Method Used to Control Ticks in South Africa

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Ticks are amongst the important ectoparasites where livestock are concerned, as they adversely affect the animals through bloodsucking. In tropical and subtropical countries, they transmit pathogens such as babesiosis, theileriosis, ehrlichiosis, and anaplasmosis in cattle, causing a reduction in production rate and significant concomitant economic losses. Ticks affect 80% of the cattle population across the world, with an estimated economic loss of USD 20–30 billion per year. In South Africa, economic losses in the livestock industry caused by ticks and tick-borne diseases are estimated to exceed USD 33 million per year (ZAR 500 million). There are seven major genera of ixodid ticks in Southern Africa (i.e., *Amblyomma*, *Dermacentor*, *Haemaphysalis*, *Hyalomma*, *Ixodes* and *Rhipicephalus*). The environment in which a tick lives is made up of all the various biological and abiotic factors that are either necessary or unnecessary for its life.

cattle ticks diseases

1. Introduction

Ticks, which are arachnids, are of primary importance in veterinary and human health due to the role they play in transmitting pathogens such as rickettsia, protozoan (*Babesia* spp.), spirochaetes, and viruses [1]. They are ectoparasites of different terrestrial vertebrates, amongst which are birds, amphibians, reptiles, and mammals [2]. Approximately 900 tick species have been described globally, of which more than 700 are hard ticks (Ixodidae) and approximately 200 are soft ticks (Argasidae), with only one species belonging to the *Nuttalliellidae* family [3]. *Nuttalliella namaqua* Bedford, 1931 (from the *Nuttalliellidae* family) have features found in both hard and soft ticks [4][5]. Hard ticks (*Acari: Ixodida*) are divided into two morphological and phylogenetic groups, namely the *Prostriata* and the *Metastriata* [6]. The subfamily *Prostriata* has one genus known as *Ixodes* (240 species), while the subfamily *Metastriata* is further subdivided into five subfamilies: the *Amblyomminae* (129 species), *Bothriocrotoninae* (indigenous Australian, 7 species), *Haemaphysalinae* (164 species), *Hyalomminae* (25 species), and *Rhipicephalinae* (81 species) [7][8].

Ticks evolved over a million years ago. It is further suggested that they may have originated 350–400 million years ago (Norton, Bonamo [9]) and biological, physiological, and ecological evolution have resulted in different abilities to be vectors of tick-borne diseases [10]. Hard ticks can transmit a variety of pathogens and are considered primary vectors of diseases that affect livestock globally [11]. In humans, they are the second most effective arthropods, after the mosquito, in terms of transmitting pathogens in tropical countries [12]. Annual livestock losses due to tick-borne diseases, and the costs associated with the treatment, are estimated at USD 22 billion to 30 billion globally

[13]. The livestock industry in South Africa incurs annual losses of ZAR 1.059 billion due to heartwater disease. Heartwater disease is one of the tick-borne diseases that is transmitted by ticks of the genus *Amblyomma* which severely affect livestock in Southern Africa. In Southern Africa, seven significant genera of ixodid ticks exist (i.e., *Amblyomma*, *Dermacentor*, *Haemaphysalis*, *Hyalomma*, *Ixodes and Rhipicephalus*) [14]. The identification of these ticks in developing countries is mostly through traditional techniques.

2. Control of Ticks and Tick-Borne Diseases

There are different methods used to control ticks. The most common method used to control ticks is through a chemical approach such as acaricides. However, this method loses its efficiency when the ticks selected are resistant to acaricides [15]. The sections which follow detail traditional and innovative approaches associated with the control of ticks and tick-borne diseases in South Africa.

2.1. Control of Ticks in South Africa

Common methods that have been utilized for tick control include chemicals known as acaricides; however, these have limitations because of their residue which remains present in the environment and meat, the high costs involved, and the selection of cattle breeds which are resistant to ticks [16]. Multiple types of resistance to acaricides occur [17]. For instance, the *Rh. (Bo.) microplus* species have shown significant multi-resistance: the species was reported to be resistant to OP (organophosphates), SP (synthetic pyrethroids), and Am (amidines) [18]. Additional chemicals used in the acaricides include organochloridespyrethroids, amitraz, macrocyclic lactones, insect grown regulators (IGRs), and phenilpirazolons (fipronil) [19]. Currently, chemicals are applied to livestock using systems such as spraying, dipping, or pouring [20]. Uncontrolled usage of chemical acaracides in many countries has resulted in tick species such as *Rh. (Bo.) microplus* developing resistance [21]. The mechanism that the acaricides use to control ticks on the host is either by direct contact with the specific parasites after external application or absorption of the substance from host tissues [22]. These acaricides are neurotoxins that affect the tick's nervous system [23]. Conversely, tick resistance to acaricides has become a major driver of the need for new products and strategies to successfully reduce ticks and tick-borne diseases in South Africa, and worldwide. Ranchers of dairy and beef cattle in South Africa most frequently employ the class of synthetic pyrethroid acaricides. Common acaricides used in South Africa are summarized in **Table 1**. Every week in the summer and every two weeks in the winter, the government offers a dipping service in which the acaricide Triatix 500 TR® (Amitraz 50 percent) is supplied enough to be used in communal dip tanks [24]. Alternative tick-control techniques used by farmers in South Africa include using old motor oil, having hens peck at the calves, manually removing ticks by cutting and pulling them, applying Jeyes Fluid, and using medicinal plants such as *Aloe ferox* and *Ptaeroxylon obliquum* [25]. These methods have been used commonly in South Africa with sufficient impact. However, the development of resistance and chemical residues have recently rendered these methods not efficient enough. This has motivated the need for other alternative methods such as developing breeding programs which will be used to breed animals that are resistant to ticks. The other method that can be applied is using vaccines.

Table 1. Acaricide use and resistance in South Africa.

Compound	First Used	Resistance 1st Reported
Arsenic	1893	Du Toit and Bekker [26]
DDT	1948	Whitehead [27]
BHC and Toxaphene	1950	Whitnall, Thorburn [28]
Carbamates	1960	Shaw [29]
Organophosphates	1960	Shaw [29]
Synthetic Pyrethroids	1981	Coetzee, Stanford [30]
Growth regulators	2000	Whitehead [27]

2.1.1. Control of Ticks with Vaccines

Vector vaccines have made it possible to lessen the effects of ticks and tick-borne diseases, by (a) reducing tick abundance and, consequently, the likelihood that hosts will contract vector-borne diseases, (b) reducing the ticks' capacity to transmit pathogens, and, preferably (c), a combination of the two factors [26]. Since its invention at Onderstepoort in 1945, vaccination has been widely employed in Southern Africa [27]. The first vaccine to be used on cattle against heartwater was an attenuated vaccine using *E. ruminantium* [28]. The vaccine was administered through the intravenous (IV) route. The vaccine showed 83% protection against heartwater on Friesian cattle [29]. Acaricides and vaccines methods do not completely eradicate ticks; they are also not sustainable and are shaping the use of acaracides due to the costs involved in South Africa and globally, respectively, and environmental health concerns [30]. Other methods that have been employed to control ticks and tick-borne diseases are summarized below.

2.1.2. Other Methods of Tick Control

Manual Removal

This technique involves removing ticks from cattle and is mainly done on small-scale farms where the infestation of ticks on cattle is low [31]. Engorged ticks, ranging from 5 to 10 mm in length, are removed from cattle in the morning, and this method can reduce the tick population by approximately 21% [32]. Approximately 10% of farmers have been documented to make use of blades or scissors to pull and cut ticks off animals [33]; some lowveld smallholders and highveld farmers in Zimbabwe have been reported to use their hands to remove ticks from cattle [34]. This technique has limits, in that the inappropriate removal of ticks manually may cause more damage to the cattle's tissue, particularly with tick species that have long mouthparts [24].

Husbandry Practices That Support Tick Control

Ticks and tick-borne diseases can also be controlled using their habitat through controls that include growing plants that are not tick friendly, grazing management, pasture burning, animal nutrition, plant extracts, essential oils, vaccination, and biological control [31]. Certain plant species such as *Stylosanthes scabra* (a tropical legume) attract and trap ticks at the larval stage in their sticky exudate [35]. Rotating cattle to clean fields is used to starve ticks, as it interrupts their life cycle [36]; however, this technique has limitations due to managerial complexity and the costs involved in fencing paddocks [37]. Another tick control strategy is the burning of pasture.

Burning pasture exposes ticks (at different stages) to high temperatures and also destroys vegetation that serves as tick habitat [21]. The burning of pasture is applied globally, particularly in countries such as South Africa, Zambia and Australia, and in North and South America [36]. This method, however, has effects on the environment such as the decrease in soil nutrients leading to leaching and/or erosion [38]. Animal nutrition also plays a part in controlling ticks, as nutrition mediates host resistance to ticks [39]. Plant species from the *Poaceae*, *Fabaceae*, *Lamiaceae*, *Verbenaceae*, *Piperaceae*, and *Asteraceae* families have been reported to contain acaricidal properties [40]. Their secondary metabolites have been used against ticks of the *Amblyomma*, *Rhipicephalus*, *Hyalomma*, *Dermacentor*, *Argas*, and *Ixodes* genera [41].

2.2. Host Resistance

Animals that are resistant to tick infestation terminate the life stage of ticks as a result of the latter's inability to feed on the host, thus reducing engorgement weights, egg production, and larval development, all of which reduce the tick population [42]. Host resistance of cattle to ticks varies across breeds, including cattle breeds such as *Bos indicus*, which display the strongest innate tick resistance [43]. In South Africa, Nguni cattle are known to be more tick-resistant than other, exotic cattle breeds. Variation in tick resistance within the Nguni cattle population has been reported by Mapholi and Maiwashe [44]. As a result, exotic breeds have been cross bred with South African indigenous breeds with the aim to improve cattle's tick resistance and other local adaptive traits (heat and humidity stress). For example, Bonsmara cattle are a composite breed developed for tick resistance, especially for cowdriosis, and to endure heat stress [45]. Host resistance to ticks is assessed by counting and scoring the number of ticks on the cattle [46]. It is increasingly possible to use genomics tools in combination with phenotyping information to achieve a genomic selection of tick-resistant cattle and it was revealed that utilizing genomic predictions, a joint genetic assessment of the Angus, Hereford, Brangus, Braford, and Brahman breeds may be easily adopted to increase tick resistance within those populations [47]. Their selection is based on the ability to transmit resistant genes from one generation to the next [48]. Currently, the breeding of tick-resistant cattle currently ensures that the animals can still produce in hostile environments and during tick challenges.

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