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Chemical tick control practices in southwestern and northwestern Uganda

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A R T I C L E   I N F O

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A B S T R A C T

Tick acaricide failure is one of the leading challenges to cattle production in Uganda. To gain an understanding into the possible drivers of acaricide failure, this study characterized the current chemical tick control practices in the southwestern (Mbarara, Mitooma and Rukungiri districts) and northwestern (Adjumani district) regions of Uganda. A total of 85 farms participated in a survey that utilized a semi-structured questionnaire. Moreover, ticks were collected to determine the most common species on the farms. Tick acaricide failure was mainly encountered in the districts where 95% (60/63) of the farms reared exotic cattle (dairy cross-breeds) under a paddocking (fenced) system. In the northwestern region, local cattle were reared in communal grazing areas. All farms used chemical acaricides for tick control, predominantly amidine (amitraz) (48%, 41/85) and co-formulated organophosphates and pyrethroids (38%, 32/85). The spraying method was the most common (91%, 77/85) acaricide application technique, with cattle crush (81%, 69/85) as a common means of physical restraint. Less than optimal tick control practices encountered included use of substandard equipment for spraying, inappropriate dilutions, frequent interaction between animals in neighboring farms despite lack of synchronized chemical tick control and malpractices in acaricide rotation. Only *Rhipicephalus appendiculatus* and *R.* (*Boophilus*) *decoloratus* ticks were found in the southwestern region, where 51% (32/63) of the farmers used high acaricide concentrations above the manufacturers' recommendation. Farmers in the northwestern region used 2.2 times less acaricide volume per cattle than those in the southwestern region, and more diverse tick species were encountered. Toxic effects of acaricide to cattle and workers were reported by 13% (11/85) and 32% (27/85) of the respondents, respectively. All 27 cases of human acaricide toxicity reported were from the southwestern region. Overall, our findings may inform strategies for more prudent chemical tick control and safe acaricide handling to benefit animal welfare, food safety and public health.

1. Introduction

Ticks and tick-borne diseases (TBD) have become one of the leading challenges to cattle production in Uganda. *Rhipicephalus appendiculatus*, *R.* (*Boophilus*) *decoloratus* and *Amblyomma variegatum* are among the most important tick species in the country (Byaruhanga et al., 2016). Besides the physical damage ticks cause on cattle (Brizuela et al., 1996), they also vector disease agents that are associated with severe economic loss. The climate in Uganda favors tick survival throughout the year. Thus, cattle farmers continuously have to use acaricides to reduce production losses associated with tick-borne diseases (Jongejan, 1999; Jongejan and Uilenberg, 2004). A recent study in Uganda reported that the most economically important ticks − *R. appendiculatus* and *R.* (*B.*) *decoloratus* − were resistant to commonly used acaricides (Vudriko et al., 2017a,b, 2016). However, the study did not sufficiently investigate the practices for usage of acaricides associated with resistant

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ticks. Acaricide resistance is a natural response to selection pressure (Robbertse et al., 2016) and inappropriate farm tick control practices may facilitate resistance development. Abbas et al. (2014) noted that acaricide application practices is the most important factor that influence the pace at which resistance develops. Consistent use of the same acaricide class on a farm is amongst the leading drivers of selection for resistance (Jonsson et al., 2000). In view of the wide spread complaints of acaricide failure, especially in western Uganda (Vudriko et al., 2016), this study sought to assess the practices involved in acaricide usage and determined the common tick species infesting cattle in four selected districts in southwestern and northwestern Uganda. The study also documented gaps in tick control as part of the baseline knowledge needed for developing better practices, including development of extension materials and farmer training. The study findings were also used for designing intervention strategies using evidence-based tick acaricide control practices (EBATIC) (Vudriko et al., 2017b). Therefore, this study adds to the body of knowledge on the challenges of tick control in smallholder farms, and highlights the key areas of concern that requires mitigation by authorities responsible for the animal industry to prevent a future acaricide resistance crisis in Uganda.

2. Materials and methods

2.1. Study area

The study was conducted in four districts, Adjumani, Mbarara, Mitooma and Rukungiri, in Uganda between July and September 2015 (Supplementary Fig. S1). Three of the districts in (Mbarara, Mitooma and Rukungiri) lie within the high acaricide pressure zone in Uganda's dairy shed areas (Balikowa, 2011) where in an earlier study we identified tick resistance against acaricides (Vudriko et al., 2016). Adjumani district on the other hand is located in the northwestern part of Uganda where acaricide pressure/use is generally lower. Adjumani is at an altitude of 900–1500 m above sea level and receives an average rainfall of 1125 mm per annum based on the district report. Mixed farming (crop-livestock) is the major economic activity with Zebu cattle as the dominant breed reared.

2.2. Study design

This was a cross sectional study that involved use of a semi-structured questionnaire to assess the knowledge, attitude and practice of farmers regarding tick control. Ticks were also collected from cattle and identified to determine species distribution in the four districts. In the southwestern region, farms with and without complaints of acaricide failure at the time of the study were identified by the local district veterinary office or drug shop outlet operators in the community. A total of 85 farms were purposively selected from the four districts by the district veterinary officers in charge of the study areas. A subjective score was used to rank acaricide failure based on the number of ticks recovered on animals in the southwestern region. Farms with a total of less than 10 ticks picked from half of the animals inspected were considered not to have acaricide failure and those with at least 10 ticks were categorized as having acaricide failure. Based on this criterion, 33 southwestern region farms were classified as having acaricide failure and another 30 farms were considered not to have acaricide failure. In Adjumani district, 22 farms were identified by the district veterinary office and used for obtaining data on chemical tick control practices in northwestern Uganda. Adjumani district was excluded from the criteria for southwestern due to low acaricide pressure and our earlier study showed ticks were susceptible (Vudriko et al., 2016; Vudriko et al., 2017a).

2.3. Survey to identify gaps in tick control

A semi-structured questionnaire was used to capture on-farm use of acaricides and possible factors that predispose to acaricide failure. The purpose of the research was explained to each farmer by the research team and the district veterinarian to obtain oral consent and permission. The questionnaire (Supplementary Fig. S2) was administered by the research assistants to either the owner or manager of a farm. Key variables captured included characteristics of the farm, equipment and facilities used for tick control, acaricide dilution and acaricide application practices, strategies used for coping with acaricide failure, and acaricide toxicity to animals and farm workers. Data on the types of acaricide used per farm was categorized into current (acaricide in-use at the time of data collection), intermediate (acaricide used just before the current one) and previous (acaricide used before the intermediate one). This was used to determine the acaricide brands and classes used and the correctness of rotational schemes. Acaricide rotation was considered incorrect if the change of acaricide was effected within the same class of acaricide, change from co-formulated acaricide to respective mono-formulations, or not being sure of the brand name of the acaricide used before (intermediate) changing to the current acaricide in use. The volume of acaricide mixed with 20 liters or per liter of water for application on animals was used to determine whether manufacturer's recommendation for dilution of the acaricide in use was followed. Dilution was deemed incorrect if the acaricide strength was higher (double, triple or quadruple) or lower than manufacturers' recommendation, estimated or the respondent was not sure. The number of animals sprayed with 20 liters of mixed acaricide solution was used to calculate the average volume (liters) of mixed acaricide solution used for spraying one cattle against the FAO recommended (FAO, 1998) ratio of 10 liters to 1 cattle.

2.4. Collection and identification of ticks

At each farm, at least half of the cattle were randomly taken to the holding yard or kraal (Fig. 1A). Animal handling procedures during sample collection were done by qualified personnel (district veterinarians and research team) to avoid any pain and distress to the animal. The cattle were restrained using either crush or ropes and visible ticks were hand-picked from their various attachment sites. The ticks were transferred into aerated sample bottles, sorted and identified to species level using a published key (Walker et al., 2014).

2.5. Data analysis

The data captured were coded and entered in MS Excel and analyzed in SPPS version 21 (IBM SPSS Statistics for Windows, Version 21.0; IBM Corp., Armonk, NY, USA). Fisher's Exact Test was used to determine the operational factors associated with acaricide failure in farms in southwestern Uganda at 95% confidence and p value ≤ 0.05 was considered statistically significant. Tick data were further analyzed to determine the distribution of tick species per district.

2.6. Ethical considerations

The study was approved by the College of Veterinary Medicine, Animal Resources and Biosecurity, Makerere University (Approval number: VAB/REC/15/104). Both questionnaire administration and sample collection were done in only farms that gave oral consent. Animals were handled by Veterinarians during sample collection to avoid distress. The identity of the respondents were kept confidential. Any mention of the brand name of an acaricide should not be taken as promotion or demotion of the product.

3. Results

3.1. Characteristics of the farms

A total of 85 farms participated in this survey, 63 of which were