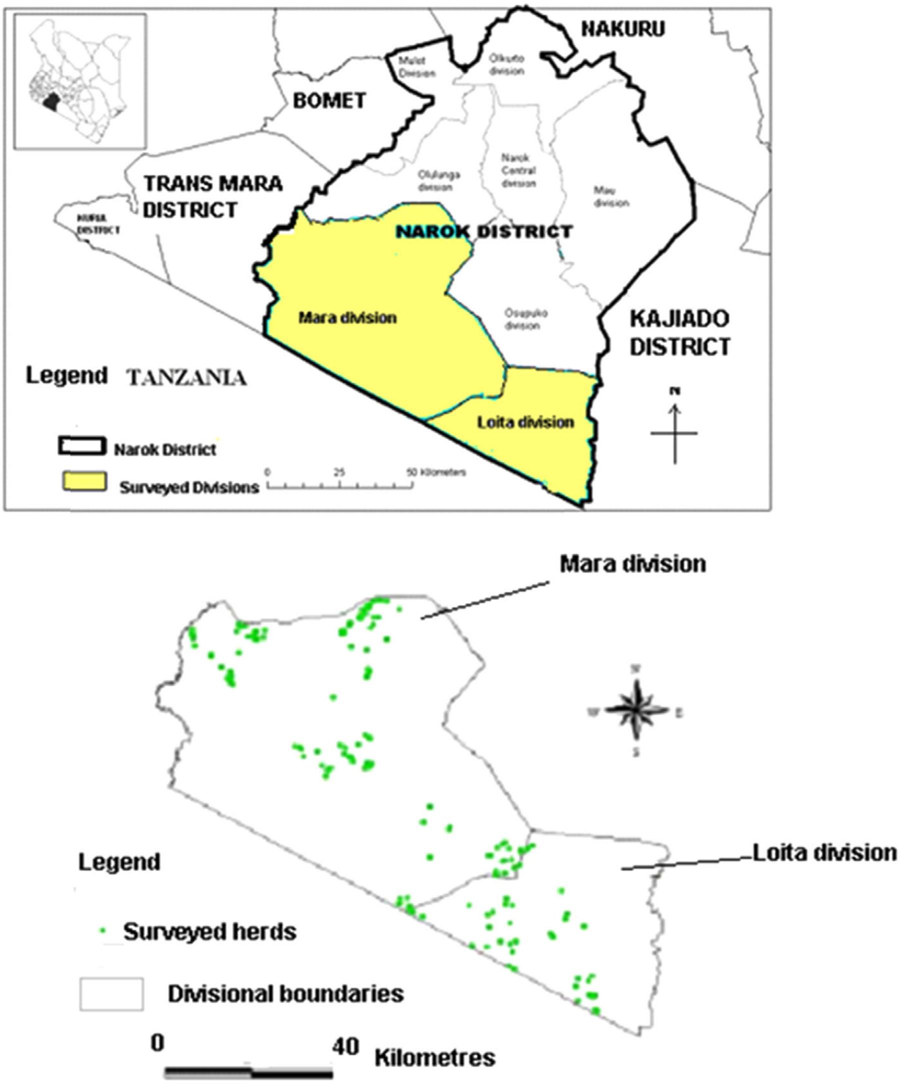

Fig. 1. Map of the study area, Narok, Kenya, 2006–2007.

main inhabitants of this district) on diseases impacting livestock is generally good because of their long experience in livestock keeping and livestock diseases (Wanyoike, 2009). Thirdly, the two study divisions border the United Republic of Tanzania to the South which was considered appropriate for the purpose of obtaining information that could be used in formulating joint CBPP control policies.

2.2. Description of the study area

Narok South district forms part of Maasailand and the arid and semi-arid lands (ASALs) of Kenya. The Maasai are semi-nomadic pastoralists found on both sides of the Kenya-Tanzania border. Men are involved in the protection, vaccination and treatment of livestock and management of cattle as well as the income they generate. Livestock products as well as income emanating from them and small stock are managed by women. Mara division is home to the Maasai Mara Game Reserve and the main economic activities are pastoralism, agro-pastoralism in a few locations and eco-tourism as well as wildlife related activities. Loita division is characterized by lowlands in which pastoralism and agro-pastoralism are practiced (Thompson and Homewood, 2002).

The traditional Maasai homestead called a *boma* belongs to one or more families, often bound together by age-set and clan relationships. Cattle (mainly African Zebu) from one *boma* are herded either together or separately either by family members or by hired herdsmen. At night, cattle belonging to different households come together in the central cattle holding area to protect them from predators and stock rustlers which contributes substantially to disease spread (Lamprey and Reid, 2004). There is seasonal migration between the plains and woodland areas in search of pastures, water and saltlicks and also to avoid diseases such as trypanosomiasis. Livestock cross the Kenya-Tanzania border from both sides leading to cross-border disease spread (Zaal and Ole Siloma, 2006).

The important livestock diseases in Narok district include CBPP, tick borne diseases (mainly East Coast Fever – ECF), Foot and Mouth Disease (FMD), anthrax and trypanosomoses. However, other diseases such as endo-parasites (liver flukes and helminthes), bovine emphemeral fever, pneumonia, lumpy skin disease, black quarter and mastitis also exist (Wanyoike, 2009). The cattle population is approximately 130,000 in Mara division, and 70,000 in Loita division. The number at risk of CBPP is 160,000 as 40,000 cattle are within private ranches and other CBPP low risk areas where grazing is enclosed and herd growth is dependent on calvings rather than purchases (Wanyoike, 2009).

2.3. CBPP control methods in the study area

The incidence of CBPP in Kenya and in Maasailand in particular was largely reduced by test and slaughter and mass vaccination such that by 1970, CBPP was present only in north of the 1° parallel (Wanyoike et al., 2004). Between 1975 and 1990, Narok district was considered as a CBPP 'clean' district as there had been no reported outbreaks (Wanyoike, 1999). The control method had changed to mainly prevention of introduction of CBPP and zoo-sanitary measures at livestock markets, checkpoints (international and zonal) and stock routes (GOK, 2003). However, following civil disturbances in Somalia in 1990–1991, a large number of animals moved into Kenya from Somalia (Wanyoike, 1999). These animals mixed with grazing Maasai cattle or were purchased by traders and pastoralists in South Narok to increase their herds which led to a re-emergence of CBPP in Maasailand in 1990 and inclusion of Narok in the newly infected districts (Wanyoike, 1999; Wanyoike et al., 2004).

Following the re-emergence of CBPP in Narok district in 1989/90, control resumed in the form of quarantine, test and slaughter and annual vaccinations. However, there was resistance by herders to quarantine and movement control due to trade liberalization and dwindling grazing land and rejection of test and slaughter due to reducing cattle herd sizes. Mass vaccinations reduced the disease incidence, but vaccination coverage was still lower than the desired minimum of 80% due to fear of post-vaccination reactions (Wanyoike, 1999). To enhance acceptability, CBPP vaccination had to be combined with other vaccinations such as that against rinderpest or FMD (Wanyoike, 1999).

Currently, Narok South district is in the infected zone (GOK, 2003; Wanyoike et al., 2004) and is under permanent quarantine (Wanyoike, 1999). In Kenya, permanent quarantine is where movement of cattle is restricted to within the district. Movement outside the district is only for slaughter in designated slaughterhouses.

2.4. Selection of sampling units and sample size determination

In the participatory rural appraisal (PRA), the sampling unit was a village cluster. To identify the communities involved and their characteristics, maps of the area under study with respect to household clusters, clans, and resources were created.[5] Candidate clusters were selected in a manner to allow variability in the aspects investigated which included disease reporting and quarantine and pastoralist knowledge, attitudes, perceptions and practices in control against CBPP. Key criteria for selection of the clusters included history of CBPP, sources of livelihood and distance from main roads as a measure of accessibility. Effort was made to cover distant and difficult to access clusters which are often left out in routine service provision. There were 16 and 43 clusters in Loita and Mara division respectively. The number of clusters to be sampled in each division was determined by proportional allocation based on number of clusters in the area. Using these criteria, 37 out of a possible 59 clusters, 10 from Loita and 27 from Mara, were selected.

The sample size for the cross-sectional study was calculated taking into account the larger study whose objective was to determine the prevalence of CBPP. The World Organization for Animal Health (OIE, 2008) (http://www.oie.int/eng/normes/mcode/en_chapitre_1.11.8.htm; last accessed 14 July 2008) recommends the use of complement fixation test (CFT) or competitive enzyme-linked immunosorbent assay (cELISA) as herd-level test and suggests that sample size should be adjusted to compensate for low sensitivity of the tests. The sample size was calculated using Win Episcope 2.0 (http://www.clive.ed.ac.uk) based on 95% confidence level, 5% absolute precision and an expected prevalence of 5% at herd level, higher than the reported prevalence of 2.8% (Wanyoike, 1999) given the perceived rising prevalence (Thomson, 2005). This resulted in a sample size of 6,998 animals. Sampling units comprised single herds belonging to single households. Pastoralists who were interviewed were those whose animals were sampled. Given the need to sample 40 animals in each herd in order to accommodate all age groups and gender resulted in 179 herds (households). This was increased by 30% to take care of any pastoralists that may decline questionnaire administration resulting in 232 herds (households) to be sampled. The number of pastoralists interviewed in each division was determined by proportional allocation based on number of herds in the area, two thirds in Mara division and one third in Loita division (CBS, 2001). Within each division, sub-locations were purposively selected to attain a wide geographical representation. Lists of households from all the villages in the selected sub-locations in the two divisions were obtained from non-governmental organizations working in the area (Loita division) and from a local person hired to list all the households in the selected sub-locations (Mara division). Probabilistic random sampling was then used (Kairu-Wanyoike et al., 2013) to provide the households to be sampled in each division.

In order to collect data on perceptions about the ongoing vaccination, pastoralists from both divisions, were listed and interviewed as the vaccination was happening throughout the vaccination period. It was expected that

[5] In the study area, several households belonging to different owners may come together in a cluster in order to spare the rest of the land for grazing. These clusters can have two to 46 households (Wanyoike, 2009).

the number of pastoralists that would be interviewed in a vaccination period of 60 days would be the same as those interviewed during the cross-sectional study (232). However, since some herds were combined during presentation for vaccination and six out of thirteen sites, mainly in Mara division, were missed out due to inaccessibility following adverse weather, the number of pastoralists available for interview during the vaccination period was only 157. In the next two months after vaccination, the herds of the pastoralists who were interviewed during vaccination were followed up. The owners were interviewed by the trained enumerators using a semi-structured questionnaire to obtain data on the effects of vaccination in their animals. An additional 46 randomly selected herds vaccinated at the six sites not visited during vaccination were also followed up to ensure that the area under study was adequately covered. Ultimately, 203 pastoralists were interviewed which was considered a sufficient sample size to collect the required data given that the minimum calculated sample size in the cross-sectional study was 179 increased to 232 to take care of non-responses.

2.5. Data collection

Ethical clearance for the various studies was obtained from the University of Reading Ethical Committee. A one page information sheet backed by a verbal explanation of the purpose of carrying out the studies was given to the participants. Data collection progressed only after consent was given by the participants. Data were collected through a participatory rural appraisal (PRA) in April to May 2006, a cross-sectional study between July and September 2006 and a vaccination follow up from May to June 2007 after a vaccination in February to April 2007.

Participatory rural appraisal was used in order to involve pastoralists in the study area in identifying problems and finding solutions as a community (Chambers, 1994). It addressed the issues of sources of livelihoods, types of animals kept and their uses, importance of livestock, constraints of livestock keeping as well as symptoms, frequency, seasonality, relative incidence, impact and control of cattle diseases experienced. While other issues are dealt with elsewhere (Wanyoike, 2009), this paper deals with CBPP control issues.

Two teams were involved each consisting of a team leader, a translator and two recorders. The team members had a good command of English and spoken local language. They were trained on participatory methods as described by Catley (2005). Men and women were interviewed separately due to different times of availability and due to the fact that women do not express themselves in the presence of men as found out in the first four mixed trial interviews and as also observed in other pastoralist communities (LDG, 2003). The enumerators introduced themselves and a comprehensive introduction of the objectives of the project was given by the team leader. The participants introduced themselves individually and any questions were dealt with before the interview commenced. Unrealistic expectations were avoided by making no promises, except that information would be fed back to the participants. The team-leaders asked key questions according to a checklist followed by probing questions depending on the respondents' response. At the time that focus group discussions were carried out key informants were also interviewed in order to triangulate information given by the pastoralists. The key informants included knowledgeable pastoralists, veterinary personnel and non-governmental organization personnel working in the area on animal health. The teams were supervised by one of the researchers and daily interview reports were made by each team at the end of each day of data collection.

The cross-sectional study was carried out in two parts and involved in-person administration of semi-structured questionnaires by trained enumerators. The completed questionnaires were checked and any clarifications and corrections made before leaving the premises. The questions in the questionnaire were designed to obtain individual pastoralist data on the aspects under investigation. These also included a prioritization question in which pair-wise ranking was used in a matrix with livestock activities (livestock disease reporting, vaccination, purchase of drugs) on one axis and socio-economic activities on the other axis.

The pastoralists presenting animals for vaccination were interviewed at the vaccination site by trained enumerators using a semi-structured questionnaire to obtain data on attitudes, perceptions and practices as well as constraints in vaccination. In the following two months after the vaccination in each division, the same randomly selected pastoralists interviewed at the vaccination sites and the additional ones were interviewed by the trained enumerators using a semi-structured questionnaire to obtain data on the effects of vaccination in their animals.

2.6. Data analysis

Data were managed using Microsoft Access 2007 and analyzed using Microsoft Excel and SPSS version 20 (SPSS Inc., Chicago, IL). Data from the PRA were analyzed to show the knowledge, attitudes, perceptions and practices in CBPP control at community level while data from the cross-sectional and the post-vaccination follow up studies were analyzed to show knowledge, attitudes, perceptions and practices in CBPP control at individual household level. The proportions reported in the findings include 95% confidence intervals. The confidence intervals of proportions were calculated using an online calculator (Newcombe, 1998) applying the equation:

$$p \pm Z_{0.95}\sqrt{\frac{p(1-p)}{N}} \pm \frac{0.5}{N}$$

where p is the proportion, $Z_{0.95}$ is the standard normal variate for 95% confidence which is 1.96 and N is the sample size. The value of $0.5/N$ is the correction factor for continuity (normal distribution) since the distribution for proportion is discrete rather than continuous. Chi-square test was used to compare proportions using MedCalc Version 13.1.0.0 online calculator. Findings were considered significant at $p < 0.05$.

Table 1
Social structure of the population surveyed, Narok, Kenya, 2006.

Variable description	Median	Range
Household cluster size	3	2–46
Number of cattle in individual herd	75	4–600
Number of crossbred cattle in a herd	0	0–110
Number of years of education of household head	0	0–14
Number of family members	7	1–45
Number of times CBPP experienced in last 15 years	0	0–4
Number of years since CBPP was experienced	0	0–47

Source: Adapted from Kairu-Wanyoike et al. (2013).

3. Results

In the PRA, on average four to 20 self-selected interviewees were present for 52 focus group discussions (FGDs). Each focus group discussion had a males and females subgroup. In large village clusters, more than one focus group discussions were held in the 37 selected village clusters.

The results of the first four interviews besides these 52 were not taken into consideration because of the underrepresentation of women opinion. The results of the FGDs are as reached through consensus of the FGD participants. The cross-sectional study involved 232 households. In the first part of the cross-sectional study responses were obtained from all 232 households. In the second part responses were obtained from 209 households as some households could not be reached following adverse weather. However, the latter sample size was still sufficient as the sample size calculation had taken care of such eventualities and the missed households were distributed over the entire study area (Kairu-Wanyoike et al., 2013). In total, 79,959 cattle in 458 herds were vaccinated with T1/44 vaccine through the tail tip and ear-tagged. During vaccination 157 pastoralists, 90 from Mara division and 67 from Loita division were interviewed. Two months post vaccination, 203 pastoralists, 140 (69.0%) from Mara division and 63 (31.0%) from Loita division were interviewed. The social structure of the population under survey is in Table 1. In the cross-sectional study, 67.9% of respondents were strictly pastoralists with male participants accounting for 73.7% of the total respondents. Mixing of animals during grazing, watering and salt-lick visits was by 70.0% of the pastoralists. About 87.4% had knowledge of CBPP. The respondents were well distributed across the various sub-clans.

3.1. Pastoralist knowledge, attitudes, perceptions and practices in CBPP reporting and quarantine

According to the focus group discussions, there was fear of reporting CBPP by pastoralists due to fear of quarantine. However in the case of rumours of the disease, the pastoralists reported the disease in the hope that their cattle would be vaccinated to avoid possible outbreaks. Pastoralists indicated that response to such reports by the veterinary department was not always immediate, causing them to report several times (thus incurring considerable travel and time costs) and to seek the intervention of local leaders. Although they cited traditional quarantine as an effective method of CBPP control, they felt that its implementation was diminishing due to declining respect for traditional values, rules and norms. They expressed that veterinary quarantine, which involves closure of markets, though effective, was no longer adequately enforced. Pastoralists had turned to measures to avoid grazing, watering points and salt licks frequented by suspected infected animals, restriction of trekking of animals through the area by stock traders and separation of the sick from the healthy.

3.2. Pastoralist knowledge, attitudes, perceptions and practices in CBPP control

According to the cross-sectional study, 61 out of 72 (84.7%) pastoralists from Loita division and 136 out of 137 (99.3%) pastoralists from Mara division thought it was important that CBPP be controlled. According to the pastoralists, CBPP has not been controlled because of inaccessibility to CBPP vaccine (36.6%), uncontrolled cattle movement (26.1%), communal grazing, watering and saltlicks (15.8%) and purchases, gifts and loans from infected sources (14.0%). Other reasons quoted (7.5%) were low vaccination coverage due to pastoralists 'hiding their animals' sometimes because there is no disease at the time of vaccination, short-lived vaccine potency and presence of wildlife.

A ranking of activities in the cross-sectional study indicated that except when there is need to seek medical attention for humans, livestock disease reporting, presentation of animals for CBPP and other vaccinations and buying of control products such as drugs and vaccines took priority over social, farming and other economic activities for 98.1% of pastoralists in Mara division and 93.8% of pastoralists in Loita division. However, among 209 pastoralists (from the total 232) interviewed in the cross-sectional study, the diseases that were considered as priority in the two divisions with regard to control were ECF, trypanosomoses, FMD, CBPP, heartwater and anthrax (Table 2). Overall, 33 (15.8%; 11.3–21.6%) pastoralists were indifferent to priority for CBPP control with a statistically insignificant difference between the two divisions ($p = 0.2547$). Another 71 (34.0%; 27.7–40.9%) did not think CBPP was priority, more so in Loita than in Mara division ($p = 0.0314$). The number of pastoralists who thought that CBPP control was priority was 104 (49.8%; 42.8–56.7%), without statistically significant difference ($p = 0.3265$) between the two divisions. The differences between the proportions of pastoralists in the two divisions who considered FMD ($p = 0.0069$), trypanosomoses ($p < 0.0001$) and heartwater ($p < 0.0001$) as top priority regarding control were statistically significant. Overall, the pastoralists thought it was more important to control ECF, trypanosomoses and FMD than to control CBPP.

The prevention options that pastoralists said they could use against CBPP are detailed in Table 3. The preferred prevention methods were vaccination and avoiding contaminated grazing, watering and saltlicks points. The latter was cited more in Mara division than in Loita division ($p = 0.0002$). Traditional quarantine was also mentioned more in Loita division than in Mara division ($p = 0.0117$). However, some pastoralists mainly from Loita division ($p < 0.0001$) would not apply any prevention method while

Table 2
Prioritization of diseases for control, Narok, Kenya, 2006.

Priority disease for control	Total, *n* (%)	Mara, *n* (%)	Loita, *n* (%)	*p*
FMD	123 (58.9) (52.1–65.3)	71 (51.8) (43.2–60.4)	52 (72.2) (60.2–81.8)	0.0069
Anthrax	36 (17.2) (12.7–22.9)	22 (16.1) (10.6–23.5)	14 (19.4) (11.4–30.8)	0.6836
ECF	186 (89.0) (84.0–92.6)	120 (87.6) (80.6–92.4)	66 (91.7) (82.1–96.6)	0.5042
CBPP	104 (49.8) (43.1–56.5)	72 (52.6) (43.9–61.1)	32 (44.4) (32.9–56.6)	0.3265
Trypanosomoses	132 (63.2) (56.4–69.4)	107 (78.1) (21.9–37.7)	25 (34.7) (24.1–46.9)	<0.0001
Heartwater	84 (40.2) (33.8–47.0)	40 (29.2) (21.9–37.7)	44 (61.1) (48.9–72.2)	<0.0001

The values below the number and proportions, in parentheses, are the 95% confidence intervals for proportions. The *p* value is for the difference in proportions.

Table 3
Prevention methods that pastoralists would use against CBPP, Narok, Kenya, 2006.

Prevention method	Total, *n* (%)	Mara, *n* (%)	Loita, *n* (%)	*p*
Vaccinate	86 (37.1) (31.1–43.5)	58 (37.7) (30.4–45.5)	28 (35.9) (26.2–47.0)	0.9011
Avoid infected communal grazing, watering, saltlicks	49 (21.1) (16.4–26.8)	44 (28.6) (22.0–36.2)	5 (6.4) (2.8–14.1)	0.0002
Avoid infected communal grazing, watering, saltlicks and vaccinate	44 (19.0) (14.5–24.5)	35 (22.7) (16.8–30.0)	9 (11.5) 6.2–20.5)	0.0602
None	17 (7.3) (4.6–7.3)	2 (1.3) (0.4–4.6)	15 (19.2) (12.0–29.3)	<0.0001
Don't know	13 (5.6) (3.3–9.4)	4 (2.6) (1.2–6.5)	9 (11.5) (6.2–20.5)	0.0130
Traditional quarantine	11 (4.7) (2.7–8.3)	3 (1.9) (0.7–5.6)	8 (10.3) (5.3–19.0)	0.0117
Avoid infected communal grazing, watering, saltlicks, purchase of cattle from infected origin and vaccinate	8 (3.4) (1.8–6.7)	4 (2.6) (1.2–6.5)	4 (5.1) (2.0–12.5)	0.5447
Avoid purchase of cattle from infected origin	2 (0.9) (0.2–3.1)	2 (1.3) (0.4–4.6)	0 (0.0) (0.0–4.7)	0.7948
Traditional quarantine and vaccinate	2 (0.9) (0.2–3.1)	2 (1.3) (0.4–4.6)	0 (0.0) (0.0–4.7)	0.7948
Total	232 (100.0)	154 (100.0)	78 (100.0)	

The values below the number and proportions, in parentheses, are the 95% confidence intervals for proportions. The *p* value is for the difference in proportions.

others, mainly from Loita division did not know any prevention method ($p = 0.013$). The interventions that they indicated they could use in the event of an outbreak are detailed in Table 4. About 21 (9.1%; 5.1–13.7%) pastoralists would not know ('Do not know') what to do in the event of an outbreak. The pastoralists would mainly report or treat but would also use various combinations of interventions with differences between the divisions. The interventions that they instituted in actual CBPP outbreaks are detailed in Table 5. These were mainly vaccination and treatment. A large proportion intervened by a combination of treatment and vaccination more so in Loita division than in Mara division ($p = 0.0169$). However, in the event of an outbreak, 6 (5.3%; 2.2–11.7%) of pastoralists did nothing.

3.3. *Pastoralist attitudes, perceptions and practices in treatment against CBPP*

In the focus group discussions, pastoralists expressed reservations about the effectiveness of the treatment as indicated in the following statements:

- "We use Terramycin but the animal "pretends" to recover, goes into chronic stage and becomes emaciated and may die. More animals then come up with disease and follow the same course".
- "Diagnosis of CBPP is when a coughing animal does not respond to treatment".
- "After treatment, although outbreaks are reduced, the disease rotates within the area or within the herd"
- "When we use Terramycin, recovery is not guaranteed".

Table 4
Interventions pastoralists would use in the event of a CBPP outbreak, Narok, Kenya, 2006.

Intervention method	Total, *n* (%)	Mara, *n* (%)	Loita, *n* (%)	*p*
Report	39 (16.8) (12.36–22.39)	24 (17.9) (12.03–25.68)	15 (19.2) (11.51–30.05)	0.9587
Treat	31 (13.4) (9.39–18.58)	19 (14.2) (8.97–21.51)	12 (15.4) (8.54–25.72)	0.9706
Don't know	21 (9.1) (5.82–13.69)	11 (8.2) (4.37–14.55)	10 (12.8) (6.65–22.77)	0.3991
Report and treat	18 (7.8) (4.80–12.18)	11 (8.2) (4.37–14.55)	7 (9.0) (3.99–18.17)	0.9570
Report and vaccinate	18 (7.8) (4.80–12.18)	17 (12.7) (7.78–19.81)	1 (1.3) (0.07–7.91)	0.0089
Report and traditional quarantine	15 (6.5) (3.80–10.66)	2 (1.5) (0.26–5.83)	13 (16.7) (9.52–27.18)	0.0001
Treat and vaccinate	15 (6.5) (3.80–10.66)	10 (7.5) (3.84–13.65)	5 (6.4) (2.38–14.97)	0.9813
Report, treat, traditional quarantine and vaccinate	12 (5.2) (2.82–9.08)	12 (9.0) (4.92–15.45)	0 (0.0) (0.00–5.85)	0.0155
Report, traditional quarantine and vaccinate	10 (4.3) (2.20–8.02)	9 (6.7) (3.32–12.74)	1 (1.3) (0.07–7.91)	0.1462
Vaccinate	9 (3.9) (1.91–7.48)	3 (2.2) (0.58–6.91)	6 (7.7) (3.16–16.59)	0.1173
Traditional quarantine and vaccinate	6 (2.6) (1.06–5.82)	6 (4.5) (1.83–9.91)	0 (0.0) (0.00–5.85)	0.1409
Report, treat and vaccinate	6 (2.6) (1.06–5.82)	6 (4.5) (1.83–9.91)	0 (0.0) (0.00–5.85)	0.1409
Traditional quarantine	5 (2.2) (0.8–5.24)	1 (0.7) (0.04–4.71)	4 (5.1) (1.66–13.31)	0.1142
Treat and traditional quarantine	5 (2.2) (0.8–5.24)	2 (1.5) (0.26–5.83)	3 (3.8) (1.00–11.6)	0.5509
Do nothing	2 (0.9) (0.15–3.41)	1(0.7) (0.04–4.71)	1 (1.3) (0.07–7.91)	0.7608
Total	232 (100.0)	134 (100.0)	78 (100.0)	

The values below the number and proportions in parentheses are the 95% confidence intervals for proportions. The *p* value is for the difference in proportions.

- "With treatment, the disease only subsides and comes back after about 2 months".

The term Terramycin was used to mean any form of oxytetracycline. Older animals were said not to respond well to treatment.

In the cross-sectional study, 101 out of 232 (43.5%; 37.1–50.2%) pastoralists admitted that they were treating CBPP cases. Of these, 96 (95.0%; 88.3–98.2%) indicated they used between 10% and 30% concentration of tetracycline with 85 (84.2%; 75.3–90.4%) using the 10% concentration. Only 3 (3.0%; 0.8–9.1%) indicated they were using a penicillin-streptomycin formulation. The drugs were administered mainly intramuscularly by 84 (83.4%; 74.1–89.6%) and intra-pleurally by 56 (55.4%; 45.3–65.2%). Nine pastoralists (8.9%; 4.4–16.7%) indicated they used the intravenous route and all used more than one route of administration at one time or the other. A few pastoralists indicated that they treated for CBPP by injection through the ribs "because it is close to the lungs" or in the neck region "because it is close to the jugular" and they believed this may be more effective. Those using 10% tetracycline indicated they used a dosage of 10–20 ml as the animals affected are mainly two years old and above and did not necessarily take into account the weights of the animals. Dosages between 25 ml and 50 ml were used by a few pastoralists.

Treatments were recorded to last between one and four days in the majority 88 (87.1%; 78.6–92.7%) of those who treated but longer treatments ranging from five to 90 days were also recorded. About 63 (62.5%; 52.1–71.7%) pastoralists who treated against CBPP indicated that treatment was not effective as disease re-occurred after about two months with cattle becoming emaciated and dying if they were not vaccinated. The remaining 38 (37.5%; 28.3–47.9%) believed the treatment is effective saying that it relieved the symptoms and fewer animals died. Some indicated that they treated the animals due to lack of any other option as the vaccine was unavailable to them. Others treated the animals as they waited for the vaccine as they had observed that "Terramycin" cures other diseases but not CBPP. Only 10 (4.3%; 2.2–8.0%)

Table 5
Interventions instituted by pastoralists against CBPP cases, Narok, Kenya 1999–2005.

Type of intervention used	Total, *n* (%)	Mara, *n* (%)	Loita, *n* (%)	*p*
Treatment	35 (31.0) (22.8–40.5)	11 (42.3) (24.0–62.8)	24 (27.6) (18.8–38.4)	0.2378
Vaccination	12 (10.6) (5.9–18.2)	4 (15.4) (5.0–35.7)	8 (9.2) (4.3–17.8)	0.5909
Treatment and vaccination	42 (37.2) (28.4–46.8)	4 (15.4) (5.0–35.7)	38 (43.7) (33.2–54.7)	0.0169
Nothing	6 (5.4) (2.2–11.7)	0 (0.0) (0.0–16.0)	6 (6.9) (2.8–15.0)	0.3798
Reporting	5 (4.4) (1.6–10.5)	2 (7.7) (1.3–26.6)	3 (3.4) (0.9–10.5)	0.6939
Traditional quarantine and treatment	3 (2.7) (0.7–8.1)	2 (7.7) (1.3–26.6)	1 (1.1) (0.1–7.1)	0.2504
Reporting and vaccination	2 (1.8) (0.3–6.9)	2 (7.7) (1.3–26.6)	0 (0.0) (0.0–5.3)	0.0777
Traditional quarantine and vaccination	2 (1.8) (0.3–6.9)	0 (0.0) (0.0–16.0)	2 (2.3) (0.4–8.8)	0.9465
Traditional quarantine, reporting, treatment and vaccination	2 (1.8) (0.3–6.9)	0 (0.0) (0.0–16.0)	2 (2.3) (0.4–8.8)	0.9465
Traditional quarantine, report, treatment, slaughter and vaccination	2 (1.8) (0.3–6.9)	0 (0.0) (0.0–16.0)	2 (2.3) (0.4–8.8)	0.9465
Reporting and treatment	1 (0.9) (0.1–6.5)	1 (3.8) (0.2–21.6)	0 (0.0) (0.0–5.3)	0.5314
Reporting, treatment, and vaccination	1 (0.9) (0.1–6.5)	0 (0.0) (0.0–16.0)	1 (1.1) (0.1–7.1)	0.4949
Total	113 (100.0)	26 (100.0)	87 (100.0)	

The proportions (%) are of the total herds affected between 1999 and 2005; 26 in Loita division and 87 in Mara division. The values below the the numbers and proportions, in parentheses, are their 95% confidence intervals. The *p* value is for the difference in proportions.

of the 232 interviewed pastoralists indicated that they observed recovery of CBPP cases without treatment, half of who indicated that such animals fell sick again.

3.4. Pastoralist perceptions, attitudes and practices in vaccination against CBPP

In the focus group discussions, pastoralists offered that vaccination was the solution for CBPP as demonstrated by the following statements about vaccination:

- "It is preferred to treatment as it keeps the disease away for at least 6–12 months".
- "It is the only solution for CBPP".
- "It is the only protection for CBPP".
- "It saves the lives of our cattle".
- "Animals recover if vaccinated".

There was high demand for the vaccine during the course of the study following extensive movements during the drought in 2005. However, in a key informant interview, a resident veterinarian explained that CBPP vaccination is unpopular when there is no obvious threat of outbreaks, due to fear of adverse post-vaccination reactions. In the absence of a CBPP outbreak, pastoralists preferred vaccinations in combination with other vaccinations as they did not see the benefits of presenting animals for CBPP vaccination alone given the adverse post-vaccination reactions. In the areas bordering Tanzania, the pastoralists felt that the CBPP vaccine used in Tanzania may not be effective leading to many Tanzanian pastoralists crossing over to Kenya to have their cattle vaccinated. The pastoralists in these areas blamed CBPP outbreaks on migration of unprotected cattle from Tanzania. Generally, pastoralists found fault in that it sometimes took three to four months before vaccination requests were responded to. In the case of vaccination following an outbreak, sometimes vaccination began away from the focus herd leading to losses of animals in the focus and in-contact herds.

In the cross-sectional study, 215 (92.7%; 88.3–95.5%) of pastoralists indicated that they would ask for CBPP vaccination even if the veterinary authorities did not host a vaccination campaign. Two hundred and thirteen (91.8%; 87.3–94.9%) pastoralists indicated that they vaccinated their animals against one disease or another while 197 (84.9%; 79.5–89.1%) indicated that they vaccinated against CBPP in one year or another. About 199 (85.6%; 80.5–89.9%) pastoralists believed that CBPP vaccination coverage can be improved if pastoralists chose when to vaccinate. The trend of vaccinations was increasing for all other diseases except for rinderpest, with pastoralists vaccinating more for CBPP and FMD than for the other diseases. However the level of vaccination across the herds reached a maximum of only 45.2% (Fig. 2). The reasons for vaccinating

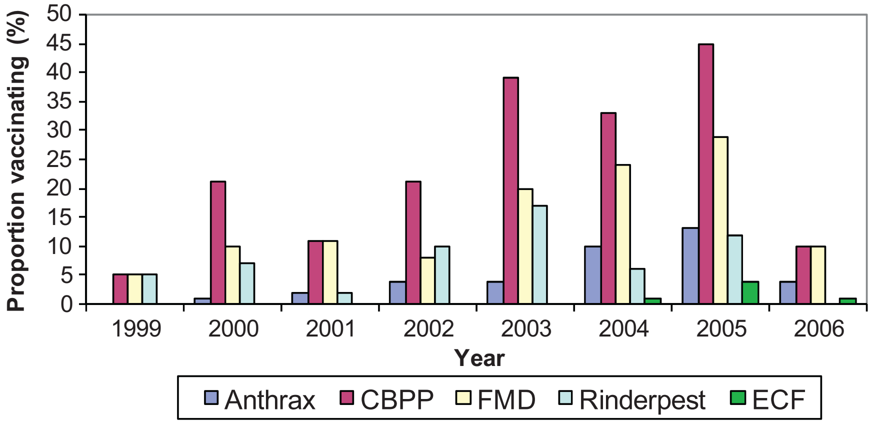

Fig. 2. Vaccinations against various diseases according to pastoralists, Narok, Kenya, 1999–2006.

against CBPP were quoted as outbreak in own herd (32.7%; 26.8–39.1%), ring vaccination due to presence of an outbreak in contact herds (28.6%; 22.8–34.8%), response to rumours (22.4%; 17.3–28.4%), routine preventive vaccination by the veterinary department (12.2%; 8.3–17.1%), and other reasons (4.1%; 2.2–8.0%) which included requests by the pastoralists and suspected disease in the herd.

Virtually all pastoralists were not vaccinating their cattle against CBPP annually but rather, skipped years. By far, the main reason for not vaccinating was unavailability of vaccine (79.6%; 73.9–84.6%), absence of outbreak (10.2%; 6.9–15.2%), fear of severe post-vaccination reactions (5.1%; 2.8–9.1%) and expense of vaccination (2.0%; 0.8–5.2%). Other reasons (3.1%; 1.3–6.4%) mentioned were preference to do something else, no rumours, inappropriate vaccination season and pastoralists having no knowledge on disease or vaccine. Many had a multiplicity of reasons for not vaccinating. The pastoralists associated the lack of the vaccine with the fact that the vaccine is in the custody of the government and 'not just sold to anyone'.

The perceptions of the pastoralists regarding CBPP vaccine protection period are presented in Fig. 3. Of the pastoralists interviewed, 60.0% (53.3–66.2%) perceived the vaccine to be protective for eight months and beyond. However, about half (55.2%; 48.5–61.1%) of the pastoralists interviewed preferred to have their animals vaccinated against CBPP once a year while 36.6% (30.5–43.2%) preferred to have their animals vaccinated twice a year (biannual vaccination). About 4.3% (2.2–8.0%) preferred vaccinations more than twice in a year while 3.9% (1.9–7.5%) did not see the need to vaccinate since they had not experienced the disease. Pastoralists preferring annual vaccination preferred vaccination mainly in June. The reasons for preferring once a year vaccinations were: because of fear of post vaccination reactions more than once a year in their herds (31.2%; 25.2–37.5%); for effective CBPP control because they believed the vaccine works for up to one year (54.4%; 47.7–60.8%); and because CBPP occurs once in a year following migration during drought (14.4%; 10.5–20.0%).

For pastoralists preferring biannual vaccination, they preferred January and June as first months of vaccination and June and December as second months of vaccination. The reasons for preferring these specific months were that animals are healthy and can withstand post vaccination reactions. The reasons for preferring twice a year vaccination were: because they believed the vaccine protects for six months (83.6%; 78.1–88.0%); because they believed the disease comes twice a year (13.8%; 9.8–19.1%); and also so that new calves and purchased animals can be vaccinated (2.3%; 0.8–5.2%).

Unlike with other vaccinations, CBPP vaccination is officially free but according to the focus group discussions, the pastoralists were prepared to pay for it due to the perceived threat of the disease. They were paying an unofficial fee of KSh. 10 (USD 0.12) per head and KSh. 25 (USD 0.29) for a combined vaccination against CBPP and another disease such as FMD or LSD. Sometimes they paid KSh. 1000 to KSh. 2000 (USD 11.7–23.5) per herd of 300 animals which often required them to combine herds. The pastoralists expressed that when there was a need to pay, charges should be fair and should be per herd. According to the cross-sectional study, the pastoralists were also paying on average KSh. 1735 (USD 20.4) for anthrax vaccination, KSh.

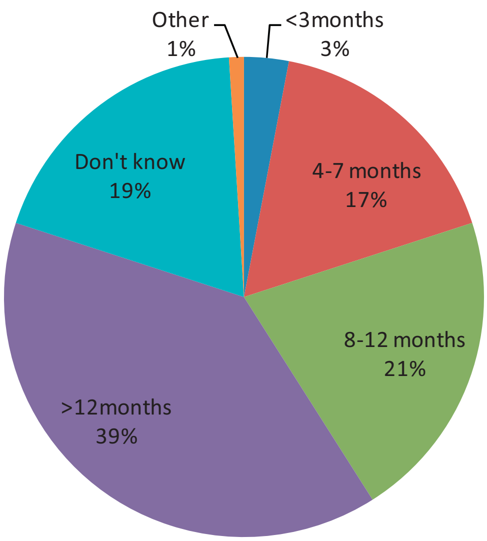

Fig. 3. Pastoralist perception of CBPP vaccine protection period, Narok, Kenya, 2006.

3540 (USD 41.6) for ECF vaccination, KSh. 598 (USD 7.0) for FMD vaccination and KSh. 1403 (USD 16.5) for CBPP vaccination per herd annually.

Vaccination was described by a veteran veterinary officer in the area as 'a major family commitment which supersedes all other activities at the time of vaccination'. Nevertheless, in the interviews during vaccination, 54.1% (46.0–62.1%) of pastoralists felt that vaccination interfered with other activities among them businesses, farming, household and social activities. About 53.5% (45.4–61.4%) of the pastoralists indicated that they would have preferred that the vaccination be combined with another vaccination. Of these, 54.8% (43.6–65.5%) preferred FMD vaccine while 45.2% (34.5–56.4%) preferred other vaccinations among them anthrax, rift valley fever (RVF), ECF and rinderpest.

The constraints of vaccination and suggestions to counter them as cited by the pastoralists are presented in Table 6. The main constraints mentioned were inadequate vaccination days and fatigue among pastoralists and animals. Too few vaccination sites and inadequate vaccines and vaccinators were also cited. Of the pastoralists interviewed post vaccination, 110 (54.2%; 47.1–61.1%) indicated that some 455 out of 17,433 (2.61%; 2.38–2.86%) animals in the vaccinated herds were not vaccinated mainly due to the animals being too young, fear of adverse post vaccination reactions, vaccination sites being too far and sickness.

Adverse post-vaccination reactions were experienced in 143 out of 203 (70.4%; 63.6–76.5%) herds, 96 out of 140 (68.6%; 60.1–76.0%) from Mara division and 47 out of 63 (74.6%; 61.8–84.4%) from Loita division. The reactions involved 497 out of 13,083 (3.8%; 3.5–4.2%) animals, 280 (2.1%; 1.9–2.4%) from Mara division and 217 (1.7%; 1.5–1.9%) from Loita division. There was no statistically significant difference between the proportions of animals reacting in the two divisions ($p = 0.1074$). Among the 143 pastoralists whose animals reacted adversely, 12 (8.4%; 4.6–14.5%) from Loita division and 1 (0.7%; 0.04–4.42%) from Mara division indicated they would not vaccinate in future due to the reactions. The difference between the divisions was statistically significant ($p = 0.0497$). Another 107 (74.8%; 66.8–81.5%) indicated they would still vaccinate. The main drivers for subsequent vaccination were if the vaccine is available (54.2%; 44.3–63.8%) and the perception that vaccine was protective (45.8%; 36.2–55.7%). The remaining 23 (16.1%; 10.7–23.4%) were non-commital.

One hundred and nineteen (83.2%; 75.9–88.8%) pastoralists treated their animals for adverse reactions using 10–30% oxytetracycline either alone or in combination with penicillin-streptomycin. The treated animals were 411 out of 497 (82.7%; 79.0–85.9%) at an average cost of KSh. 58.20 (USD 0.68). per animal.

4. Discussion

This study was carried out in a community which has good knowledge of CBPP and the results cannot be generalized to national level. However, it provides a model that can be used for KAPP studies in other countries and on other diseases. This being a vaccination project, it was not possible to adequately study treatment against CBPP and other control methods that may be useful. The PRA was designed to have a general KAPP view and to inform the design of the cross-sectional study and not for a detailed comparison between the divisions.

Spatial bias was reduced by using accessibility as a selection criterion and making specific efforts to cover distant and difficult to access clusters. Gender bias was minimized by interviewing men and women separately as suggested by LDG (2003). Season bias in the cross-sectional study was decreased by asking questions covering a whole year. Subject bias in which the responses may have been in favour of the project interests was minimized in all studies by giving no special attention to CBPP even in the introduction of objectives. Personal and professional and team biases were reduced through proper training of the enumerators and reshuffling of the teams every two to three days. Reduction of 'dominant-speaker' bias was by allowing as many participants as possible to give their views on a certain issue, by prompting rather silent individuals and by identifying and interviewing more knowledgeable participants separately (key informants). Exposure bias was reduced by constant reassurance of the respondents of the importance of their responses (LDG, 2003).

The lifting of CBPP quarantines requires the confirmation of absence of CBPP in the area (Wanyoike, 1999). With inadequate personnel and declining funds, this can be difficult to achieve (Wanyoike et al., 2004). However, pastoralists have their own coping-mechanisms to control CBPP among them traditional quarantine as has also been observed in Tanzania (Hodgson, 1999). CBPP control can be enhanced through involving pastoral communities and encouraging traditional coping mechanisms. Unfortunately, there was fear of reporting the disease which can seriously affect control and therefore there is need to create awareness among the pastoralists on the benefits of reporting CBPP. In addition, response to CBPP outbreaks is not prompt leading to repeated reporting and treatment of cases with antimicrobials just like any other bacterial disease as has also been observed by Chima et al. (1985) cited by Fasanmi (2004) in Nigeria.

It has been shown using data from Sudan and Ethiopia that a combined vaccination and treatment programme offers potentially greater impact than either approach in isolation (Mariner et al., 2006b; Bonnet and Lesnoff, 2008). Although the approach is used in the study area, treatment is often instituted because the vaccine is not available. It would be advantageous if awareness were created among the pastoralists on the correct use of the two methods.

Although a large number of pastoralists were conversant with CBPP prevention methods and saw CBPP control as a priority in both divisions, 12.9% of pastoralists had no prevention method in mind and 10.0% would not know what to do or would do nothing in the event of an outbreak which may hamper CBPP control. Indeed, 5.3% of pastoralists did nothing in the event of an outbreak. In addition, the level of vaccination reached only 45.2% in the period studied (1999–2006). The researchers did not come across other KAPP studies on CBPP control but there are some regarding other livestock diseases.

Nawayeleselassie et al. (2012) in a canine rabies knowledge, attitudes and practices study in Ethiopia found out that although animal owners may have good knowledge

Table 6
Constraints of vaccination and suggestions to counter them as cited by pastoralists, Narok. Kenya, 2006.

Constraint	No. of times mentioned (n = 157) n (%)	Suggestion	No. of times mentioned n (%)
Farmer and animal fatigue due to slow vaccination leading to unrest	66 (42.0)	Brand instead of ear-tag to save time Regular vaccination	3 (4.5) 64 (97.0)
Crushes too few, far and poorly constructed	39 (24.8)	More and better constructed crushes	38 (97.4%)
Harsh weather for humans (rain and cold)	29 (18.5)	Vaccinate during less harsh weather	15 (51.7)
Too many animals, too few vaccination days	68 (43.3)	Increase vaccination period Regular vaccination	10 (14.7) 64 (94.1)
Inadequate vaccine	28 (17.8)	Provision of adequate vaccine	28 (110.0)
Loss of animals due to mixing	20 (12.7)	Have an organized vaccination schedule so that not all animals arrive at the vaccination crush at the same time	17 (85.0)
Lack of co-operation between farmers in driving animals into vaccination crushes	17 (10.8)	Animals should be accompanied by adequate number of family members	15 (88.2)
Inadequate vaccinators	6 (3.8)	Provision of adequate vaccination personnel	6 (100.0)

of a disease, they may not vaccinate adequately. On the other hand, a similar study in Tanzania showed that those who were more knowledgeable on the disease claimed to practice better rabies prevention and control (Maganga, 2012). In this study, there were also significant differences between the divisions as to which other diseases were important. It was also observed that pastoralists considered the avoidance of infected animal contact points in CBPP prevention as more important in Mara than in Loita division while treatment for CBPP was more rampant in Loita than in Mara division. These findings should be considered in instituting preventive measures in the respective divisions. Pastoralists from Loita division were less aware of CBPP preventive measures and although there were no statistical differences between the divisions regarding the proportion of animals in which there were adverse post vaccination reactions, more pastoralists in Loita division than in Mara division may resist subsequent vaccinations. Therefore, in communities where CBPP is likely to occur, dialogue and awareness creation are important in CBPP prevention and control.

Several scientists have supported the use of antimicrobials on the basis of pastoralists' use of them (Mariner et al., 2006b; Amanfu, 2007). Various modelling and controlled studies have shown that antimicrobial treatment of CBPP may be of use as it reduces mortalities and bacterial burden (Mariner et al., 2006b; Huebschle et al., 2006). However, following discouragement of use of antimicrobials in CBPP control (FAO, 1967), there has been limited research in the use of antimicrobials in control of CBPP. The fact that pastoralists did not regard treatment with antimicrobials (specifically oxytetracyclines) as a real cure for CBPP was demonstrated by the statements made by the pastoralists about treatment. This study has shown that there may be incorrect use of the antimicrobials as regards the dosages used and the routes and frequencies of treatment as also observed by Twinamasiko (2002) in Uganda and Lesnoff et al. (2004) in Ethiopia. There is urgent need to communicate to the pastoralists the correct use of antimicrobials for CBPP control from recent findings of research in new antimicrobials. It is important that more field studies on the use of antimicrobials in CBPP control be carried out.

Pastoralists perceived vaccination to be the solution to CBPP. However, a large number of pastoralists were not vaccinating their animals regularly against CBPP mainly due to unavailability of the vaccine. Further, in the event of no outbreak or rumours, pastoralists will often resist CBPP vaccination alone as also observed generally about livestock vaccinations (McLeod and Wilsmore, 2002). From the sentiments about vaccination, some pastoralists regard vaccination against CBPP as a 'treatment' than control method as also found out by Wanyoike (1999) in the same area. This perception could arise from the fact that vaccinations are more often in response to outbreaks. It is important that the value of CBPP prevention through vaccination be adequately explained to the pastoralists. Vaccinations should be planned together with the pastoralists and carried out for prevention rather than only in response to outbreaks.

The pastoralists suggested that the favoured time to vaccinate animals was when fodder is available and animals are healthy enough to withstand adverse post-vaccination reactions consistent with the findings of Teshale (2005) in Ethiopia, Wanyoike (1999) in Kenya and Thiaucourt et al. (2003). In addition, animals have developed immunity for the next migration in search of pastures. However, often at such times, government funds may be unavailable for vaccination. Efforts can be made to reserve funds for vaccination at the appropriate time to avoid resistance from pastoralists.

The protection period for CBPP vaccine protection is one year but may be longer (Wesonga and Thiaucourt, 2000; Nkando et al., 2011). Biannual vaccination is more desirable as it takes care of protection periods of less than one year. A second vaccination also raises herd immunity. Although some 39% perceived the vaccine to protect for over one year, they still preferred annual vaccination due to the annual migration of animals in search of pastures increasing the risk of CBPP. The perception that the vaccine protects for more than a year could be from the fact that most herds did not suffer CBPP in consecutive years and were therefore assumed protected. Some of pastoralists had no idea about the protection period of the vaccine. The suggestion that vaccination should be twice a year in order to raise herd immunity to over 80% (Thiaucourt et al., 2003) was not favoured by about half the pastoralists mainly due to fear of reactions twice in a year as also found out by Kairu-Wanyoike et al. (2013). Biannual vaccination is more desirable as it raises herd immunity from 67% to 95.5% (Wesonga and Thiaucourt, 2000). Awareness should therefore be created among pastoralists on the protection period of the vaccine and the need for at least annual and biannual vaccination at best.

Majority of the pastoralists who indicated that the pastoralist should pay for CBPP vaccination suggested that the pastoralist pays 50% of the cost of the vaccination or less. However, pastoralists were also financing vaccination against other diseases which took priority over CBPP as far as control was concerned and may be unable to pay for CBPP vaccination. Further, although the pastoralists had indicated that livestock related activities took priority over social, farming and other economic activities, about half of them felt that vaccination interfered with other activities in the vaccination during the study. It is possible that in the absence of disease, this proportion of pastoralists will prefer to do other things and not present their animals for vaccination. Ultimately, left to pastoralists, there may not be adequate vaccination against CBPP to the desired levels for effective control and eventual eradication hence the need for encouragement and budgetary support for the pastoralists in vaccination against CBPP.

The proportion of 3.8% of animals reacting adversely to the vaccine was within 1–5% given by Thiaucourt et al. (2003) in experimental animals and close to the proportion given by Teshale (2005) of 0.23–3.91% in a vaccination in Ethiopia using the same type of vaccine. Conversely, Twinamasiko (2002) observed no adverse reactions at all to the same type of vaccine in Uganda in Ankole cattle. It is possible that these reactions are unique to some breeds of cattle such as the small East African Zebu which is dominant in Kenya and Ethiopia (Teshale, 2005). As a result of the adverse post vaccination reactions in their herds, about 25.2% may resist presenting their animals for future CBPP vaccinations leading to a further shortfall in vaccination coverage. In addition, a high number of animals that reacted adversely to vaccination were treated with antimicrobials. There was no revaccination of animals treated for post-vaccination reactions contrary to what is suggested by Radostits et al. (2000). Over time, this could lead to a substantial proportion of non protected animals following the killing of the vaccine by the antimicrobials used for treatment. This category of animals should be revaccinated.

Although publicity for vaccination against CBPP was good, there were other constraints in vaccination that could lead to an inefficient vaccination campaign. Pastoralists gave suggestions on how these constraints could be overcome which should be taken into account in vaccination campaigns.

5. Conclusions

The KAPP study has proved useful in obtaining information from pastoralists for use in improving CBPP control. Pastoralists had traditional disease coping mechanisms in CBPP control but feared to report the disease. There may be incorrect use of the antimicrobials by pastoralists. The pastoralists perceived vaccination to be the solution to CBPP. However, vaccination was irregular due to unavailability of the vaccine and fear of adverse post-vaccination reactions. The pastoralists preferred that CBPP vaccination is part of vaccinations for other diseases and is carried out at specific times of the year. Following adverse post vaccination reactions, a proportion of pastoralists may not vaccinate their cattle in subsequent vaccinations. Pastoralists should be encouraged to report CBPP and their preferences should be considered when planning interventions. Awareness should be created among the pastoralists regarding preventive CBPP vaccination and its effects as well as the correct use of antimicrobials. Further, monitoring and management of adverse post vaccination reactions including revaccination following treatment where necessary should be carried out. Further KAPP studies on CBPP control are recommended.

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