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ANIMAL HUSBANDRY & VETERINARY SCIENCE | RESEARCH ARTICLE

Factors worsening tick borne diseases occurrence in rural communities. A case of Bindura district, Zimbabwe

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Abstract: Since 2018, Zimbabwe has lost more than 9% of its national beef herd due to tick-borne diseases. Theileriosis is the major suspect among the tick-borne diseases. A survey was conducted to find out factors which are worsening the occurrence of tick-borne diseases in Zimbabwe, using Bindura district as a case study. A structured questionnaire was used to collect information on socio-demographics and general tick-related challenges confronting cattle farmers in the district. Cattle were dying in Bindura district, and tick-borne diseases were suspected to be causing the losses. A smaller proportion (13%) of cattle were not being dipped regularly, posing risk of providing hosts on which ticks complete their life cycle. More than 50% of the farmers had received some training on animal health issues. It was concluded that cattle were dying of tick-borne disease-related ailments. It was fervently agreed that higher acaricide costs were deterring farmers from sticking to the recommended dipping frequencies. Efficacy of acaricides was compromised since not all ticks were falling-off their host following dipping. The government and private sector were identified as key stakeholders to subsidize acaricides so as to make them affordable to the small-scale communal farmers. Researchers urged farmers to form smaller groups to boost their purchasing power

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PUBLIC INTEREST STATEMENT

Tick-borne diseases cost billions of dollars every year all over the world. Tick management is a major concern for smallholder farmers in poor nations, who rely on acaricides purchased by their governments. Tick resistance to acaricides is becoming more prevalent as a result of fluctuations in acaricide supply and poor management. As a result of unfavorable environmental conditions, climate change has resulted in the appearance of ticks in previously immune geographical areas. Regular examinations of tick prevalence in specific locations are required, as is the implementation of tick-specific management measures that are cost-effective, simple to apply, and long-lasting. Using strategic dipping, it is possible to interrupt the parasite's life cycle in regions where ticks are a significant problem. In this study, the goal was to figure out what was causing cattle mortality from tick-borne diseases to continue to occur despite improved government surveillance.

as they will order the acaricides in bulk. Veterinary services department should improve their surveillance and offer postmortem services on dying beasts.

Subjects: Agriculture; Agricultural Development; Agriculture and Food

Keywords: Tick-borne; theileriosis; Bindura district; acaricide; communal dipping

1. Introduction

Livestock contribute significantly to the livelihoods of the majority of the rural populace. Majority of cattle owners in Africa are resource-constrained communal farmers (Sungirai et al., 2016) and their herds are frequently attacked by tick-borne diseases. Parasites and diseases are among the most severe factors that affect livestock productivity (Lamy et al., 2012) and continue to impede growth of the livestock sector in Zimbabwe. The country recorded a 9% mortality rate in the national beef herd in 2019 (Ministry of Lands, Agriculture, Water, Fisheries & Rural Resettlement, 2020)[1] and more than 50,000 cattle died of tick-borne diseases in the year 2018 (Global Press Journal, 2019). The Zimbabwean national beef cattle herd was estimated to be around 5.5 million heads (Bennett et al., 2019) with the majority (90%) of them in the hands of the smallholder farmers. The control of tick-borne diseases in Zimbabwe is based primarily on the control of their vectors through dipping using various methods and acaricides on the market. According to Food & Agriculture Organization of the United Nations (2004) there is a wide spread of some tick species that are resistant to organophosphates, one of the acaricide groups commonly used in the control of ticks. The spread and increase in the number of the *Rhipicephalus appendiculatus* ticks and theileriosis cases are generally attributed to lack of adherence to cattle dipping routines or the shortage of acaricides and drugs (DVS, 2021). Ticks differ in their morphology; hence, various families exist.

Ticks are classified under the phylum *Arthropoda*, class *Arachnida* and order *Acarina* (Nicholson et al., 2019). According to Oundo (2019), *Acarina* has three key economically important families namely *Argasidae* (soft ticks), *Ixodidae* (hard ticks) and *Nuttalliellidae*. In the *Ixodidae* genera, groups of veterinary significance are the *Amblyomma, Hyalomma, Rhipicephalus* and *Ixodes*. However, there are fourteen (14) *Ixodidae* genera (Guglielmone et al. (2010). Genus *Rhipicephalus* has eighty-two (82) species (Guglielmone et al., 2010); examples are *Evertsi, Appendiculatus* and *Decoloratus* (International Centre of Insect Physiology & Ecology, 2019). The brown ear tick, main vector of theileriosis disease, is in the *R. appendiculatus* grouping.

Ticks suck blood from their host, which they locate by responding to cues associated with host odors, breath, body heat and the vibration of the victim (Hussain et al., 2021). Ticks have their predilection sites on the udder, ear, groin region and tails of cattle, where they can affect livestock directly by causing irritation and allergic reaction. The life cycle of brown ear ticks takes about 2–3 years but may last up to 6 years and that depends on environmental conditions, that is temperature, relative humidity and sunlight (Parola & Raoult, 2001). Unfed larvae can survive for up to 7 months, nymphs 6.5 months and adults up to 2 years (Parola & Raoult, 2001). It, therefore, becomes difficult to control the tick by management practices such as rotational grazing which are intended to starve the ticks. Therefore, following routine dipping is the only effective way for reducing brown ear tick populations as the animals will be going to grazing lands and bring the ticks to the dip tank for culling.

Methods of tick control in use currently are chemical, biological and cultural control methods (Nicholson et al., 2019). Physical methods are also carried out (Nath et al., 2018), and use of herbal plants has been practiced in some parts of Zimbabwe (Nyahangare et al., 2019). Chemical method involves the use of acaricides available such as organophosphates, amidines, synthetic pyrethroids, mixtures or macrocyclic lactones (Rodriguez-Vivas et al., 2017). Dipping cattle is regarded as the most effective method for preventing high incidences of tick-borne diseases and associated losses (Shahardar et al., 2019). Inadequate dipping cycles due to the shortage of acaricides has exacerbated the situation (Shekede et al., 2021). Controlled burning of paddocks and rotational grazing are examples of cultural methods. However, their applicability in communal set-up is a challenge as communities share grazing lands (Levin, 2020). Tick control thus can either be on host or off host with holistic integrated ecto-parasite management being practiced (Nath et al., 2018) to reduce selection pressure in favor of acaricide-resistant individuals (Rodriguez-Vivas et al., 2017). Use of dipping chemicals is the most commonly practiced control method. Animal Health (Cattle-Cleansing) Regulations of 1993 in Zimbabwe have made it compulsory that cattle should dip (Makuvadze et al., 2020), and this regulation dates back to 1914 when intensive dipping of cattle became mandatory for the control of East Coast Fever, a virulent form of *Theileria parva* infection (Norval & Deem, 1994).

The dipping guideline is that in summer cattle dip weekly and in winter fortnightly (Sungirai et al., 2018) as informed by tick populations. In most critical cases, a 5-5-4 dipping regime is recommended in tick infested areas. A 5-5-4 dipping regime is a strategic dipping practice where animals are dipped every 5 days and then at 4-day intervals to ensure that there is effective tick control. The basis of the 5-5-4 dipping regime is to cut the life cycle of the ticks before they are engorged (Walker, 2011). This strategy is most suitable considering the short period in which the ticks engorge (Sekkin, 2017).

Regardless of application method, efficacy of acaricides can be reduced by improper calibration and presence of mud or organic substances in the plunge pool. It therefore follows that dipping water must be regularly changed to maintain high efficiency of the acaricide. Use of footbaths at the entrance, which are at least 3 meters long, helps to reduce siltation rate as the hooves of animals are socked and cleaned in the footbaths (Sungirai et al., 2018). This may prolong the efficacy of dip wash and reduce mortalities as a result of tick-borne ailments.

There has been a rise in cattle mortalities mainly due to tick-borne diseases, particularly January disease (Lawrence & Waniwa, 2020), Red water, Heart water and Gall sickness (Ministry of Lands, Agriculture, Water, Fisheries & Rural Resettlement, 2020). Despite the fact that the department of veterinary services had increased the surveillance and disease control measures to curb the spread of tick-borne diseases, high incidences of cattle mortalities due to tick-borne diseases are still on the rise. This is evidenced by high mortalities reported to be attributed to tick-borne diseases since the onset of the tick challenge in 2017: 3,430 head died of tick-borne diseases in 2018; 1,133 in 2019; 1,903 in 2020; 2,772 in 2020 and 1,478 died in 2021 (Chikwati, 2021; NewZimbabwe, 2022). Holistic approach on investigation of the reasons why the cases are still high is critical so as to advice the policy- and decision-makers on the way forward. The current study investigates the likely factors worsening the occurrence of tick-borne diseases in rural communities of Bindura district. The extent of tick-borne related mortalities was also captured. Findings from this research will go a long way in curbing tick-borne challenges which are a threat to the national beef herd.

2. Materials and methods

2.1. Study site

The study was conducted in Bindura district, Mashonaland Central province which has a latitude of 17°18′4.7”S and a longitude of 31°19′11.46”E. Bindura district falls under agro-ecological region IIb, which receives rainfall ranging from 750 to 1200 mm per annum (Mugandani et al., 2012). The district is conducive for both crop and livestock production. Bindura is the capital of the Mashonaland Central province.

2.2. Study design

The research used a quantitative research design in which a structured questionnaire and secondary data were used to gather the quantitative responses on the factors exacerbating tick-borne diseases occurrence in rural communities.

2.3. Study population
The livestock farmers in the ten rural communities' wards of Bindura district were the study population.

2.4. Sampling procedure
Systematic random sampling technique was used to select five communal wards from a total of ten. A list of livestock farmers was obtained from AGRITEX department. Random selection of 10 livestock farmers who own cattle was done per ward to come up with a total of 50 livestock farmers.

2.4.1. Sample size determination
The researchers used the formula $n = z^2pq/e^2$ (Kothari, 2004) to calculate the sample size for the livestock farmers owning cattle.

Where:

n = Sample size

z = Standard normal deviate which is set at 1.96 corresponding to 95% confidence interval

p = Proportion of cattle farmers in Bindura district

q = 1−p

e = Maximum allowable error set at 0.05

2.5. Data collection
The data were coded to facilitate entries into Statistical Package for Social Sciences (SPSS) package used prior to analysis.

2.5.1. Household survey
The researcher designed the structured questionnaire and pre-tested it to ensure that the survey questions were in correct order and without ambiguity. The paper-based questionnaire was administered to 50 livestock farmers through face-to-face interviews. COVID-19 regulations such as wearing of masks and social distancing were adhered to during the interviews. The questionnaire gathered data including socio-demographic characteristics, animal health, dipping situation, challenges confronted by farmers, suspected causes of diseases and mortalities as well as possible solutions to improve cattle dipping.

2.5.2. Secondary data
The researcher collected secondary data which included disease incidences, cattle mortalities and dipping frequencies from the Mashonaland Central Veterinary Department.

2.6. Data analysis
Data were analyzed using SPSS version 21. The statistical package generated frequency distributions for disease occurrences, cattle deaths and dipping challenges. Association between gender of household head and cattle ownership was carried out using x^2 test. Microsoft Excel was used to produce graphical presentations. Tables and graphs were used to present the research findings.

2.7. Ethical considerations
Permission was sought from the provincial Veterinary and AGRITEX[2] Departments. Then the departments conveyed information to the wards where the researcher intended to collect data. Ethical principles such as privacy and confidentiality, anonymity and consent were adhered to. Objectives of the research were clearly explained to the interviewees.

3. Results and discussion

3.1. Sociodemographic findings

Majority of the respondents were married male who had attained secondary education (Table 1).

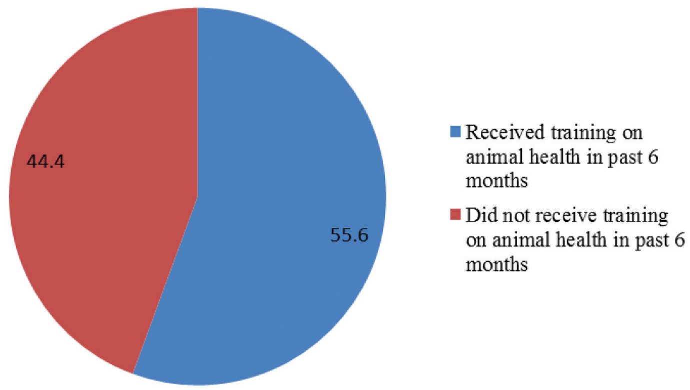
Males constituted the greatest (67%) proportion of the respondents. This was attributed to the fact that males, as heads of households, own bigger stock like cattle at household level whereas women own smaller stock like chickens. Findings from the x^2 test indicated that there was an association between gender of household head and cattle ownership. This is in concurrence with Galiè et al. (2015), who aver that men generally own larger livestock species such as cattle than women. A higher proportion of cattle owners had a certain level of education, with more than 50% having attained secondary level qualification. Results of the current research are comparable to Muvhuringi et al. (2021) who also reported that majority of farmers in Mazowe district having attained secondary education level. Education is key to success as it leads to better understanding of the fundamentals of cattle management practices like dipping regimes and general disease control. All religions were represented, indicating the critical roles of cattle in the society. Cattle is mainly used for draught power, manure, milk and a form of savings for farmers in rural areas (Mkuhlani et al., 2018). Tick-borne diseases thus deplete savings of farmers and threaten their food security as their main draught power source will be depleted.

Table 1. Percentage distribution the demographic and socioeconomic characteristics of the respondents

Characteristic	Percentage
Gender	
Male	66.7
Female	33.3
Total	100
Marital status	
Never married	8.9
Married/ Cohabiting	53.3
Divorced/ Separated	20.0
Widowed	17.8
Total	100
Highest level of education	
Primary	32.2
Secondary	51.1
Tertiary	15.6
None	1.1
Total	100
Religion	
Traditional	26.7
Catholic	15.6
Protestant	6.7
Pentecostal	24.4
Apostolic Sect	22.2
Others	4.4
Total	100

(n = 50)

Figure 1. Percentage distribution of the livestock farmers' responses on whether they had received training in the past 6 months (n = 50).



3.2. Animal health training

A higher proportion (55.6%) of farmers had received some training in animal health care in the past 6 months (Figure 1).

Maiyaki (2010) aver that farmer trainings and extension services are fundamental for successful agricultural production. The trainings were received from local veterinary extension staff workers in the area. This shows that farmers were cautioned as they were entering the rainy season on issues to do with health care of their animals as many parasites find the environment conducive during this time of the year. Farmers were trained on prophylactic herd health management skills which included vaccination, dipping and dosing of their animals.

Despite the majority of farmers having received some training, the proportion of untrained farmers (44.4%) was high. Such a proportion might cause despondence among the farmers as they may fail to understand the need to have all cattle in the area being dipped on the same day. Some ticks feed on more than one host, hence they will have hosts to feed from which would not have been dipped when other animals were dipped. Extension workers in the area should keep on encouraging farmers on the importance of refresher training courses. Failure to receive training by farmers was as a result of other commitments on the training days. Researchers urge extension workers to notify farmers well in advance so that they can make adjustments to their programs and attend training sessions. It is of value to the farmer to attend such platforms as farmers exchange valuable information which is beneficial in the fight against tick-borne diseases.

3.3. Tentative diagnosis of the cattle disease

The data obtained from the department of veterinary services (Figure 2) indicated that theileriosis was the major disease (47.2%) affecting cattle in Bindura district.

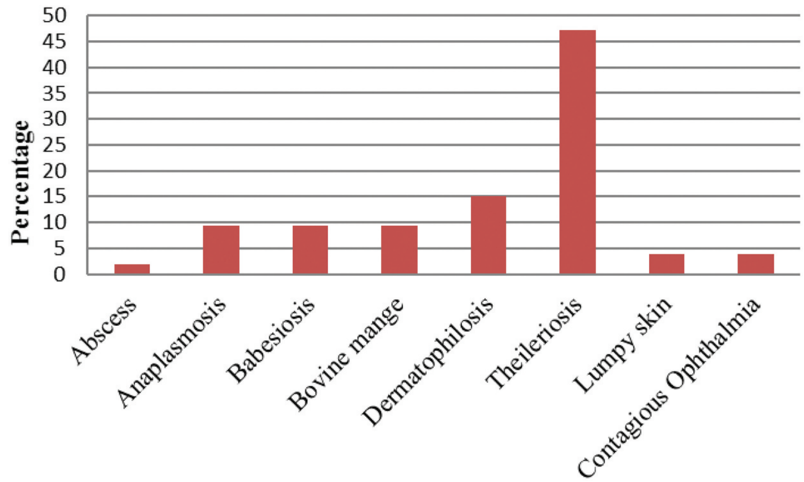
The majority of the diseases (57.2%) affecting the cattle are tick-borne diseases: anaplasmosis, babesiosis and theileriosis. Results corroborates with the 2015–2016 DVS report which indicated that tick-borne deaths accounted for 65% of the reported cases (OAG, 2018).

3.4. Causes of cattle death in Bindura district

Annual report from DVS (2020) indicated a total of 941 deaths with 580 (61.6 %) being due to ticks and 361 (38.4 %) other causes. The survey findings indicated that diseases were the major causes of death (66.7 %) of cattle in the area (Figure 3).

A research conducted by the Department of Veterinary Services in Nkayi and Lupane districts in Matabeleland North province from 2015 to 2016 indicated that tick-borne diseases are responsible for major cattle losses (OAG, 2018). This finding is in support with Nyangiwe et al. (2018) who assert that in Africa the impact of ticks is ranked highest and contribute greatly to cattle loss owing

Figure 2. Percentage distribution of the tentative diagnosis of the cattle disease (DVS quarterly report, March 2021) (number of cases = 53).



to morbidity and mortality. Although farmers were not sure of the causes of diseases and death of their stock, they suspected tick-borne diseases to be responsible for most of the diseases. Deaths due to slaughter were minimal at around 10%. This points to the fact that smallholder farmers' view selling their beasts as a secondary issue hence lower numbers were disposed-off for slaughter.

3.5. Dipping situation in Bindura district

The majority (62%) of households in Bindura district reside within a 5-km distance to dip tanks (Table 2).

The following acaricides were used in Bindura district; deltamethrin 5%, deltamethrin 1% and amitik. A smaller proportion of farmers reside at a distance of up to 10 km away from the dip tanks. A proportion of 86.7% reported to have been dipping their cattle adequately. A smaller proportion of 13% reported inadequate dipping. Communal areas share grazing lands as such; two or three host ticks might have unclean hosts where they can complete their life cycle without disturbance. This will result in contamination of grazing lands with ticks which will continue to infect cattle from their grazing lands. Farmers need to be educated and kept on being encouraged to make sure that all their stock are dipped on agreed dipping days so as to effectively control ticks.

Dipping frequencies were being observed. However, there were indications that a smaller proportion was dipping their stock at frequencies outside the recommended ranges. The government of Zimbabwe regulations stipulates that cattle must be dipped at weekly intervals during summer

Figure 3. Percentage distribution of the farmers' responses on cause of cattle deaths (n = 50).

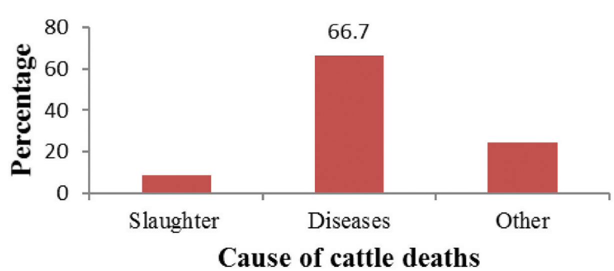


Table 2. Percentage distribution of the dipping situation

Dipping characteristic	Percentage
Distance to dipping facility	
Less than 5 km	62.2
5-10 km	37.8
Total	100
Dipping status	
Adequate dipping	86.7
Inadequate dipping	13.3
Total	100
Dipping frequency in winter	
Fortnightly	80.0
After more than 2 weeks	20.0
Total	100
Dipping frequency in summer	
Once a week	100.0
Total	100

(n = 50)

season and fortnightly during winter/dry season (DVS, 2020). Chi-square test indicated that there was no association ($p > 0.05$) between distance to dipping facility and cattle mortalities.

3.6. Challenges on dipping of cattle

High cost of acaricides was singled out as the most impediment to regular cattle dipping (Figure 4).

About 64% of the respondents were in agreement that acaricides were being priced beyond their reach. This is in agreement with Irvin et al. (1996, p. 13) who notes that with increased complexity of acaricides they continue to be out of reach for many smallholder farmers and governments of developing countries. Shortage of acaricides was raised by 13% of the farmers. This was augmented with the 2018 report of the Auditor General's documentary review which showed that dipping chemical was in short supply during the period 2015 to 2017 (OAG, 2018). Although the current research indicated that the dip tanks in the study area were functional, a review of DVS reports audit noted that 71% of dip tanks (2,637 out of 3,726) for the entire country needed rehabilitation

Figure 4. Percentage distribution of the respondents' main challenges on dipping of cattle (n = 50).

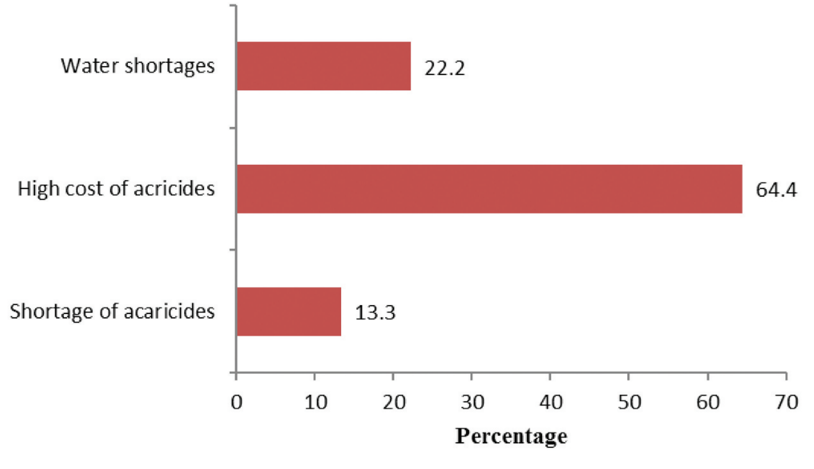


Table 3. Suggestions by farmers to improve dipping situation

Suggestion	Percentage
Government/ NGOs/Private sector to supply subsidized acaricides	66.7
Rehabilitation of dip tanks	22.2
Organise farmers into groups to collectively buy acaricides	6.7
Awareness campaigns	4.4
Total	100

(n = 50)

to function properly (OAG, 2018). Water shortage to refill the plunge dips was also cited by 22% of the respondents. Although the water challenge was raised by a few farmers, this might actually contribute to muddy water in the plunge pool which result in reduced efficacy of acaricides used. Thorough dipping must be done to effectively control ticks since tick-borne diseases account for 75% of cattle losses in Zimbabwe (DVS, 2020). There is a need for farmers to collectively contribute to make sure that water is fetched for use; otherwise ticks might end up resisting the acaricides being used. Communities can adopt water-conserving dipping methods such as the use of spray races.

3.7. Suggestions to improve dipping situation

Since the cost of acaricides was a thorn in the flesh for many farmers, a suggestion was made to have government or other private players to chip in to assist farmers with subsidized acaricides (Table 3).

Subsidizing acaricides will enable the resource-constrained communal farmers to access them and reduce the deleterious effects of ticks and tick-borne diseases (Irvin et al., 1996). A reasonable proportion (22%) suggested rehabilitation of dip tanks in the area. This could serve on those farmers who travel a longer distance to access the functional dip tanks. The majority of farmers did not value awareness campaigns and organization of farmers into small groups to improve their buying power if they collectively bring together their money.

4. Conclusion and recommendations

4.1. Conclusion

Possible causes of continued tick-related mortalities include failure to follow recommended dipping regime, high cost of acaricides deterring farmers from buying enough of their own supplementary acaricides and possible tick resistance. Availability of acaricides is not consistent among farmers; hence, some cattle are not dipped during such periods when the communal dip tank does not have acaricides to use. Due to the fact that cattle are not all dipped during dipping days yet they share grazing lands, efficacy of acaricides in Bindura district is reduced; hence, most of the mortalities recorded were attributed to tick-borne diseases. Cattle are dying from perceived tick-borne diseases in Bindura district.

4.2. Recommendations

Farmers are encouraged to adhere to all agreed dipping days. Farmers are also encouraged to purchase acaricides in bulk for use during those days they fail to take their animals to the common dip tank. Researchers also urge manufacturers of acaricides to consider smaller packages to cater for farmers with smaller herd sizes. Veterinary services department should train farmers hand dressing techniques to control brown ear ticks. The government is encouraged to subsidize acaricides to protect the national herd from external parasites. Veterinary services department should conduct acaricide resistance test to determine effectiveness of acaricides in use against the ticks in the area.

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Notes
1. MLAWFRR: Ministry of Lands, Agriculture, Water, Fisheries and Rural Resettlement.
2. AGRITEX: Agricultural Technical and Extension Services is a government department under the Ministry of Lands, Agriculture, Water, Fisheries and Rural Resettlement responsible for technical assistance to farmers.

Disclosure statement
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