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Methodological Issues and Applications in Economic Evaluation of Alternative Livestock Diseases Control Strategies: The Case of the CBPP Quarantine Line in North-Eastern Kenya

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Abstract: Contagious bovine pleuro-pneumonia (CBPP) is one of the endemic and life-threatening livestock diseases in the arid and semi-arid land areas (ASALs) of Kenya, which justify the case for the control of livestock diseases to avoid the spread of such diseases from the ASALs to the rest of the country, and a CBPP control quarantine line (CQL) that to help prevent the spread of CBPP from the ASALs of North-eastern Kenya to the rest of the country has been in existence since the colonial (pre-1963) times in Kenya. However, the livestock keepers in the ASALs view the CQL as an impediment to their main source of livelihoods because it entails livestock movement restrictions, thus constraining unfettered livestock marketing. Available literature shows that there is a dearth of information on the economics of livestock diseases control in Kenya in terms of its impacts on social welfare. Employing the CQL as a case study, this study shows that an application of analytic techniques that combine disease risk analysis and conventional cost-benefit modelling that incorporates some aspects that are specific to livestock diseases and their control strategies can generate indices of economic impacts of livestock diseases control on social welfare. The study finds that the livestock keepers and traders in Kenya do not consider CBPP a major problem to warrant livestock movement restrictions, yet the official records of the veterinary authorities indicate that CBPP is a major threat to the cattle industry in Kenya. Annually, the government spends substantial resources on the CQL operation and maintenance and also on CBPP surveillance and monitoring to contain the CBPP menace in Kenya. This study shows that such expenditures are economically and socially justifiable. Nevertheless, the study finds some operational inefficiencies in the enforcement of the CQL requirements. The authors, therefore, undertake an evaluation of alternative CBPP control strategies and conclude that it would be more cost effective to shift the CQL from its current location to the international borders of the arid districts, provided that this action is preceded by adequate CBPP control preparatory measures, as described in the paper.

Key words: Evaluation, livestock diseases control, CBPP, pastoralists, marketing, welfare, Kenya.

1. Introduction

The arid and semi-arid land areas (ASALs) that are generally referred to as rangelands constitute about 80% of Kenya's total land areas and are home to about 60% of Kenya's total livestock population [1]. Livestock keeping that involves constant mobility in search of water and pasture and is popularly referred to as nomadic pastoralism is the main source of livelihoods in these rangelands. The pastoralists (i.e., those who practise nomadic pastoralism) in the rangelands of Kenya have developed an elaborate culture of livestock marketing to cater for their cash needs. These pastoralists, however, face many

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livestock marketing constraints, and livestock diseases that are endemic in the ASALs and the associated livestock movement restrictions that are imposed by the veterinary authorities as a strategy for livestock diseases control whenever disease outbreaks occur are a key constraint. Contagious bovine pleuro-pneumonia (CBPP) is one of the life-threatening livestock diseases that are endemic in the arid districts of North-eastern Kenya. This disease is a serious threat to the very survival of the livestock industry in any country [2, 3].

Veterinary professionals agree that there is need to be cautious when dealing with cattle flows from the rangelands to the rest of Kenya to ensure that such livestock movements do not result in a spread of livestock diseases that are endemic in the ASALs to the rest of the country. To control and contain the CBPP menace in Kenya, a CBPP control quarantine line (CQL) that is intended to help prevent the spread of the CBPP from the arid districts of North-eastern Kenya to the rest of the country has been in existence in Kenya since the colonial (pre-1963) times. The CQL is evidently designed to be one of the key measures in the control of the CBPP in Kenya. However, this CQL has been of great concern to the pastoralists from the arid districts of North-eastern Kenya, and they view the CQL as an impediment to their main source of livelihoods. Even though the pastoralists' opposition to livestock movement restrictions can be said to be based on their desire to promote unfettered livestock marketing and trade so as to maximize their profits, there is need to educate them on the importance of livestock diseases control to Kenya's economy. Except for some work that was undertaken by the authors while assisting the Arid Lands Resource Management Project (ALRMP) in the Office of the President, Kenya, in the assessment of the effects of livestock diseases and disease control measures in the rangelands of Kenya on livestock marketing in the country [2, 3], there is a dearth of information on the economics of livestock diseases control in Kenya. Therefore, this article attempts to narrow down that information gap by examining and preparing a synthesis on the efficacy and economics of livestock diseases control in the ASALs of Kenya, using the CQL as a case study. This article thus builds on Techlink and Mbogoh, et al. [2, 3], among other sources of information, to explore methodological issues and application of appropriate techniques in the evaluation of the economics of livestock diseases control, particularly focusing on the impact of such a control on the livelihoods of the pastoralists in the ASALs of Kenya, using the CQL as a case study.

The arid districts of North-eastern Kenya where CBPP is said to be endemic are relatively contiguous in terms of their CBPP status and livestock interaction and relationship with each other—see their positions on the map of Kenya that is given in Fig. 1. Ordinarily, they all experience low rainfall, mostly within the mean range of 200-400 mm per annum, so that the feasibility of arable (rain-fed) crop agriculture in these districts is very low and nomadic pastoralism is the main source of livelihoods in these districts.

2. Methodology

The two key studies of Techlink and Mbogoh, et al. [2, 3] constitute the main basis for this article were undertaken in the ASALs of Kenya on behalf of the ALRMP in the Office of the President, Kenya, by an inter-disciplinary team of specialists with the authors of this article as principal researchers. The authors highly appreciate and acknowledge the support that they received from some key officials of the ALRMP and the Directorate of Veterinary Services in Kenya during these studies. Techlink [2] basically focused on the impact of the CQL on livestock marketing, while Mbogoh, et al. [3] focused on the assessment of the feasibility of establishing livestock diseases free zones (DFZs) in Kenya as a strategy for enhancing livestock marketing and export trade in livestock commodities for the country. Information from Techlink and Mbogoh, et al. [2, 3] is supplemented by some additional

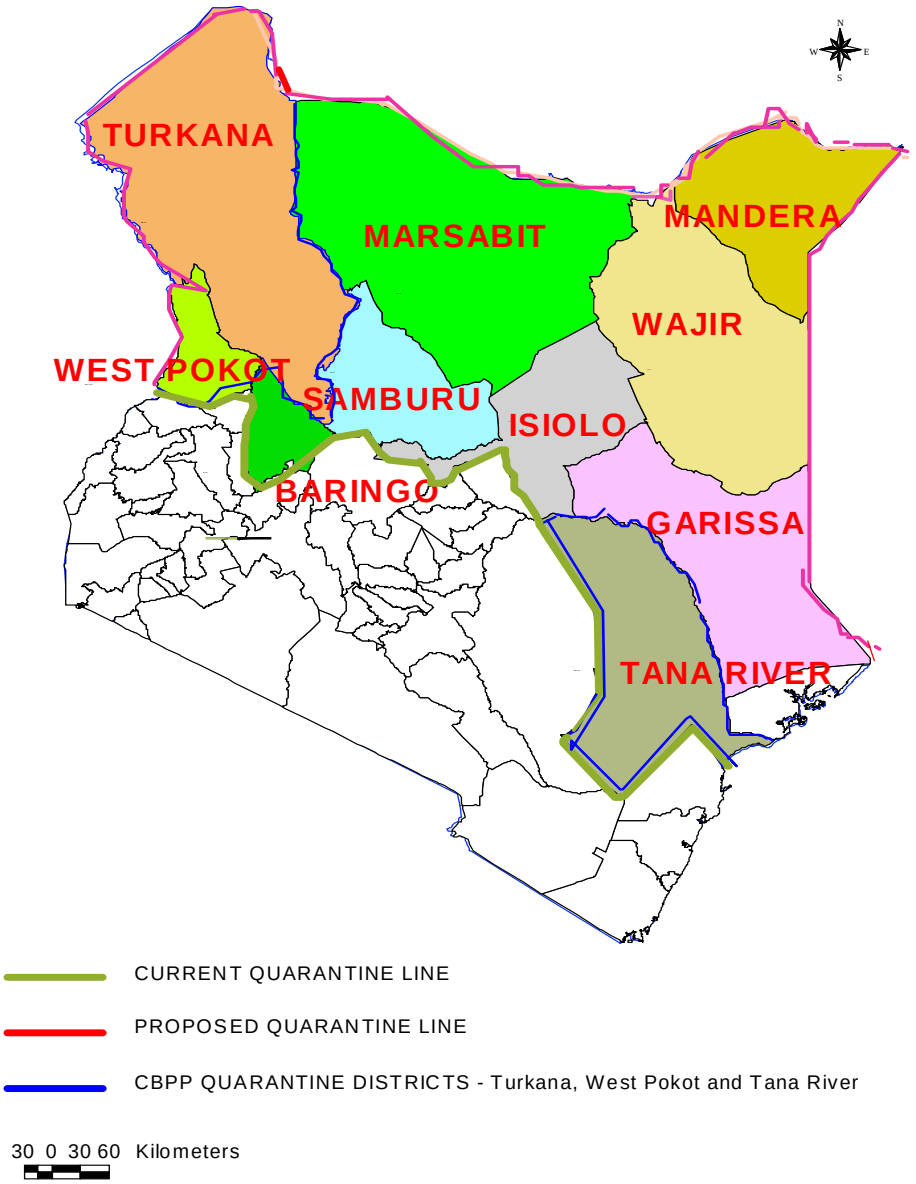

Fig. 1 CBPP quarantine lines and vaccination districts in Kenya.

Source: Techlink [2].

information that was gathered by the corresponding author of this article while serving as an advisor for the ASALs-based Livestock and Rural Livelihoods Support Project (ALLPRO) in the Ministry of Livestock Development in Kenya between 2006 and 2008, with a specific responsibility of researching and advising on livestock marketing and business development issues [4].

An evaluation of the economic impacts of livestock diseases control must consider the risks of the spread of the livestock diseases and the associated costs and benefits of the diseases control system. The risks of the spread of the livestock diseases will depend on the actual cattle population in the country and the populations of healthy cattle at risk of being infected with diseases by those from the disease-endemic areas. This study focuses on the status of CBPP control through the enforcement of the CQL stipulations [2, 3]. Even though the primary responsibility of the corresponding author as an advisor in ALLPRO

involved researching on and advising on matters of livestock marketing and business development for livestock products in Kenya [4], the assignment also involved some engagements and follow-up issues on livestock diseases control and the establishment of livestock DFZs in the country.

From a research methods perspective, both Techlink and Mbogoh, et al. [2, 3] employed extensive reviews of relevant literature and interviews with some selected key government officials, especially those in the ALRMP and the Veterinary and Livestock Production sections of the Ministry of Livestock Development in Kenya, pastoralists and other livestock industry key stakeholders, such as livestock traders. The interviews were based on participatory research methods—primarily focus group discussions (FGDs) and key informant interviews (KIIs). The work undertaken by the first author while working for the ALLPRO also involved some FGDs and KIIs with some selected pastoralists and other key livestock industry stakeholders drawn from the ASALs districts of Kenya during the various "training workshops on livestock marketing and business development in Kenya" that were conducted between 2006 and 2008 [4].

In economic evaluation of the impacts of livestock diseases control measures on social welfare, this article applies the technique of disease risk analysis followed by cost-benefit analysis using conventional models that have been modified to incorporate some aspects that are specific to livestock diseases and their control strategies. The most important parameters that are considered in the analyses include disease risk factor (based on the interaction of disease infection rate and disease morbidity), costs of disease control and the benefits of disease control (primarily in terms of the value of the animals protected from infection and possible deaths), and the appropriate discount rate and discount factors. Thus this paper is based on a case study of CBPP and its prevalence outside the CBPP-endemic areas in Kenya (Table 1) and the key parameters that are considered in the analysis of the impact of CBPP control on social welfare in Kenya. These parameters are presented in Tables 2-6 and are then reviewed and discussed thereafter.

3. Results and Discussions

3.1 Pastoralism and Livestock Marketing, Marketing Constraints and Impacts on Social Welfare

This study finds that pastoralism is now generally accepted as an appropriate strategy for the utilization of the fragile rangeland resources. However, the frequency of migration as the pastoralists move from place to place in search of water and pasture increases as the drought conditions worsen, as has been the case in Kenya at this time (2011) when the arid districts of North-eastern Kenya have been experiencing unprecedented drought conditions [5]. The study also finds that most livestock markets in the arid districts are poorly organised, and this problem is compounded by the poor marketing infrastructure, including inadequate holding grounds and watering facilities along the major traditional stock routes. This makes livestock marketing a costly affair for the pastoralists in the ASALs of Kenya. Lack of designated cattle auction market and the absence of an open auction system generally hinder market transparency, and livestock producers and traders alike usually complain about lack of price information at the major livestock markets. Therefore, the pastoralists face many livestock marketing constraints, including livestock movement restrictions that are imposed by veterinary authorities as a strategy for livestock diseases control (especially whenever there are livestock disease outbreaks). These marketing constraints impact negatively on the pastoralists' welfare [2-4].

Livestock diseases affect livestock marketing, trade and social welfare in many ways. For example, once there is a disease outbreak and quarantine measures are imposed, livestock prices decline. Furthermore, quarantines lead to the closure of livestock markets, thus depriving producers and traders of their livelihoods.

Table 1 The location of CBPP outbreaks outside the endemic ASALs areas in Kenya, 1986-2000.

Year	Locality	District	Year	Locality	District
1997	Musikoma/Kanduyi	Bungoma	1995	Laikipia Airbase	Laikipia
1989	Karaba	Embu	1990	Naikara	Narok
1989	Evurore	Embu	1990	Narok Prison Farm	Narok
1993	Muminji & Kiambere	Embu	1991	Ildamat Location	Narok
1991	Ngong Division	Kajiado	1991	Osupuko Division	Narok
1993	Ngong Division	Kajiado	1994	Transmara Sub-district	Narok
1993	Central Kaputei	Kajiado	1994	Lorroki & Kisiria Locations	Samburu
1998	Loiyangalani	Kajiado	1988	Maungu	Taita-Taveta
1986	SMS Farm	Kiambu	1991	Taita Ranch	Taita-Taveta
1988	Ruiru	Kiambu	1996	Cherengany Location	Trans Nzoia
1997	Juja & Thika Locations	Kiambu	1987	Loitikipi	Turkana
1990	Mariakani Research Centre	Kilifi	1988	Witu Division	Lamu
1997	Musikoma/Kanduyi	Bungoma	1994	Mkunumbi Loction	Lamu
1986	Yatta Cooperative Ranch	Kitui	1986	KMC Athi River	Machakos
1986	Mutitu Division	Kitui	1986	EAPC Athi River	Machakos
1986	Mwakini Ranch?	Kitui	1992	Makueni Dvision	Machakos
1986	Kyuso Division	Kitui	1994	Kimani Wanyoie Farm	Machakos
1987	Mutomo Division	Kitui	1997	Lukenya Location	Machakos
1986	Lewa Downs Farm	Laikipia	1996	Chebororwa Location	Marakwet
1988	Sossian Ranch	Laikipia	1999	Ntumburi Location	Meru
1988	Kimura Ndura	Laikipia	1986	Wempa Farm	Murang'a
1988	Loidaiga Location	Laikipia	1991	Marula Estate	Nakuru
1989	Lewa Downs Farm	Laikipia	1991	Gilgil Township	Nakuru
1991	Kimuri Farm	Laikipia	1992	Kedong Ranch	Nakuru
1992	Ereri	Laikipia	1995	Monedat Farm-Gilgil Div	Nakuru
1994	Sirima Location	Laikipia	2000	Lanet Location	Nakuru

Source: Techlink [2].

Table 2 Cost Estimates—Mobile CBPP Testing Unit.

Details		Cost in KShs. '000					
A: Capital Costs: Mobile Laboratory	(i) 2 Four-wheel Drive Vehicles (Landrovers) fitted with Laboratory Equipment, including a Generator						14,000
	(ii) Laboratory Equipment						780
	(ii) Camping Equipment						400
Sub-total I							15,180
B: Recurrent Costs	Project/Programme Year	1	2	3	4	5	Total
	(i) Maintenance of Laboratory Equipment (10%)	0	78	78	78	78	312
	(ii) Glassware & Reagents	240	240	240	240	240	1,200
	(iii) Staff Costs (for Animal Health Personnel)	800	800	800	800	800	4,000
Su-total II							5,512
Grand Total = Sub-total I = Sub-total II							20,692

Livestock diseases and deaths due to diseases also lower the economic value of the farm—the fertility and productivity of the animals decline, and the cost of livestock trade goes up. Worse still, inability to control livestock diseases in a country leads to the ban on the export of live animals and the allied animal products from such a country. Problems related to incidences of livestock diseases and weaknesses in livestock disease control in Kenya are to blame for the loss of the country's export markets for livestock commodities since the late 1970s [3]. Furthermore, the absence of adequate and convenient

Table 3 Annual costs of activities to be undertaken before the shifting of the CQL to international Borders.

Type of Activity		Annual Costs in KShs. '000			
		Year 1	Year 2	Year 3	Total
(a) CBPP Testing Services (9 Units*)		186,228*	49,608*	49,608*	285,444*
(b) Enhanced CBPP Vaccinations (III)	DC	32,000	32,000	32,000	96,000
	IC	30,832,000	30,832,000	30,832,000	92,496,000
(c) Enhanced CBPP Surveillance (IV)	DC	16,400	16,400	16,400	49,200
	IC	34,200,000	34,200,000	34,200,000	102,600,000
(d) Total Investment and Operating Costs		65,266,638*	65,130,008	65,130,008	195,526,654

Notes on assumptions for Table 3:

*: Capital cost per CBPP testing unit = KShs.15,180;

**: Annual operating cost per CBPP testing unit = KShs. 5,512;

DC = Direct costs of disease control campaigns (vaccines and sero-surveillance);

IC = Indirect costs of disease control campaigns (due to livestock losses from deaths).

Table 4 Annual benefits of the activities to be undertaken before shifting the QL to international borders.

Type of Activity and Year	Annual minimum benefits in KShs. '000			
	Year 1	Year 2	Year 3	Total
1. Enhanced CBPP Surveillance	212,000,000	212,000,000	212,000,000	636,000,000
2. Enhanced CBPP Vaccinations	216,000,000	216,000,000	216,000,000	648,000,000
3. Total Annual Benefits	428,000,000	428,000,000	428,000,000	1,284,000,000

These activities are associated with the establishment of CBPP testing facilities at strategic entry points along the international borders and the enhanced CBPP vaccinations and sero-surveillance activities.

Table 5 Discount factors for years 1-3 at 20% rate of interest.

Year	DF @ 20%
1	0.833
2	0.694
3	0.579

holding grounds for quarantine and surveillance against CBPP and other livestock diseases for the cattle from the northern rangelands that are south-bound toward the coastal region of Kenya exposes livestock in the rest of the country to disease risks, and this has negative welfare effects [4].

3.2 Current Livestock Diseases Control Practices in Kenya, the Efficacy of the CQL, and the Perceptions on the Impacts of the CQL on Livestock Marketing and Social Welfare

Veterinary professionals agree that pastoralism and migrations can have far-reaching potential effects on livestock diseases spread, so that there is danger of any one country with greater commitment to disease control (as is generally the case for Kenya) being put at risk by its neighbours unless the countries with shared borders agree on common and coordinated disease control strategies. This study finds that traditional trans-boundary migrations pose a CBPP disease threat to Kenya. However, there is a widely held view, particularly among the pastoralists and livestock traders, CBPP is not a serious problem in most of the arid districts in Kenya, yet there is officially recorded evidence that CBPP was a major threat to the cattle industry in the arid border districts, especially in Mandera, Turkana and West Pokot, in the late 1990s and early 2000s [2].

"No Objection" and "Movement Permit" documents from the Veterinary Authorities in Kenya remain that the statutory documents required for moving animals from one district to another. These documents are thus the main instruments for ensuring the adherence to livestock diseases control regulations by those involved in the movement of livestock for trade in Kenya. A major problem often arises when a large number of livestock traders call in at the district veterinary offices to obtain these statutory documents

Table 6 Summary of the Total Annual Benefits and Costs of the Activities to be Implemented before the Shifting of the QL to International Borders.

Item Category (in Relation to CBPP Control Efforts)	Annual Totals in KShs.'000			
	Year 1	Year 2	Year 3	Total
(i) Discounted Annual Total Benefits = BDVs	356,524,000	297,032,000	247,812,000	901,368,000
(ii) Discounted Total Annual Costs = CDVs	54,367,102	45,200,226	37,710,274	137,277,602
(iii) Net Present Benefits (NPBs)	302,156,898	251,831,774	210,101726	764,090,398

(a) The excess of (i) over (ii) is a measure of the net economic worth of the disease control activities associated with the eventual shifting of the CBPP quarantine line (CQL) to the international borders by the end of the third year of these activities.
(b) The Benefits and Costs are discounted at the 20% rate of interest to reflect the average base rental for capital in Kenya for the last four years.

and there are some delays due to the bureaucracy associated with securing these papers. Therefore, securing "No Objection" and "Movement Permits" documents appears to be one of the most important constraints to livestock trade. The "Movement Permit" requirements are complicated by the fact that any livestock that is moved in trucks is banned from being moved after sunset (i.e. at night) to prevent the movement of stolen animals. This requirement may sound clumsy because it is usually impractical to offload and reload trucked animals enroute. However, it is also understandable that a regulated movement is necessary in order to minimise trade in stolen cattle.

Ordinarily, livestock traders at primary and secondary markets are usually at a loss to understand why they are obliged to travel to distant terminal markets, such as Nairobi and Mombasa, to physically obtain documents that are supposed to be an official communication between the animal destination and the animal source veterinary officers. The perception and the feelings were that the system is colonial-based and archaic and needs review: colonial veterinary officers deliberately made it difficult for individual Africans to move animals to protect high livestock and meat prices in urban centres for the animals originating from the ranches that were owned by the white settlers. Until recently, it was felt that there had been little effort to facilitate pastoralists to enter into the formal livestock market on their own. The situation has improved drastically since the creation of the Kenya Livestock Marketing Council (KLMC) now offers a forum for discussions on how to improve livestock marketing in the country.

Even though livestock disease quarantines are a major concern to pastoralists and livestock traders, these livestock industry stakeholders do appreciate the importance of livestock diseases control. However, they openly resent having any livestock disease interventions being undertaken at times when their animals are stressed, as happens to be the case during droughts, except in cases where quarantine restrictions are imposed following outbreaks of "notifiable" livestock diseases. "Notifiable" livestock diseases are usually gazetted by veterinary authorities. The main concern of pastoralists and livestock traders is that the quarantines should be timely circumscribed just to control the disease, and promptly removed immediately the need for them ceases. At times, they do not perceive as if the DVS (Directorate of Veterinary Services) is carrying out its mandate effectively in ensuring that the quarantine notices are revoked as soon as the need for them elapses.

Isiolo remains the main base for the CBPP quarantine line (CQL). As pointed out elsewhere, most livestock traders "came face-to-face" with all the rigours connected with the processing of the cattle through the quarantine testing facilities for the first time after the government ceased to be involved in livestock marketing through the livestock marketing division (LMD) of the ministry responsible for livestock development following the collapse of the operations of the Kenya Meat Commission (KMC) in

1984. At first, all the cattle passing through the CBPP cordon (CQL), whether for slaughter or for fattening or for breeding, had to be detained for at least twelve weeks while they underwent three CBPP tests. Slaughter cattle could then be moved by truck, while the breeding or fattening stock could be moved, under supervision, on the hoof. At the time when the terminal market was the KMC, the major effect of this delay was the cost in grazing and watering fees since the prices per kilogram of live animals were relatively steady. However, after the closure of the KMC, a liberalised market meant that the livestock prices varied widely and unpredictably. This study finds that the holding of animals for a long time at the CBPP testing centres was of much concern to the livestock traders. This concern partly explains why the rules for CBPP testing had to be modified to make it possible for slaughter animals to be merely branded and trucked directly to slaughter houses, while the regulations for dealing with fattening or breeding cattle remained unchanged.

This study finds that Isiolo, as the main base for the quarantine line, is greatly weakened and is no longer performing the function for which it was established. The majority of the cattle traded out of the Isiolo district are sold in the open markets in Isiolo town, Oldonyo Nyiro and Kinna under permissive conditions that allow crossing without observing the laid down CQL regulations. The stipulation that any slaughter cattle crossing the line at Isiolo from outside must be trucked is not being observed. The study also finds that there is no CBPP testing at all for the cattle destined either for slaughter in the Mombasa market or for fattening in the coastal region ranches (i.e. along the Mandera-Wajir-Garissa-Ijara-Tana River-Malindi stock route). Generally, all categories of cattle, both the immatures and those that have attained slaughter weight, are moved from the arid districts of Kenya on foot, and untested for CBPP, to ranches leased by livestock traders and Mombasa butchers in Taita-Taveta, Kilifi or Kwale districts. Most of these are private ranches, but two of them (the KMC holding ground near Bachuma and the former LMD holding ground) are public property. These, as well as a large expanse of state land west of Sabaki holding ground, are in effect a vast holding ground for trade cattle that could be used for disease quarantine and CBPP testing purposes.

The data given in Table 1 basically constitute the main basis for the applications of quantitative techniques in the evaluation of the impact of CBPP control in Kenya, primarily on the basis of cost-benefit analysis (CBA). For the period under consideration, the data suggest that there had been a widespread presence of CBPP positive reactors within Kenya, but the CBPP incidences appear to have been declining from the late 1980s (Fig. 2). However, the results from serological tests, based on those reported and recorded cases, indicated that the prevalence of the CBPP in Kenya by the year 2000 was relatively low, and only sporadic cases were being reported in some of the arid North-eastern Kenya districts, especially in the arid border districts of Mandera, Turkana and West Pokot. On the basis of these findings, it would appear that the annual vaccinations against CBPP that were being carried out together with the rinderpest vaccinations in the arid districts, particularly in the late 1980s and 1990s, have contributed to the low incidence of CBPP in the arid and semi-arid districts of Kenya.

Apart from the subjective perceptions of the pastoralists and livestock traders, the actual impact of the CQL on livestock marketing and social welfare can only be assessed indirectly. A major complaint that is usually voiced by pastoralists and livestock traders against the CQL has been that it limits livestock trade in cattle only to the slaughter stock at the virtual exclusion of the more lucrative market for immature or breeding cattle. The traditional market for immature livestock (say immatures) and breeding cattle has been commercial ranches, especially in Laikipia district. The coast province ranches,

especially those in Taita-Taveta were designed for and have largely remained a market for immatures for fattening. This study finds that a sizeable proportion of the trekked livestock from the arid districts of North-eastern Kenya ends up as breeding and fattening stock in some ranches within other parts of the country, specially in the coast province (mainly in the Taita-Taveta District ranches). Therefore, it appears that the pastoralists and traders are generally going about their business without much regard for the quarantine line (CQL).

The movement of the livestock along the trek routes that link the major primary, secondary and terminal markets within and outside the northern districts of Kenya appears to circumvent the strict requirements of "movement permits" and "no objection" letters—the livestock easily move across district boundaries. Therefore, the existence of the CQL does not appear to hinder livestock marketing in the northern districts of Kenya in any significant manner, and the general outcry by the pastoralists that the law that enforces the requirements for "livestock movement permits" and "no objection" letters is discriminative to pastoralists does not appear to be justified. This study concludes that the CQL does not impact negatively in any significant manner on livestock marketing and social welfare of the pastoralists in Kenya.

Fig. 2 presents the incidences of CBPP outbreaks outside the endemic areas in Kenya during the period considered in the quantitative evaluation of the economic impact of CBPP control on social welfare of pastoralists in Kenya.

Evidently, the cases of CBPP outbreaks were declining between 1980s and 2000s, and this is attributed to the CBPP vaccinations that were being carried out together with the rinderpest vaccinations in the arid districts, particularly in the late 1980s and 1990s [2]. Rinderpest is another life-threatening livestock disease in Kenya that has virtually been eradicated in the country [3].

3.3 The CBPP Control Policy in Kenya and Evaluation of Alternative CBPP Control and Management Strategies

3.3.1 Preamble

Available evidence, as alluded to in this article, indicates that CBPP still remains a serious problem in the northern rangelands of Kenya. For this reason, the government policy is that the cattle from the northern rangelands of Kenya must be tested for CBPP and pass two serological tests, carried out six weeks apart, to attest to their freedom from the disease before they can be allowed to move across the northern CBPP cordon (CQL) and be able to join the herds in the rest of the country.

Conceptually, there are three possible approaches to the control and/or management of CBPP. These approaches include: (1) treatment with drugs to try and cure the disease; (2) vaccinations to try and prevent

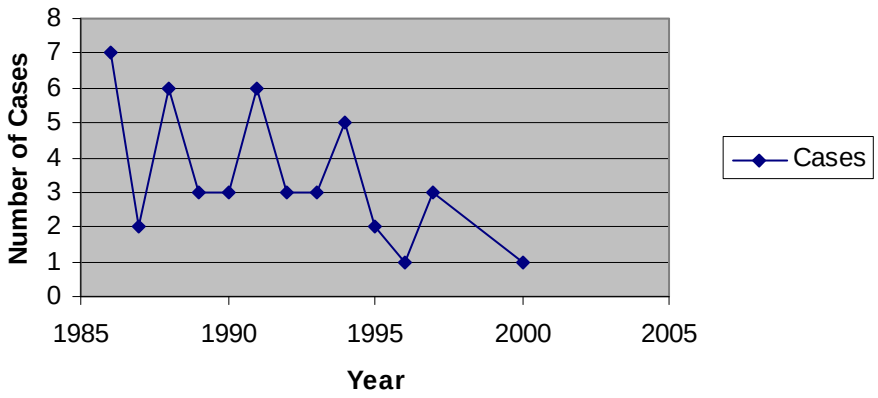

Fig. 2 Recorded CBPP cases outside the CBPP-endemic areas in Kenya.
Source: Table 1 data based on Techlink [2].

future outbreaks of the disease; and (3) case detections (through serological testing) and movement controls (quarantines), including the possibility of slaughtering the infected animals. Even though treatment against CBPP using drugs is possible, it is very expensive and creates a pool of disease carriers within the treated animals that do actually recover from the disease. These two mitigating factors negate the utility of the treatment of CBPP using drugs and this approach is thus not an effective and economically viable disease control strategy. For this reason, only annual vaccinations against CBPP, coupled with sero-surveillance and restrictions of livestock movements to facilitate disease control, remain technically and economically viable as strategies for CBPP control. This argument justifies the current government policy on CBPP control, which is to eradicate the disease and undertake measures to ensure an effective control of any future infections and disease outbreaks.

Given the current government policy on CBPP control and the existing disease situation, the following alternative CBPP control and management strategies that could be undertaken were evaluated:

(1) Do nothing at all (Option I);

(2) Continue with current disease control system (Option II);

(3) Increase CBPP vaccination rate from the current level of 38% to a minimum of 80% while maintaining sero-surveillance coverage at the current level of 2% (Option III);

(4) Increase CBPP sero-surveillance rate from the current level of 2% to 5% while maintaining vaccinations coverage at the current level of 38% (Option IV);

(5) A combination involving the novel attributes of Options III and IV, i.e., increasing the coverage of vaccinations from the current level of 38% to a minimum of 80%, increasing the coverage of sero-surveillance from the current level of 2% to 5%, and posting animal health personnel at strategic entry points along the international borders, followed by the shifting of the quarantine line (QL) from its current position to the international borders (Option V).

The implications of the various strategies were assessed as outlined hereafter.

3.3.2 Implications of Alternative CBPP Control Strategies in Kenya

3.3.2.1 Implications of Option I

"Doing nothing at all" would actually result in financial savings equivalent to the current annual costs of CBPP vaccinations and disease screening in the northern rangelands, including the associated costs of the maintenance of the CBPP quarantine line between the north and the south. However, this action (i.e. "doing nothing at all") would expose the country to serious risks of CBPP outbreaks which would likely result in several deaths of cattle throughout the country.

3.3.2.2 Implications of Option II

Continuing with the current system of CBPP control actually implies maintaining the current levels of expenditure on CBPP control. The current levels of expenditure on CBPP control, including the costs of the quarantine line measures, have been shown to be associated with the prevention of 27.6% probability of the cattle from the north infecting the cattle populations in the high potential areas (in the south) with CBPP. Economic evaluations show that the benefits of the current CBPP control system with respect to the activities in the northern rangelands far outweigh the costs of the system, given the associated benefit-cost ratio of about 5.3 (Table 7). However, the benefit-cost ratio would be expected to decrease as the number of cattle at risk in the south (i.e., those that get exposed to the cattle from the north) decreases.

3.3.2.3 Implications of Option III

Since the current CBPP vaccination annual coverage in the ALRMP districts is about 38%, increasing the vaccination rate of coverage to a minimum of 80% in order to try and eliminate the CBPP prevalence in the northern rangelands would

raise the annual costs of CBPP control by an estimated 110.5%. However, this increased coverage would be expected to reduce the disease risk substantially. Even if the disease risk were assumed to get reduced only by 20% following the 110.5% increase in vaccinations coverage, then the "unrestricted disease risk factor" would be expected to fall from the estimated current level of 27.6% to 22.1%. Economic evaluations still show that the benefits of this option would far outweigh the costs of the option, with an associated benefit-cost ratio of about 7.0. This result, therefore, underscore the economic significance of intensifying CBPP control campaigns in the northern rangelands—raising the vaccinations coverage from 38% to 80% under the stated assumptions of Option III that raises the benefit-cost ratio from 5.3 to 7.0 (Table 7).

3.3.2.4 Implications of Option IV

Increasing CBPP sero-surveillance from the current rate of about 2% to the expected coverage rate of 5% entails a 150% would increase in sero-surveillance costs. This action would, therefore, entail a significant increase in the surveillance expenses even though the level of vaccinations coverage under Option IV would still remain at 38%. If the improved efficiency in CBPP sero-surveillance resulted only in a modest reduction of the risks of moving sick cattle from the north to the south, let us say by 10%, the "unrestricted disease risk factor" would drop from 27.6% to 24.8%. The associated 10% reduction in the disease risk factor would result in a 10% reduction in the likely losses of livestock from CBPP outbreaks, and the benefit of this enhanced disease control programme would be the value of the 75.2% of the cattle population in the southern high potential areas that are not at the risk of being infected with CBPP. Economic evaluation of the Option IV gives a benefit-cost ratio of about 6.2 (Table 7), and this result also underscores the economic significance of intensifying CBPP sero-surveillance in the northern rangelands—raising the level of coverage from 2% to 5% under the stated assumptions of Option III that raises the benefit-cost ratio from 5.3 to 6.2 (Table 7).

Table 7 Summary of Estimated Benefit –Cost Ratios for All the Envisaged Options on Alternative CBPP Control and Management Strategies.

Option	Benefit-Cost Ratio (BCR)
I	0.00004*
II	5.3
III	7.0
IV	6.2
V	6.6

3.3.2.5 Implications of Option V

This option requires the following actions to be taken before the CBPP quarantine line (CQL) can be shifted from its current position to international borders to allow the cattle from the northern lowland districts to move freely to the south:

(1) Strengthening of CBPP control along the international borders by posting animal health personnel at strategic entry points and equipping them with CBPP testing capability;

(2) Strengthening of CBPP surveillance in the northern lowlands, combined with stamping out of any disease outbreaks. This action, however, would require a policy change to empower the Director of Veterinary Services (DVS) to be able to order and enforce slaughter of affected animals/herds. Nevertheless, the action would reduce disease incidence or prevalence in the lowland districts and thus reduce the risks of transferring the disease to the high potential areas of the country. In addition, the strengthening of disease surveillance would also involve decentralization of CBPP testing to the respective districts;

(3) The enhancement of CBPP vaccination campaigns should aim at a minimum level of vaccination coverage of 80% of the cattle in all the CBPP-endemic lowland districts as opposed to the current average coverage of 38% for three consecutive years. This action would be expected to increase the immunity of the cattle herd in the north to over 90%. The OIE (International Animal Health Code, a

quasi-international veterinary health organisation) recommends three consecutive years of vaccination and surveillance before a country or zone can be declared provisionally free from CBPP [3].

3.4 Empirical Analysis of Potential Effects of Pastoralism and Frequent Migrations on the Spread of CBPP: Disease Risk Analysis

3.4.1 Overview

The risk of livestock diseases spreads and hence the costs and benefits of the livestock diseases control system will depend on the actual cattle population in the country and the populations of healthy cattle at risk of being infected with disease by those from the disease-endemic areas. Due to frequent droughts and other problems, the cattle populations in Kenya have fluctuated from year to year, and the current situation is now difficult to ascertain. However, the current (2011) drought in Kenya is said to have resulted in the loss of 25% of the Country's Zebu cattle herd of 14 million animals in the–ASALs of the country by the beginning of the second week of August, 2011, with the prognosis that the worst was still likely to come, according to an official statement from the Ministry of Livestock Development [5].

For the purposes of the analysis of the CBPP disease risk and the benefit-cost ratio of the CBPP control in this study, thirteen million heads of cattle are taken as the national average of the cattle population in Kenya, of which 3 million are dairy cattle and 10 million are beef cattle. Out of these cattle numbers, it is assumed that only about 2 million heads of cattle, which are generally classified as beef cattle, are in the CBPP endemic northern rangeland districts so that the rest (about 11 million heads of cattle, of which 3 million are dairy cattle and 8 million are beef cattle) will be in the southern CBPP non-endemic areas.

The Government of Kenya has invested substantial resources in annual CBPP control and vaccinations in the arid districts of Kenya since the 1960s [2]. Under the current CBPP control strategy that focuses primarily on CBPP eradication measures, the estimated annual cost of CBPP vaccination campaigns would be about KShs. 250 million in 2010 prices, based on the evaluation of available data and discussions on unit costs of required services with Veterinary Department officials. To enhance CBPP surveillance, CBPP screening (through serological testing) is important in guiding decisions on the need for livestock movement restrictions as a disease control strategy. If it is assumed that the government aimed at a serological testing for CBPP for only about 5 % of the cattle population in the arid districts, then the cost of CBPP control services would increase by another KShs. 37.5 million in 2010 prices for serological tests. The combined cost would thus amount to an annual government expenditure of KShs. 287.5 million on CBPP surveillance and control in the arid districts of Northern Kenya.

The KShs. 287.5 million annual government expenditure on CBPP control strategies clearly illustrates the immensity of the resources required to ensure an effective CBPP surveillance, control and eradication programme for the arid districts of Northern Kenya. However, this annual CBPP eradication campaign cost can be said to be relatively low when compared with the estimated annual value of the cattle off-take: assuming an off-take at 6% and a mere average price of KShs. 5,000/ = per head of cattle on the lower side, the value of marketed livestock would amount to about at KShs. 7.5 billion. Therefore, the CBPP control and eradication campaign costs would appear to be highly justifiable from an economic viability criterion. This statement is authenticated through the results of a detailed cost and benefit analysis hereafter.

3.4.2 Disease Risk Analysis: Methodological Issues and Applications in the Case of the CBPP

3.4.2.1 Background

Risk assessment is the process of identifying and estimating the risks associated with the "importation"

of a commodity (e.g. livestock) from one region (or country) into another and evaluating the consequences of taking those risks. The risk associated with the movement of livestock from a “disease-endemic area” to a “disease-free zone” is often referred to as the “unrestricted risk estimator”, and is represented by the symbol “R”. Thus “R” is basically an estimate of the risk of infection of healthy animals in the disease free region with a particular disease as the animals move freely from a “disease endemic region” into the “non-endemic or disease free region”. “R” can be estimated as a product of “A” (the probability of entry of the disease-causing agent (hereafter referred to simply as the agent) into the "disease-free zone”) and “B” (the probability of exposure of the susceptible livestock in that zone). The probability of agent entry (i.e. “A”) is the probability that at least one animal “import” is infected with the agent. This “R” basically gives the probability of the healthy animals that are initially at risk getting infected by a given type of disease in a year, and is expressed in terms of “the number of disease events per 100 healthy animals that were initially at risk per year”. For the CBPP study, the “R” was determined following the procedure that is described hereafter.

3.4.2.2 Modelling

During this study, an estimate of “R”, the risks involved when cattle move from the CBPP-endemic northern arid districts of Kenya to the CBPP non-endemic areas of the country (such as Laikipia), was made on the basis of the CBPP test results at Isiolo (Table 1). The model presented and discussed hereafter, which is adapted from the International Animal Health (OIE) code, was used in the calculation of the so-called “unrestricted risk estimator” “R”. The theoretical aspects and applications of the model are highlighted hereafter.

(1) Theoretical model

$R = A \cdot B$

$A = 1 - (1 - SF \cdot AF) \cdot M$

where: R is the “unrestricted risk estimator”;

A is the probability of agent entry;

B is the probability of exposure in the disease free zone;

SF is the “source factor”;

AF is the “animal factor”;

M is the “import units”, the number of animals moving from “disease endemic zones” into the “disease free zones”.

· represents the multiplicative sign and is less confusing when used this way in a formula rather than using the sign “×” itself.

(2) Model applications

For the purposes of the model applications, the CBPP outbreaks figures are derived from the CQL study [2] and are given in Table 1.

Isiolo is the main CBPP testing base for quarantining cattle purposes in Kenya. Based on the results of the CBPP testing at Isiolo, the following risk estimates were obtained:

The estimate of the “R” for CBPP in Kenya was calculated as follows:

Probability of agent entry (A) = [1 - (1 - (0.008a × 0.008)] × 5,750b

= (1 - 0.999936) × 5,750

= 0.368

Probability of agent exposure (B) = 0.75c

Thus the “Unrestricted Risk Estimator” (R) = (0.38 × 0.75) = 0.276

where:

a: derived from an estimated infection rate of 0.8%;

b: average number of cattle tested and passing through Isiolo annually;

c: estimated susceptibility, based on CBPP morbidity of 75%.

Based on above calculations, the “unrestricted risk estimator” for CBPP in Kenya is 27.6%, implying that there is a probability of nearly 28 CBPP disease events per 100 animals initially at risk per year in Kenya. This factor basically gives the probability of CBPP outbreaks that are prevented by the current CBPP control system and suggests that the risks of

CBPP outbreaks even in the high potential (i.e. non-ASALs) areas of the country are high. Therefore, only the screening and vaccinations of cattle against CBPP in the endemic areas of Kenya can reduce the risks of the disease outbreaks even in the high potential areas of the country.

(3) Comments on the Risk Assessment Results

In interpreting the "R" estimate results, it is important to note that the test results used in the CBPP testing in Kenya (i.e. the CFT test) has lower sensitivity compared to other tests (e.g. ELISA). However, it is the most useful test in detecting antibodies to the causative agent of CBPP (*Mycoplasma mycoides* var. mycoides) and is the procedure recommended by the OIE because it is very specific. In addition, the animals with encapsulated sequestra in which antibody formation is not always stimulated may be missed during the tests using this procedure. Therefore, the test results may actually understate the actual disease prevalence situation. The extent is to which an introduced infection will spread and the magnitude of the risk will depend on several factors, the most important being:

- the closeness of the contact between the infected and the susceptible animal;
- the intensity of infection; and
- the number of susceptible animals.

It is also important to note that CBPP transmission occurs by droplet infection either from clinically sick or sub-clinical carriers excreting the organisms. Aerosols or infected droplets may spread long distances of 20 metres or more. Pulmonary sequestra, which may develop in animals that have recovered from clinical disease, may persist for many months, and these may harbour viable mycoplasma for up to 12 months or longer [3]. Immuno-depression, resulting from stress of livestock trekking or trucking, may induce the capsule of the sequestrum to break, thus allowing new foci of active pneumonia to develop. The animals may become infective once again. The level of susceptibility of animals in a given herd varies considerably between individuals. Even though the CBPP morbidity is about 75%, up to 60% of the cattle in some infected herds may be resistant to the disease. Therefore, the survivors in a CBPP outbreak will have a substantial degree of disease resistance [3].

3.5 Economic Evaluation of the Costs and Benefits of Disease Control

3.5.1 Assessment of the Indirect and Direct Benefits of the Current CBPP Screening and Control Strategy in Kenya in Terms of the Estimated CBPP Risk Factor

Based on the results of the testing for CBPP in the young cattle (immatures) from the northern districts that move across the quarantine line and pass through the Isiolo testing station (as given in Table 1) and on the basis of the above disease risk analysis, it can be stated that the "unrestricted risk estimate" of 27.6% gives the probability of disease events (outbreaks) that are prevented by the current CBPP control system. Given the estimated "unrestricted risk factor" of 27.6% for CBPP outbreaks and the estimated cattle populations at risk, and on the basis of discounted costs and returns, the benefit-cost ratio for the existing CBPP disease control programme in Kenya is estimated at about 5.3 (Table 7 Option II), and this is highly favourable.

3.5.2 Detailed Estimate of the Cost-Benefit Ratio (BCR) for a CBPP Control and Management Strategy: Example for Option V as an Alternative CBPP Control Strategy

The Option V strategy requires the strengthening of the CBPP sero-surveillance in the northern lowlands by raising the sero-surveillance rate from the current level of 2% to 5%, which is expected to improve the efficiency of case detections and thus facilitate decisions on when and where to engage in CBPP vaccinations. These actions would thus help to reduce disease incidence/prevalence in the lowland districts and this is expected to reduce the risks of transferring

CBPP from the north to the southern high potential areas of the country.

3.5.2.1 Costs

The major sources of costs for Option V alternative CBPP control strategy are as follows:

- staff costs: these include salaries, per diem allowances, etc; usually these are borne by the governments.
- transport costs: vehicles, motorcycles and/or bicycles and their spare parts, etc; such costs will depend on the numbers and types of transportation modes required.
- equipment:
- technical—e.g., syringes and needles, deep-freezers, ice-making machines, generators, iceboxes, sterilizers, etc; costs again depend on the types and numbers required.
- stationery—e.g., vaccination report forms, certificates, notebooks, etc.
- camping and other equipments—e.g., tents, camp beds, etc.
- recurrent expenditure: this includes the costs of consumables, such as petrol, kerosene, vaccines and drugs (antibiotics), and the maintenance of equipment.

For the Option V, the major costs of the activities related to the eventual shifting of the CBPP quarantine line (CQL) to the international borders at the end of the third year of the implementation of the enhanced CBPP control activities would relate to the following items:

(1) The posting of animal health personnel at strategic entry points and equipping them with CBPP testing capability;

(2) The raising of the rate of sero-surveillance from the current level of 2% to 5% of the total cattle population in the lowland districts in addition to other surveillance activities (e.g., examination of bovine lungs in slaughter houses and slabs);

(3) The enhanced CBPP vaccinations by raising the coverage from the current level of 38% to a level of at least 80% over a three–year period.

There are nine (9) strategic entry points along the international borders of the northern lowland districts of Kenya. These districts already have three (3) CBPP mobile testing units. Therefore, the strengthening of the CBPP control along the strategic entry points along the international borders of these districts requires the establishment of six (6) additional CBPP testing units and the posting of adequate animal health personnel to take care of all the nine (9) strategic international entry points. Based on the evaluation of task requirements, each CBPP testing unit requires to be operated by a minimum of seven (7) animal health officials. Consultations with the officials of the Department of Veterinary Services (Field Services Division) revealed that a fully operational CBPP testing unit needs to be equipped and operated through the facilities implied in the cost estimates given in Table 2.

Based on the Table 2 data, the estimated total cost per CBPP testing unit is thus about KShs. 20.7 million (of which annual recurrent expenses is about KShs. 5.5 million). Hence the estimated cost of the proposed six (6) additional CBPP testing units would be about Kshs. 124.2 million, with an estimated annual recurrent expenditure of about KShs. 33.0 million. However, the benefits-costs analysis is based on the assumption that all the nine (9) required CBPP testing facilities would be put up by the end of the three-year campaign. Therefore, the implementation of the Option V as a CBPP control strategy in Kenya would cost an additional KShs. 1.38 million annually, by raising the annual cost of CBPP sero-surveillance in the arid districts from KShs. 0.92 million to KShs. 2.30 million. Given these cost levels and the fact that the enhanced CBPP vaccination programme would be undertaken annually over a three-year period before the CQL (CBPP quarantine line) is shifted to the international borders, the expected annual costs of the recommended combined activities, which basically derive from Options III and IV activities, would be as summarized in Table 3.

3.5.2.2 Benefits

The major benefits associated with the Option V alternative CBPP control strategy are as summarized in Table 4.

3.5.2.3 Discounted Cost-Benefit Analysis for the Option V as CBPP Control Strategy in Kenya—The Prerequisites for and the Shifting of the CQL to International Borders

For the purposes of discounting, a 20% rate if interest was taken as the appropriate level for the capital market in Kenya for the period under analysis. Table 5 gives the discount factors at the 20% rate of interest over a three-year period, based on the standard statistical tables:

Table 6 gives a summary of the discounted total annual benefits and costs of the CBPP control and management activities to be undertaken over a 3 years' period before shifting the CQL to the arid districts' international borders:

The data summarized in Table 6 indicate that there is a significantly large and positive excess of benefits over the costs associated with the Option V disease control and management strategy. From the summation of the discounted values of the benefits and costs of the Option V, the BCR is given by the following calculation:

BCR = (SBDVs) / (SCDVs) = (901,368,000) / (137,277,602) = 6.6

where: SBDVs stands for the sum of the discounted values of the benefits over the three-year period and SCDVs stands for the sum of the discounted values of the costs over the three years period.

The calculated BCR of 6.6 clearly demonstrates that the proposed programme of enhanced CBPP control activities followed by the shifting of the CQL from its current position to international borders of the northern districts of Kenya would be economically viable. In terms of sensitivity analysis, the estimated BCR figure shows that the costs of the programme would have to increase almost sevenfold before the programme becomes marginal from the economic viability criterion.

3.5.2.4 Discounted Cost-Benefit Analysis for the considered Options (Alternative Strategies) for CBPP Control in Kenya

Table 7 presents the results of discounted cost-benefit analyses for the other possible CBPP control and management options (alternative strategies) in Kenya:

Table 7 indicates that Option III has the highest B-C ratio, followed by Options V, IV, II and I in the descending order of economic superiority. However, Option III (i.e. enhanced vaccinations only) is best done with Option IV (i.e. with sero-surveillance) as a back-up service for case detections. Even though the Option III would be preferred over Option V on economic grounds, it has low levels of sero-surveillance and is thus not considered technically ideal. This study, therefore, finds the Option V, which involves combinations of the novel attributes of Options III and IV among other aspects, to be optimal from both technical and economic criteria, and thus recommends that the government could adopt this strategy as an alternative in its CBPP control efforts, because this alternative is associated with a relatively large quantum of benefits from a relatively small quantum of costs. Following this recommendation, Fig. 1 (Map of Kenya and Insertions) indicates the positions of the current and the proposed CBPP quarantine lines [2].

3.5.3 Overall Assessment

Based on the above evaluations of cost effectiveness of the alternative CBPP control strategies, this study recommends that the government could consider adopting Option V as an alternative CBPP surveillance and control strategy because it appears to be more cost effective than the current strategy. This alternative strategy would culminate with the shifting of the CBPP quarantine line (CQL) to the international borders of the arid districts at the end of the third year of CBPP vaccinations campaign. Evidently, this enhanced CBPP control strategy would

be costly. However, economic evaluations suggest that the enhanced CBPP control activities (i.e. vaccinations and sero-surveillance activities) would have a fairly attractive BCR of 6.6, which is a fairly robust measure of economic viability and, arguably, positive welfare impacts. In terms of sensitivity analysis, the costs of the enhanced CBPP control programme with the estimated BCR figure of 6.6 would have to increase almost sevenfold before the programme becomes marginal from the economic viability criterion.

CBPP screening is important in guiding decisions on the need for livestock movement restrictions as a disease control strategy. The technology of CBPP screening has now been reduced from three to two serological tests, 21 days apart, and this is considered to be satisfactory by the veterinary professionals. Therefore, it was not found necessary to try to identify and evaluate alternative CBPP testing methods.

4. Conclusions and Recommendations

4.1 On Livestock Marketing

Based on the study findings, there is need for the establishment of a main national terminal market to facilitate livestock marketing in Kenya, and the Kenya Meat Commission (KMC) could play that role if it properly restructured. Markets organization can be improved with the Kenya Livestock Marketing Council (KLMC) being given political and stakeholder support to become a well managed and technically strong body, capable of designing projects for the benefit of all livestock industry stakeholders. Market transparency should be improved by having an open livestock auction system, principally by encouraging the stakeholders to device and put into operation a coordinated market information system, and by encouraging them to get together and agree on a designated livestock/cattle auction day per market.

The marketing infrastructure, including holding grounds and watering facilities along the major traditional stock routes, should be improved with the participation of user groups. In addition, consideration should be given to establish a holding ground in Garissa district and to utilise a portion of the ADC Galana ranch as a holding ground for quarantine and surveillance against CBPP and other livestock diseases. Therefore, efforts should be made to ensure that official stock routes are defined and re-established. Movement through them should be fast, and grazing should be at the holding grounds only. Security along the stock routes should be improved. The roads infrastructure linkages to the main terminal markets in Nairobi and Mombasa should be improved to facilitate trucking of livestock as an alternative to trekking in livestock marketing.

The option of expanding and/or consolidating alternative slaughter facilities now serving both the Nairobi and Mombasa markets should also be explored, bearing in mind their current limitations, the principal one being lack of large well-serviced holding facilities (having forage, water, and health amenities) where pre-slaughter animals can be kept. The KLMC should thus work for the other stakeholders to develop all the livestock markets that are established with local as well as government support with a view to utilise those facilities to enhance marketing and growth within the livestock industry.

4.2 Animal Health and Linkage to Livestock Marketing

4.2.1 Marketing Improvement and CBPP Control Efforts

This study finds that problems related to incidences of livestock diseases and weaknesses in livestock disease control in Kenya are to blame for the loss of the country’s export markets for livestock commodities since the late 1970s [3]. Therefore, Kenya should invest in the infrastructure that is necessary to guarantee and convince the potential importers that the Kenyan livestock commodities are safe from livestock diseases if the country desires to recapture its lost export markets for such commodities, especially in the Middle East (ME). One way out is

for Kenya to identify and delineate some areas within the country that could be operated as DFZs, by instituting the requisite livestock disease control measures for the livestock held within such DFZs so that such livestock can be internationally certified as fit for export, either as live animals or as processed products.

Annual vaccination campaigns supported by quarantines whenever disease outbreaks occur should remain the main CBPP control strategy. Owing to persistent CBPP outbreaks, it is recommended that Turkana, West Pokot and Tana River districts remain CBPP quarantine districts and the standard regulations governing movement in and out of quarantine districts that should be maintained. To ensure that CBPP is excluded from the arid northern districts of Kenya, serious consideration should be given to shifting the responsibility for CBPP surveillance to the districts themselves. This should include post- mortem follow-ups of serological positive cases for unvaccinated cattle along with the required trace-backs to determine their origins. Appropriate resources will be required for this, including funds for the rehabilitation of mobile laboratories, equipment and other necessary facilities as well as operating funds.

In view of the widespread presence of CBPP positive reactors within the country, purposive epidemiological studies should be undertaken to determine if, indeed, the CBPP has not become endemic in more districts than that is now believed and rule out genuine post-vaccination reactors. These studies will also include post- mortem follow-ups and trace-backs indicated. Such studies, which could be done internally by the Veterinary Department, would be continued for a suitable length of time, say, three years, and funded adequately. A collaborative, trans-boundary vaccination programme (Ethiopia, Sudan, Uganda and Somalia) that aimed at a high coverage—above 80%—should be instituted and carried out for a period of at least three years as part of a general animal health improvement programme.

Alongside the enhanced animal health programme, there should be rigorous and permanent, epidemiologists-led surveillance for CBPP and other diseases in the border districts, with units stationed at strategic points along the border. The border teams should have both fixed and mobile CBPP laboratories. Linked to these disease control efforts, there should be a rapid response (emergency) team to stamp out disease outbreaks as they occur. Pastoralists should be encouraged to report the Veterinary Department's their intentions to move livestock across the common borders and resources should be made available so that such animals are vaccinated.

4.2.2 The CBPP Quarantine Line

This study finds that the prevalence of CBPP in the arid districts of northern Kenya is fairly low. The economic analysis of alternative disease control strategies shows that it would be more cost effective to engage in an enhanced CBPP surveillance and eradication campaign in the arid districts of North-eastern Kenya for three years, followed by the shifting of the CBPP quarantine line from its current location to the international borders of these districts (Table 3). It is, therefore, recommended that the CBPP quarantine line is shifted from the current position to the international boundaries of the arid districts of northern Kenya after the proposed enhanced CBPP surveillance and eradication programme has been implemented, as described in the earlier sections of this article. The positions of the current and proposed CBPP quarantine lines are shown in Fig. 1.

4.2.3 Livestock "Movement" and "No Objection" Permits

Given livestock trade complications that arise out of the livestock "Movement" and "No Objection" permit requirements by veterinary authorities and the livestock traders' concerns, as discussed in this article, it is recommended that these permit requirements are reviewed and that measures to address this problem are devised to ease livestock marketing. In this regard,

it is recommended that the current practice, which obligates the livestock owner to travel to the destination in order to obtain the "Permit" is discontinued and replaced by internal communication between the source and destination Veterinary Officers. Telephoned or e-mailed authority would immediately be confirmed to the source veterinary office in writing without inconveniencing or delaying the livestock owner. The livestock owner would, therefore, obtain the permit from the local veterinary office. Adjustment of the charge for movement permits could be made to sustain this facility.

Current veterinary regulations allow for permits to be given only to individuals and not to organisations. With the emergence of government approved and supported Marketing Councils at district and lower administrative divisions, it is recommended that regulations are changed to allow permits to be issued to such councils for a given number of animals being moved on a given day. Consideration should be given to extending the time of validity, provided that the corresponding veterinary offices confirm the conditions at the destination to have remained unchanged.

4.2.4 CBPP Vaccinations

Annual CBPP vaccination campaigns accompanied by quarantines when needed should be the main disease control strategy. All the arid districts and West Pokot should be covered in annual CBPP vaccinations for a minimum period of three years. The veterinary function of a holding ground along a designated stock route, such as the one proposed at the ADC Galana ranch, would be to ascertain the transit livestock vaccination status and freedom from infectious diseases before they are released to the ranches for fattening or to await slaughter.

4.2.5 Movement Permits and Night Travel

It is usually impractical to offload and reload trucked animals enroute, but it is also understandable that regulated movement is necessary in order to minimise trade in stolen cattle. In order to accommodate both concerns, it is recommended that:

(1) Provided that a certificate of ownership for the animals being transported is provided to the movement permit issuing office, as now demanded in some livestock markets in the arid districts, and provided that such proof accompanies the animals as they travel, serious consideration should be given to permitting night travel;

(2) Such night movements be done under suitable supervision which might be provided by the provincial administration or police.

(3) Animals destined for the coast meat market are routinely given a permit for immediate movement to Mombasa while, in fact, they are held for varying periods in ranches and other facilities elsewhere in the coast, and most reach Mombasa only as meat. For that reason, it is recommended that traders are required to state where the holding destinations are in order to ensure that the permits are more precise. If and when it is agreed to establish a livestock diseases quarantine holding ground, the ADC Galana ranch say that it could be the destination district.

4.2.6 Quarantine Notices

(i) It is recommended that the general principles governing quarantines are widely publicised among communities and traders (including the district trading councils) with a view to ensuring that all stakeholders participate in their proper management, as is already happening in some of the arid districts;

(ii) Since quarantines are so disruptive of the very livelihoods of pastoralists, provincial and headquarters veterinary authorities should exercise close supervision of district quarantine administrators. This will ensure that standstills are not prolonged unduly.

4.2.7 Special Recommendation on the Strengthening the Veterinary Department

This study recognises the fact that proper implementation of the many of the recommendations made in this article will require substantial resources. Therefore, it is recommended that an adequate funding be sought and provided to strengthen the Veterinary Department in order to make it effective while

performing its core functions as they relate to livestock diseases control in the study area in particular and the rest of the country in general. The enhanced funding should also cover the costs involved in the supervision and facilitation of those functions that the department has delegated or will wish to contract out to the private sector.

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