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Cross Sectional Study on the Identification, Prevalence and Associated Risk Factor of Hard Tick on Bovine at Goro Gutu Woreda, East Hararghe, Oromia Regional State, Ethiopia

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Keywords: Amblyomma; Cattle; Goro gutu; Hyalomma; Rhipicephalus; Ticks.

Abbreviations: a. s. L: above sea level; ^{0}C: Degree Centigrade; FAO: Food and Agricultural Organization; GDP: Gross Domestic Product; SNNP: Southern Nation Nationality and People; *P-value:*Precision value; TBD: Tick Born Disease; US$: United States of American Dollars; VBD: Vector Born Disease; X^2: Chi-square.

Abstract

A cross sectional study was conducted from November, 2017 to March, 2018 at GoroGutu district, Eastern Hararghe, Oromia regional state to determine the prevalence of thetick infestation and identify the tick species in cattle. During the study period a total of384 cattle were examined and 82.81% (n =318) of them were found infested with tick. Atotal of 1727 adult hard ticks were collected from half body part of infested cattle. As awhole five different species of ticks were identified in the present study. The species of ticks identified were *Rhipicephalus (Boophilus) decoloratus* (36.88%), *Amblyomma (A) variegatum* (21.25%), *Hyalomma marginatum rufipes* (17.72%), *Amblyomma Cohaerens* (13.90%) and *Amblyomma gemma* (10.25%). In general, except for the sex and PeasantAssociation (*p-value*>0.05), there was statistically significant difference (*p-value*<0.05), in the prevalence of tick infestation between/among the different groups of other riskfactors such as age, breed, body condition, management and season. All tick species distributed and attached different parts to the host and inflicts different types of skinlesion. Since tick transmit tick borne diseases in addition causes severe damage to the hide and skin of domestic ruminants and thereby reduce the foreign exchange of thecountry. As a result effective tick control programs should be formulated andimplemented in the national or regional level.

Introduction

Ethiopia is believed to have the largest livestock population in Africa. This livestock sector has been contributing Considerable portion to the economy of the country, and stillpromising to rally round the economic development of the country [1]. In Ethiopia, livestock production remains crucial and represents a major asset among resource-poor small holder farmers by providing milk, meat, skin, and manure andtraction force [2]. Agriculture is the main stay or livelihood for 85-90% of people of Ethiopia, and is characterized to a large extent by mixed farming system [3]. Ethiopia is endowed with a very large and diverse livestock resource, composed of approximately 56.71 million cattle, 29.33 million sheep, 29.11 million goats, 2.03 million horses, 7.43 million donkeys, 0.4 million mules, 1.16 million camels, 56.87 million poultry and 5.88 million bee hives [4].

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Cattle plays a significant role in the socioeconomic life of the Ethiopian people and livestock industry represent the second largest income contributing to the GDP of the country which accounts for nearly 15% of the total GDP and about 40% of the agricultural GDP. Export of livestock and livestock by products also have appreciable contribution to the foreign exchange earning of the country accounting to about 15% and 70% of all export earning, and hide and skin are important components respectively [5].

Ticks are arachnids in the subclass of Acarina and are closely related to mites. Ticksare widely distributed throughout the world particularly in tropical and sub- tropical countries and cause a tremendous economic loss in livestock production [6]. (FAO, 1983). 889 species of ticks in three major families namely the Ixodidae,Argasidae and Nuttalliellidae, relatively few are important to man and domestic animals. The family, Ixodidae (hard tick) is relatively large and comprises thirteen genera. Among these genera Amblyomma, Boophilus, Dermacenter, Hayalomma, Haemophisalis, Ixodes and Rhipicephalus contain species of veterinary and medical importance [7]. Among the major parasitic diseases, ticks and TBDs rank third after trypanosomosis and endoparasitisms in causing economic losses of the country [8]. In Ethiopia, 47 different species of ticks are reported in livestock [9]. Studying ticks on cattle under their natural conditions without any control measure is also useful for understanding the host parasite relationship and variation of tick population in different agro- ecological zones [10]. Due to economic and veterinary importance of tick, their control and transmission of tick born disease remainchallenge for the cattle industry in both tropical and subtropical area of the world and it had been priority of many countries [11]. The most economically important genera of tick-borne haemoparasite infecting cattle in communal area are rickettsial diseases like anaplasmosis, ehrlichiosis and cowdrosisand from protozoal diseases like babesiosis, theileriosis and from bacterial disease dermatophilosis [12].

In addition to transmitting certain protozoan, rickettsial and bacterial diseases, ticks also predispose animals to secondary bacterial infection [8]. In addition to vector borne disease, tick damages hide and skin and interfere with meat and milk production [13]. The current utilization of hides and skins in Ethiopia is estimated to be 45% for cattle hide, 75% goat skin, and 97% sheep skin with expected off take of 33, 35, and 7% for sheep, goats, and cattle, respectively. However, in recent years, this rank has been relegated to fifth level mainly because of rejection and down grading inflicted on hides and skin defects mainly due to infestation by external parasites [14]. These diseases cause high morbidity and mortality, decrease milk and meat production, loss of draft power, and loss of financial resource through the institution of control measures [15]. Ixodidae tick can adopt different strategies tosuck their host and these strategies may vary widely from species to species and from region to region. Some ticks live in open environment and crawl on to the vegetation to wait their host to bypass and this behaviour of waiting on vegetation is known as questing [16]. The impacts caused by ticks initiated the development of control strategies. Different tick species are widely distributed in Ethiopia and a number of researches reported the distribution and abundance of tick species in different part of the country [17].Amblyomma tick is one of the most abundant tick genera in Ethiopia and has been reported in many parts of the country. Rhipicephalus is also reported to be predominant genera, Boophilus and Hayalomma also have a significant role [18]. Although tick and Tick-Borne Diseases (TBDs) such as babesiosis, cowdrosis and anaplasmosis are reported in Ethiopia, east coast fever caused by *Theilaria parva* and its vector *Rhipicephalus appendiculatus* has not yet been reported [19].Because diseases like east coast fever and its vector *Rhipicephalus appendiculatus* are found in the neighboring country, there will be a riskof introduction to Ethiopia and this necessitate the execution of cross sectional study surveys in different parts of the country. However there was no any researches conducted on the infestation of hard tick in Goro Gutu woreda, the economic loss due to tick infestation was still aggravated. So this study will add some information to solve the above mentioned problems. Therefore, relevant data on the identification, prevalence and associated risk factors of ticks is essential for the development of effective tick and TBDscontrol strategies. Therefore, the major objectives of this study are:

- To identify species of tick and their prevalence in Goro Gutu woreda
- To assess the distribution of the identified tick species and associated risk factorsin the area

Literature review

- **Ticks**

Ticks were considered as parasites of domestic animals as early as 400 B.C. Aristotle in his famous historia animalium, stated that the ticks were disgusting parasites generated from grass. Despite this early realization, little work was done until the latter half of nineteenth century, when a number of parasitologists all over the world started working on taxonomy, prevalence, and bionomics, seasonal and regional occurrence of the ticks [20]. Ticks are obligate blood feeding ectoparasites of vertebrates; particularly mammals, birds and reptiles throughout the world [21]. They are cosmopolitan in distribution, but occur principally in tropical and subtropical regions with warm and humid climate which are suitable to undergo metamorphosis [22].

Classification of ticks

Ticks are within a member called the phylum (Arthropoda), class (Arachnida), sub class (Acari) and Order (Parasitiformes) [23]. Within the Parasitiformes, ticks belong to the suborder Ixodida, which contains a single super family, the Ixodidae, which is divided into two major families, Argasidae (soft ticks) and Ixodidae (hard ticks) and the rare family Nuttalliellidae, with a single African species [24]. According to Jongejan and Uilenberg (1994) the family Ixodidae, or hard ticks, contains 683 species. As adults, Ixodids exhibit prominent sexual dimorphism: the scutum covers the entire dorsum in males, but in females (immature) the scutum is reduced to a small podonotal shield behind the capitulum, thereby permitting greatdistention of the idiosomal integument during feeding [25]. Adult Argasids lacka dorsal sclerotized plate or scutum, their integument is leathery and wrinkled, their mouthparts are not visible from above and they show no obvious sexual dimorphism. Argasidae are wandering ticks, which only remain on their host while feeding [26]. (Barker and Murrell, 2004). According to [27], the family Argasidae, or soft ticks, consists of about 185 species worldwide and have one important genus that infests cattle, Ornithodoros.

- **Morphology of hard ticks**

Ticks are chelicerae, bearing four pairs of walking legs, palps and mouth parts in theform of chelicerae, adults ranging from 0.5 over 20 mm long. They have external signs ofbody segmentations and are divided in to two body components, gnathosoma or captulum(mouth part or a fusion of head and thorax) and the idiosoma (the abdomen) [28]. Nymphal and adult argasids bear a pair of tiny pores, coxal pores, representing theopenings of the coxal glands, located between the paired coxae of legs I and II. Excess fluid filtered from the blood meals they take is excreted via these pores [29].

All ticks at each stage of life cycle parasitizes animals crawling on their host andattaching to skin with their mouth part which consists of hypostoms and palps penetratingthe epidermis while hypostoms penetrate to dermis with the help of chelicerae [30]. The spiracles or stigmata occur in the supracoxal folds between the coxae of legs III and IV. The range of colors or ornamentation on the scutum, particularlyof the males of certain species is spectacular, from metallic mauve, shiny dark orange, bright yellow to iridescent green. The legs of certain species may also differ in color fromthat of the scutum and the posterior edge of each segment of the legs may be encircled byan ivory-colored band [29]. Bont (brightly colored) ticks, bont-legged ticks with ivory-colored bands around their legs, red-legged ticks whose legs vary from light to dark orange, yellow dog ticks, and blue ticks, acquiring their common name from the slaty blue color of their engorged females. The various genera of hard ticks can easily be differentiated by a set of features unique to each genus: mouthparts, basis capituli, scutum, eyes, festoons, and adanal, sub anal and accessory anal plates, coxae, anal groove [29].

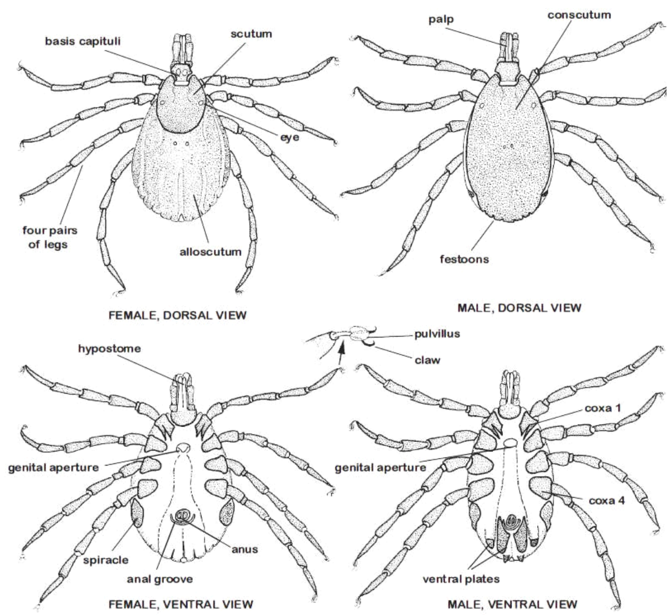

Figure 1: General anatomy of male and female hard ticks.

Source: [29].

- **Life cycle**

Ticks, like many mite species, are obligate blood-feeders, requiring a host animal forfood and development [31]. Ticks have four stages in their life cycle: egg, the 6-legged larva (seed ticks), and 8-legged nymph and adult (male or female). Depending up on the climatic condition, eggs hatch in two weeks to several months giving rise to hexapod larvae [32]. The larvae climb on toa host and suck blood for several days and molt to octopod nymphs'. The nymphs then feed on the host and molt to adult male and female ticks. The process of molting can take place either on the ground or on the host depending on the pattern life cycle of the species [7]. In the hard ticks mating takes place on the host, except with Ixodes species where it may also occur when the ticks are still on the vegetation [33]. Male ticks remain on the host and will attempt to mate with many females whilst they are feeding. They transfer a sack of sperm (spermatheca) to the female. The females mate only once, before they are ready to engorge fully with blood. When they finally engorge they detach from the host and have enough sperm stored to fertilize all their eggs. Female hard ticks lay many eggs (2,000 to 20,000) in a single batch. Female argasid ticks lay repeated small batches of eggs. Eggs of all ticks are laidin the physical environment, never on the host [34]. Membersof the family Ixodidae undergo either one-host, two-host or three-host life cycles. During the one-host life cycle, ticks remain on the same host for the larval, nymphal and adult stages, only leaving the host prior to laying eggs [29].

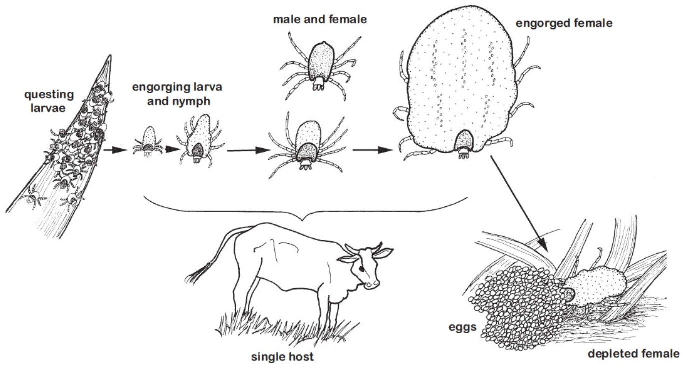

Figure 2: One-host life cycle, the example is Rhipicephalus *(Boophilus) decoloratus*.

Source: [29].

The two-host life cycle may be the same individual as the first host, the same species, oreven a second species [29].

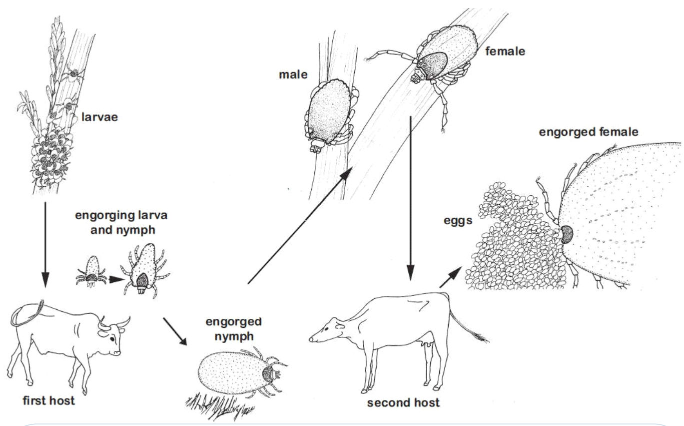

Figure 3: Two-host life cycle, the example is *Rhipicephalus bursa.*

Source: [29].

Most ticks of public health importance undergo the three-host life cycle. The three hosts are not always the same species, however it may be the same species, or even the same individual, depending on host availability for the ticks [29].

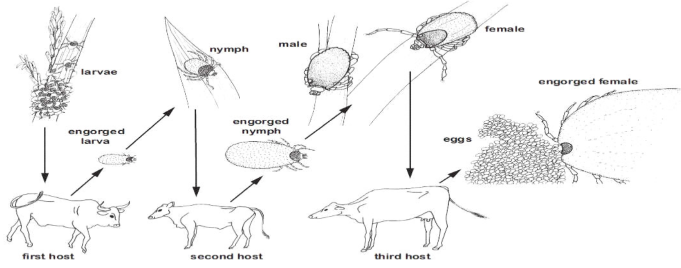

Figure 4: Three-host life cycle, the example is *Rhipicephalus appendiculatus.*

Source: [29].

Argasid ticks have two or more nymphal stages, each requiring a blood meal from a host. Unlike the Ixodidae ticks, which stay attached to their hosts for up to several days while feeding, argasid ticks are adapted to feeding rapidly (about an hour) and then promptly leaving the host. All feedings of ticks at each stage of the life cycle areparasitic. For feeding, they use a combination of cutting mouthparts for penetrating the skin and often an adhesive (cement) secreted from the saliva for attachment. Theticks feed on the blood and lymph released into this lesion. All ticks orient topotential hosts in response to products of respiration [23].

- **Tick biology and behavior**

Ticks that are restricted to the shelters of their hosts are said to exhibit 'endophilous' behavior, because these ticks live in close proximity to a suitable source of blood, and their development is not influenced by the weather outside the burrow [35]. All argasid ticks and some ixodid ticks show endophilous behaviors [36]. Fed stages of the species that have evolved this survival strategy drop from the host inside the nest or burrow. This increases their chance of survival, because they molt in the shelter under a protected environment. The opposite type of behavior, termed 'exophilous', involves the ticks waiting for a suitable host outside the burrow, exposed to the weather. Weather variables regulate the behavior of such ticks while they are actively questing for a host [35].

- **Epidemiology of ticks**

- *Host relationship*

Some ticks live in open environments and crawl onto vegetation to wait for their hosts to pass by. This is a type of ambush and the behavior of waiting on vegetation of is called questing. Thus in genera such as Rhipicephalus, Haemaphysalis and Ixodes the larvae, nymphs and adults will quest on vegetation. The tick grabs onto the host using their front legs and crawl over the skin to find a suitable place to attach and feed. Adult tick of genera Amblyomma and Hyalomma are active hunters, they run across the ground after nearby hosts [29].

- *Attachment site*

Tick attachment site, restriction of tick species to certain parts of the host specificity is one of the populations limiting system that operate through the body. They seek out places on the hosts where they are protected and have favorable conditions for their development [37]. [38] indicated that different ticks have different predilection sites on the host's body. The favorable predilection sites for *B.decoloratus* was the lateral and ventral side of the animal; *A. variegatum* teat and scrotum; *A. coherence* udder; *Hy. truncatum* scrotum and brisket; *Hy. marginatum rufipes* udder and scrotum; *R. evertsi evertsi* under tail and anus and *Rh. preaxtatus* anus and under tail [38]. Depending on the types of tick, site preference on the host depends on the accessibility for attachment, to get blood and protection to overcome the environment damage that inhibits its existence and grooming activity of thehost. Tick location on the host is lined to the possibility of penetration by hypostome. Genera with short hypostome for example Rhipicephalus, Dermacentor and Haemaphysal is species usually attach to hairless area such as under tail and anovulval area [38].

- *Ticks distribution*

Distribution and abundance of tick species infesting domestic ruminants in Ethiopia werevary greatly from one area to another area [39]. Five main types of tickgenera which are prevalent in Ethiopia are Amblyomma, Haemaphysalis, Rhipicephalus, Hyalomma and Boophilus [39]. Among the genera Rhipicephalus, *Rh.lunulatus* species were observed in Central Ethiopia [3] and *Rh.muhasmae* was observed in Borena [40] in western parts of the country [41]. [42] has recorded *Rh. humoralis*, *Rh. cliffordi*, *Rh. compositus*and *Rh. distinctus* in Wollo and Northeast areas. *Rh. evertsi evertsi*, "Red-legged tick" isthe most widespread species of Rhipicephalus [43]. [40] inBorena zone showed that *A. variegatum*, *A. gemma* and *A. lepidum* distributed in widerarea of southern Ethiopia. *A. variegatum* and *A. cohaerens* are the two most prevalent Amblyomma species in Awassa areas in decreasing order [44]. In easternEthiopia, *A. variegatum* and *A. gemma* are the two most widely spread species [8]. *A. gemma*, is also recorded in eastern and southern Ethiopia [41]. *A.variegatum* and *A. coherence* was also recorded in Haramaya [45]. It isclearly associated with dry types of vegetation or semi-arid rangelands. *A. lepidum*, ismost commonly inhabits arid habitats and in open bushed shrub or wooded grassland andits distributions overlap with *A. gemma* and *A. variegatum* [29]. InEthiopia, about eight species of Hyalomma identified which includes, *Hy. marginatumrufipes, Hy. dromedarii*, *Hy. truncatum*, *Hy. marginatum*, *Hy.impelatum*, *Hy. Anatolicum excavatum*, *Hy. Anatolicum anatolicum* and *Hy. albiparmatm* [45]. Twospecies of Rh. (Boophilus) sub genus are known to exist in Ethiopia, which include *Rh.(Boophilus) decoloratus* and *Rh. (Boophilus) annulatus*. The study done by [40] in Borena zone; [3] in central Ethiopia; [46] inAsella; [47] [21] in Assosa area. [47] indicated the distribution of *Rh.* (*Boophilus*) *decoloratus* and *Rh.* (*Boophilus*) *annulatus* is known to present in Gambella region recorded [41].

- *Pathogenic role of ticks and its impact on host*

Different study have showed that tick free herds can perform 25% better than those infected. Ticks have many effects on animals which include loss of blood (anemia), tick toxicities, tick worry, bite wound, myiasis and tick born disease [48]. Each tick infestation on animal may suck out some 0.3 ml of the animal's blood. Each engorging female tick takes between 1-5 ml of blood depending on species and size.Even in animals such as zebu breeds that are resistant to ticks this may have a serious effect when the animal is suffering from a low level of nutrition or in pregnant [6]. Direct effects of ticks on cattle are tick worry, blood loss, damage to hides and skins of animals and introduction of toxins [49]. Ticks transmit a large variety of intercellular bacteria in the Rickettsia group like Rickettsia, Ehrlichia and Anaplasma. Similarly several piroplasm protozoa like *T. annulata*, *T. parva* and *B. bigemina* are also transmitted specifically by ticks [50,51]. Hard ticks (Ixodidae) are obligate hematophaguos ectoparasites and important vectors of viruses, bacteria and protozoa [52]. This negative effect on the growth of animals and their production is thought to be due to the effects of a toxin in the saliva of ticks [49]. Anemia is another inevitable consequence of heavy infestation by any blood- feeding parasite and cattle deaths attributable to anemia as a result of tick infestation are common. Engorging Ixodidae females will increase their weight by 100–200 times butthe actual amount of blood ingested is much greater than this, as blood meal is concentrated and fluid excreted in saliva. Estimates of the amount of blood removed vary according to the species under consideration [49]. Tick saliva contains toxins which have a specific pathogenic effect. These toxins affect not only the attachment site but also the entire organs of the host [52].

- *Factors affecting the abundance of tick's and seasonal occurrence*

The microclimate in the layers of vegetation populated by ticks is an important factor regulating the abundance of their populations. The weather also regulates the periods of the year when ticks are active [47]. Ticks are responsive only to the microclimate for example, the temperature and water content recorded between the litter and the height at which the ticks quest. In the summer in temperate areas, long periods of high temperatures together with the high desiccating power of the air may promote a rise in the mortality rates of ticks in the molting or questing stages [53]. Long winters or low minimum winter temperatures may induce high mortality in the population of ticks overwintering in the ground. However, it is well known that long periods of snow cover on the ground may confer a protective effect, by insulating ticks overwintering in the ground from low temperatures [54]. Short-term changes in regional weather may also promote variations in the seasonal pattern of tick populations. For examples, mild temperatures in autumn and winter may affect the development rates of ticks, and newly mounted ticks begin questing in the vegetation if the temperatures were cooler. Similarly, if winter temperatures are high enough to promote questing behavior, ticks may quest outside the periods in which they have been recorded. This was reported in Germany for the unusually warm winter of 2006, when adult *I. ricinus* were collected while questing throughout the whole winter, a period whenthey are not commonly active [53,54,55].

The effects of the weather on the seasonality of ticks in the field are not yet completely understood, because of many uncertainties operating at the smallest scale. Several studieshave attempted to quantify the effects of different combinations of temperature andrelative humidity on each of the processes for several species of tick, expressing such effects as equations describing a physiological response [56,57,58]. In a particular field of research, landscapeepidemiology, studies have demonstrated that a territory may have a greater risk of transmission of pathogens either visited by humans or large populations of ticks and reservoirs of the pathogen are established in it. In such case the structure of the landscape may be largely responsible for such an increased risk of infestation [59,60]. Habitat fragmentation can be caused by natural processes that slowly alter the layout of the physical environment or by human activities such as land conversion. The area of the patch is the primary determinant of the number of species andthe abundance of animals [61].

- **Tick borne diseases**

The term VBD refers to any of a broad array of infectious diseases caused by pathogens that are transmitted by arthropods or other biologic intermediaries [62]. Ticks and Tick-Borne Diseases (TBDs) affect the productivity of bovines and leads to a significant adverse impact on the livelihoods of resource-poor farming communities [63]. TBDs, namely anaplasmosis, babesiosis, theileriosis and cowdrosis (heart water) are considered to be the most important Tick-Borne Diseases (TBDs) of livestock in sub-Saharan Africa, resulting in extensive economic losses to farmers in endemic areas [64]. They are responsible for high morbidity and mortality resulting in decreased production of meat, milk and other livestock by-products [65]. There are no clinical or serological reports of the presence of either *T. parva* in Ethiopia. But, there is relatively uncontrolled movement of livestock fromSudan and Kenya, where these diseases and their vectors are found [66].

Table 1: Status of ticks and tick born disease (TBD) distribution in Ethiopia.

Tick species (vectors)	TBDs	Distribution
Rh. (Boophilus) decoloratus	Anaplasmosis	Countrywide
A. variegatum, *A. cohaerens, A. gemma, Rh. (Boophilus)*	Cowdrosis, Theileriosis, Dermatophilosis	Countrywide
annulatus	Babesiosis	South-West Ethiopia (Gambella)
Unknown	Theileriosis *(T. buffeli ,T. orientalis)*	South-West Ethiopia

Source: [67].

- **Economic importance of ticks**

As ectoparasites, ticks are responsible for blood loss, irritation that results in tick worry and interruption of the grazing habits of cattle, damage and loss of udder. Damages to thehide are also caused by the attachment and feeding activity of ticks which provide portal of entry for secondary bacterial infections and for larvae that induce myiasis and tick paralysis due to the toxin they secret in to the blood. The secreted toxin may even disseminate to the respiratory organ and cause death of the animals [68]. Ticks parasite generally affect the blood and/or lymphatic system and cause fever, anemia, jaundice, anorexia, weight loss, milk drop, malaise, swelling of lymph node, dyspnea, diarrhea, nervous disorders and even death. Besides to disease transmission ticks inflict a huge economic loss. Production losses due to ticks and tick-borne diseases around the globe have been estimated at US$ 13.9 to US$ 18.7 billion annually leaving world's 80% cattle at risk [69]. [8] estimated that an annual loss of US$ 500,000 from hide and skin downgrading from ticks and approximately 65.5% of major defects of hides in Ethiopia are from ticks. Furthermore, the costs associated with maintaining chemical control of ticks in tropical and subtropical regions of the world have been estimated at US$ 25.00 per head of cattle per year [70].

- **Tick control and prevention**

The aim of tick control campaign is not to control all ticks simultaneously, but a definite species because of its particular role [71]. In most situations, however, efficient and reliable methods for the control of cattle ticks and TBD are based on the use of a chemical treatment (acaricides application), often without a local understanding of appropriate ecology or epidemiology [72]. The availability of each of these options, their advantages and disadvantages and the cost benefit of each alternative strategy should be assessed before deciding on a control programmer [73]. Ideally, strategies should target the parasitic and free-living phases of the life cycle and the role of the ticks in the transmission of TBD should not be neglected. It is now generally understood that tick control should not only be based on acaricides use, despite the fact that this remains the most efficient and reliable single method if applied properly [18]. Vaccines made against antigens from the intestine of the tickBoophilus microplus was shown to inhibit tick production. Recombination tick vaccine based on such antigens Bm86 is available in Australia but not available in Ethiopia. It hasbeen suggested that local cell mediated and immune complex hypersensitivity to tick saliva may restrict the blood flow to the tick reduce its food supply and stunt its growth.It has been possible to immunize guinea pigs with tick homogenates and show that ticks feeding on these animals' have reduced fertility and egg production [74]. On the other hand vaccines containing salivary antigens may be more effective in reducing tick feeding and thus the transmission of pathogens. The antibodies produced inhibit endocytosis by gut endothelial cells and prevent the tick from engorging fully [75]: The following are the most commonly used tick control through a prolonged, gradual decay on the animal methods.

- *Ecological tick control*

Ecological control method is used for habitat and host linked treatment. Tick control in the habitat and vegetation requires modification of the plant cover by removal of vegetation that shelter ticks [73]. Pasture management, including spelling and seasonal changes in cattle grazing areas in Australia and in Zambia respectively has been used as a tick control strategy and are believed to be responsible for a decrease its burden [29].

- *Biological tick control*

Ticks have relatively few natural enemies, but the use of predators, parasites, and pathogens has been examined for tick control. The biological agents, which potentially include predators like rodents, birds, ants, spiders, lizards and beetles as well as Parasitoids (destroy the host: the wasp lay the eggs in the engorged ticks and larvae eats the tick and emerges as adult to attack another tick) and parasites (Nematodes andfungus) attack soil living stages of the ticks are effective and depending on the conditions, these predators can consume a large number of ticks. Yet, having such effective importance the development of a biological tick control methods has been neglected as ompared to the control of plant pests or dipterous insects harmful tomen and animals [73].

- *Chemical tick control*

The majority of literature on chemical controls of tick's documents more than a century of research to test new acaricides for controlling tick on cattle strategies for usingacaricides and efforts to mitigate problems of acaricides resistance to all except the most recently developed chemicals [76]. Acaricides treatments are commonly usedin a suppressive approach, applying multiple treatments at regular intervals during the height of infestation. Most livestock holders depend completely on acaricides to control ticks, but do not have access to guidelines on how to make a profit from their tick control program or how to detect and resolve problems with resistance to acaricides [77]. The present day acaricides used properly, are very reliable in controlling ticks but, incorrectly usage of these acaricides were reduce the reliability of the compounds. However, their reliability can decline when resistance to their use builds up in tick populations. This is most frequently problem in Boophilus and Rhipicephalus species [78].

- *Genetic tick control*

The application of acaricides is the most common method used to control cattle ticks. However, the improper use of these chemicals compounds causes the development of tick resistance to various pesticides available in the market, reducing the products' useful lifetimes. Besides this problems generates the presence of chemical residues in meat,milk and the environment have prompted reflection on the need for better monitoring of their application [79]. Therefore, the study of the genetic resistance to ticks among different breeds of cattle can contribute to the development of alternative control methods [80]. It is widely known that *Bos indicus* cattle are more resistant to ectoparasites than *Bos taurus* animals. There are great differences between these two breeds of cattle in regard to their susceptibility to parasitism by cattle ticks [81]. (Bianchin *et al*., 2007). Studies are intensifying the crossing of these two groups, aiming to obtain animals that are more resistant to the conditions found in tropical countries and are also good meat producers [82].

Materials and Methods

- **Study area**

The study was conducted from November, 2017 to March, 2018 at Goro Gutu district, East Hararghe zone, Oromia Regional State of Ethiopia. Goro Gutu is 406 km far from Addis Ababa and 117 km far from Harar. Parts of the east Hararghe zone, Goro Gutu district is bordered on the South by Deder, on the West by West Hararghe zone, on the North by the Somali region and on the East by Metta. The agro-ecology of this woreda was a mix of highland, midland and lowland. It was located an altitude ranging from 1200 m - 2660 m above sea level (a.s.l) and located at latitude 9° 19' 60.00" N and longitude 41° 09' 60.00" E. The annual average temperature ranging from 10^0C to 18^0C and it receives an average annual rainfall of 800 mm. It was an area of 536.88 km^2 and about 147,041 human populations of which 89.8% live in the rural area. Goro Gutu hasan estimated population density of 273.9 people per square kilometer. The main occupation of rural population is mixed farming system and the livestock species include cattle, sheep, goats, horses, donkeys, mule, camel, honeybee and poultry. The livestock population of the zone is 87650 cattle's, 17000 sheep's, 88000 goats, 44 horses, 11000 donkeys, 22 mules, 330 camels, 43000 chickens and 4496 hive honeybee (GWVCC, 2016).

- **Study population**

The study population were local (zebu) cattle, exotic and crossbreed cattle that are localized in to the three kebele of the woreda. The study animals consist of local, exotic and cross breed with different sex, age and body condition. The different age groups of the cattle were involved in the study and the age of the animal was determined. The ageof the cattle was grouped into young (1-3 years), adult (3-7 years), and old (>8 years) according [83], while body condition score was employed after categorizing the animals into poor, medium, and good according to Nicholson and [84].

- **Research methodology**

- *Study design and sampling size determination*

A cross sectional study was conducted from November, 2017 to March, 2018, to estimateprevalence, tick identification with their predilection sites and burden with their risk factors. All the animals selected as sampling unit were checked for any tick infestation based on the number of ticks found on the animal and the study record period. The sample size required for the study had been determined according to [85] as follows. By taking a 95% confidence interval, whenever there is no information on the prevalence of the disease in the area and 5% desired absolute precision, the sample size was calculated as follows:

$$n=\frac{1.96^2 \times P\ exp\ (1- P\ exp)}{d2}$$

Where, n = required sample size, P exp = expected prevalence, d = desired absolute precision.

- *Sampling technique and sample collection*

During sampling, animals were either restrained, casted or laid down or restrained with rope and half body collection on alternative body side of the cattle was made. All visible attached adult ticks of all cattle were collected from body regions of neck, head, groin, axillae, belly, back, dewlap, brisket, udder, tail and scrotum. Ticks were removed gently and carefully in a horizontal pull to the body surface by hand.

- *Laboratory examination of ticks*

The ticks were collected from different body regions of the cattle such as head, neck, groin, axillae, belly, back, brisket, dewlap, scrotum, teat, under anus and tail. The collected ticks were preserved in universal bottles containing 70% ethyl alcohol and labeled with the animal identification and predication site, lesion inflicted, age, sex, and data of collection. The specimens were transported to the parasitology laboratory of the College of Veterinary Medicine of Haramaya University for counting and identification. The collected ticks were identified using stereomicroscope and classified in to different species level based on size, mouthparts, color of the body, leg color, presence and absence of the eye. Furthermore, different morphology of ticks such as shape of scutum, leg color, body, coxae one, festoons and ventral plates were considered for species level identification according to [29].

- *Data management and analysis*

Data collected from study sites was entered, checked and stored in a Microsoft excel spread sheet program and coded for analysis. Then data will be analyzed by using the latest version of SPSS software version 20. Descriptive stastics and chi-square for determination of association was employed in summarizing the data regarding tick isolation, count and identification in cattle of different age, breed, sex, body condition, management, localized kebele and season. The results of this study was considered as statistically significant when *P value* is less than 0.05.

Results

Out of 384 cattle examined, 82.81% (n = 318) of them were infested with at least one species of tick. Of the total 1727 adult hard ticks collected from infested cattle, five species of ticks were identified. The tick species identified in this study were *Rh. (Booph) decoloratus* (36.88%), *Amblyomma variegatum* (21.25%), *Hy. m. rufipes* (17.72%), *A. cohaerens* (13.90%) and *A. gemma* (10.25%). Higher prevalence of tick infestation was recorded in older cattle (92.4%) than younger cattle (67.4%). In addition, the prevalence of tick infestation was higher in local cattle (88.3%) than exotic cattle (53.3%). Regarding body condition score, highest prevalence of tick infestation was recorded in cattle with poor body condition (94.2%) than those with medium (73.5%) andgood body condition (73.3%). Cattle managed in extensive system (95.5%) had higher prevalence of tick infestation than those managed in intensive management system (38.8%). Similarly, higher prevalence of tick infestation was recorded during wet season (92.6%) than dry season (73.5%). In general, except for the sex and Peasant association(*p-value*>0.05), there was statistically significant difference (*p-value*<0.05),in the prevalence of tick infestation between/among the different groups of other risk factors such as age, breed, body condition, management and season. The overall prevalence of different tick species identified in this study is indicated in **Table 2**.

In present study, female ticks (n=946) were numerous than male (n=781) with female to male sex ratio of 1.21:1 (**Table 3**). The most common tick attachment sites identified in this study were neck, head and dewlap areas. In addition, ticks were also found in other sites such as belly, back, axillae or sternum, groin/hind leg, anus or under tail and udder/scrotum. The distribution or attachment sites for tick species in different body region of cattle in this study are indicated in **Table 4**. The most commonly identified tick inflicted lesions in this study were dermatitis, bite mark, skin keratinization, focal hemorrhage, inflammation and abscess. The majority of tick inflicted lesions dermatitis (20.27%) were associated with *Rh. (Booph.) decoloratus* infestation. Lesion inflicted by different species of ticks in this study are shown in **Table 5**.

Table 2: The overall prevalence of different species of tick in relation to risk factors.

Risk factor	Category	Examined animal	prevalence	*A. var*	*Rh. (B) dic*	*Hy. m. rufipes*	*A. cohaer*	*A. gemma*	X2	P –Value
Age	Young	92	62(67.4)	10(10.9)	9(9.8)	14(15.2)	40(43.5)	17(18.5)	25.635	0.000
	Adult	134	110(82.1)	29(26.1)	27(20.1)	23(17.2)	58(43.3)	21(15.7)		
	Old	158	146(92.4)	58(36.9)	27(17.2)	27(17.2)	72(45.9)	33(21.0)		
Sex	Female	194	158(81.4)	46(23.7)	35(18.0)	35(18.0)	80(41.2)	36(18.6)	0.516	0.472
	Male	190	160(84.2)	97(25.3)	28(14.7)	29(15.3)	91(47.9)	36(18.9)		
Breed	Local	282	249(88.3)	75(26.6)	50(17.7)	52(18.4)	129(45.7)	50(17.7)	28.56	0.000
	Cross	72	53(73.6)	15(20.8)	10(13.9)	9(12.5)	31(43.1)	19(26.4)		
	Exotic	30	16(53.3)	7(23.3)	3(10.0)	3(10.0)	11(36.7)	3(10.8)		
BCS	Poor	173	163(94.2)	53(30.6)	34(19.7)	31(17.9)	81(46.8)	43(24.9)	28.785	0.000
	Medium	136	100(73.5)	35(25.7)	19(14.0)	25(18.4)	55(40.4)	15(11.0)		
	Good	75	55(73.3)	9(12.0)	10(13.3)	8(10.7)	35(46.7)	14(18.7)		
Management	Intensive	49	19(38.8)	5(10.2)	5(10.2)	2(4.1)	12(24.5)	7(14.3)	89.605	0.000
	Sem-inten	137	110(80.3)	36(26.3)	21(16.3)	31(22.6)	53(38.7)	16(11.7)		
	Extensive	198	189(95.5)	56(28.3)	37(18.7)	31(15.7)	106(53.5)	49(24.7)		

PA	B/Diramu	99	82(82.8)	21(21.2)	15(15.2)	16(16.2)	50(50.5)	14(14.1)	0.000	1.000
	I/Dhaba	134	111(82.8)	37(27.6)	22(16.4)	25(18.7)	60(44.8)	28(20.9)		
	Y/Jalala	151	125(82.8)	39(25.8)	26(17.2)	23(15.2)	61(40.4)	30(19.9)		
Season	Dry	196	144(73.5)	57(29.1)	32(16.3)	32(16.3)	64(32.7)	41(20.9)	24.553	0.000
	Wet	188	174 (92.6)	40(21.3)	31(16.5)	32(17.0)	107(56.9)	31(16.5)		

Key: A: *Amblyomma; Var: Variegatum; Cohaer: Cohaerens*; *Rh. (B) dic: Rhipicephalus (Boophilus) Decoloratus; Hy. m. Rufipes: HyalommaMarginatum Rufipes; X^2:* chi-squere; *P value: Precision Value;* BCS: Body Condition Score; I/Dhaba: I-Ifa; B/Diramu: B-Biftu; Y/Jalala: Y-Yaka; Sem-inten: Semintensive; PA: Peasant Association.

Table 3: Prevalence and sex ratio of tick species in the study area.

Tick species	Male count	Female count	M to F ratio	Total	Prevalence (%)
Rh.(Booph.)	283	354	1.25:1	637	36.88
decoloratus A. variegatum	159	208	1.31:1	367	21.25
H. m. rufipes	144	162	1.13:1	306	17.72
A. cohaerens	111	129	1.16:1	240	13.90
A. gemma	84	93	1.12:1	177	10.25
Total	781	946	1.21:1	1727	100

Table 4: Distribution of tick species in different body region of cattle's.

Tick species	Male count	Female count	M to F ratio	Total	Prevalence (%)
Rh.(Booph.)	283	354	1.25:1	637	36.88
decoloratus A. variegatum	159	208	1.31:1	367	21.25
H. m. rufipes	144	162	1.13:1	306	17.72
A. cohaerens	111	129	1.16:1	240	13.90
A. gemma	84	93	1.12:1	177	10.25
Total	781	946	1.21:1	1727	100

Table 5: Tick species in relation to lesion inflicted by ticks with their prevalence.

Lesion inflicted	*Rh. (Booph.)decoloratus* (%)	*A. variegatum* (%)	*Hy. m. rufipes* (%)	*A. cohaerens* (%)	*A. gemma* (%)
Abscessation	19(1.10)	92(5.33)	16(0.93)	69(4.00)	45(2.60)
Focal hemorrhage	34(1.97)	71(4.11)	7(0.40)	25(1.45)	55(3.18)
Dermatitis	350(20.27)	2(0.12)	81(4.69)	15(0.87)	7(0.40)
Skin keratinisation	82(4.75)	37(2.14)	125(7.24)	19(1.10)	16(0.93)
Inflammation	54 (3.13)	62(3.40)	42(2.43)	51(2.95)	10(0.58)
Bite mark	98(5.67)	103(5.96)	35(2.03)	61(3.53)	44(2.55)
Total	637(36.88)	367(21.25)	306(17.72)	240(13.90)	177(10.25)

Discussion

The present study reveals that, the overall prevalence of tick infestation in Goro Gutu woreda was (318/384) 82.81%. This finding in agrees with the finding reported by [41] who reported that, more than 80% of the cattle studied were ticks infested in western Ethiopia. However, our study disagrees with the findings of low prevalence reported by [86] around Holeta town with a prevalence of 25.64%, and [87] in Dangila district, North Western Ethiopia who reported that a prevalence rate of 56.2%. [88] in western Amhara who reports high prevalence rate of 89.4%. [89] in Southern Ethiopia reports high prevalence of 88.54%. The variation among these studies could be attributed to a wide range of factors including agro-ecological, animal health practice, or management difference with in their respective study areas.

During this study five species of ticks were identified. The identified species were *Rh. (Booph) decoloratus* (36.88%), *A. variegatum* (21.25%), *Hy. m. rufipes* (17.72%), *A. cohaerens* (13.90%), *and A. gemma* (10.25%). *Rh. (Boophilus) decoloratus* was found to be the most abundant tick species which accounts for 36.88% of the total examined cattle's. Our finding in line with other authors. [90] in Horro Guduru, Western Ethiopia reports high prevalence of 33.8%. [91] in Humbodistrict, SNNP reports high prevalence rate of 30.63%. However our result disagree with the finding of [92] at Metekel ranch who report the lower prevalence of 5.7%. [39] in Eastern Hararghe reports higher prevalence rate of 48.7%. This variation due to the geographical location and altitude factors which govern the distribution of tick species in the area [93]. This tick species is abundant in wetter highlands and sub- highlands receiving more than 800mm annual rainfall [94].

A. variegatum was the second most abundant species of tick to have been collected and represented 21.25% of the total count. Our result was almost correlated with the findings of [38] in and around Sebeta town, who reports high prevalence rate of 25.00%. [91] in Humbo districts, SNNP reports high prevalence rate of 25.42%. However our result in contrast with the lower findings of [95] in Bedele districts, Oromia who reports low prevalence of 6.5%, [96] in two districts of Somali Regional State reports (Fafem and Awubere) prevalencerate of 4.2% and [89] in Southern Ethiopia who reports prevalence rateof 1.80%. Also our result was lower than the higher findings of [45] in and around Haramaya town who reports 41%. This variations may be agro-ecology of thearea, different cattle management, season of tick collection and endemicity of disease [93,94].

Hy. marginatum rufipes was the third most abundant tick species which accounts for 17.72 % of the total count. Our finding was almost correlated with the findings of [97] in Guba Koricha district, Western Hararghe who reports a prevalence of 11.8%and the findings of [98] in and around Dire Dawa, Eastern Ethiopia who reports 12.2%. But our finding disagrees with the lower findings of [99] in Sude district, Arsi Zone who scored lower prevalence of 5.44%. This variation may due to *Hy. m. rufipes* were widely distributed in the most arid tropical parts of Africa and in Ethiopia most often collected between 1000 and 2000 m. a.s.l and rare in western highland of areas [100].

A. cohaerens was the fourth most abundant tick species which accounts for 13.90% of the total count. Our finding is not correlated with the survey conducted by [101] in western Ethiopia, in which *A. cohaerens* was considered as the most prevalent tickspecies in Mezan Teferi, SNNP with a corresponding prevalence rate of 50.5%. On the contrary, the findings of [116] in Bahir Dar (0.20%), [38] in and around Sebeta town (2.4%), [102] in North Western Ethiopia (5.21%) and [103] in Welmera district, Oromia (7.73%) lower than our finding. The observation of high prevalence may be due to the persistence of humidity throughoutthe year in western Ethiopia that were favorable for this species. This difference can be attributed to the great susceptibility of *A. cohaerens* for losses of total body water which ultimately make it to perish rapidly when the humid protection is disrupted according to [104]. The population of tick are influenced by climatic changes, which affect the rate of tick population on the ground, host resistance and natural enemies [13]. *A. gemma* was the fifth least abundant tick species which accounts for 10.25 %of the total count in the study area. This finding is in line with the reports of [105] in and around Chiro with a prevalence of 11.61%. However our finding in disagrees with the lower findings of [97] in Guba Koricha, Western Hararghe district who reports a prevalence rate of 3.6 %, [89] inSouthern Ethiopia reports 5.11% and the higher finding of [106] in Dillo district, Borena around Ethio-Kenyan border report high prevalence rate of 65.8%. The variations among these study might be agro-ecology of the study area, season and management system.

The present study revealed associated risk factors. The difference in prevalence wasfound statistically insignificant between sex of cattle (*P-value*>0.05). However in this study male animals were found slightly affected than females (in male 84.2 % and in female 81.4%) with no statistical significance (^{2} = 0.516, *P-value*= 0.472) association. our result in line with findings of [107] in Arbegona district, Southern Ethiopia who reports statistical insignificance (^{2} = 0.559 *p-value*= 0.454) association between sex group and [108] in Bench Maji. However, it was in contrast with the reports of [93] in Assosa who reports differencein prevalence was found statistically significant between sex groups. This might be due toequal chances of male and female to tick infestation both in production as well asmanagement condition.

In current study, there was insignificant difference (*p-value* >0.05) of tick infestation within three Peasant Association (**Table 2**). Our result in disagrees with the reports of [89] Tamirat *et al*. (2017) in Saylem, Gesha and Masha districts, Southern Ethiopia who reports significant difference (*P-value*<0.05) between different kebeles. This difference is due to similarities in agro-ecological setting and animal health practice in the study sites. Tick activity influenced by rainfall, temperature and atmospheric relative humidity and management system include use of acaricides and other preventive measures [94].

In current study, rate of infestation with age was identified. Young, adult and old animals with prevalence rate of 67.4%, 82.1% and 92.4 % registered respectively. The rate of tickinfestation statistically significant between age of animal (^{2}=25.635, *P-value*=0.000), higher prevalence scored in old age animals (92.4%) whereas low prevalence scored in young age animals (67.4%). Our result in line with the findings of [109] in Werieleke Woreda, Tigray who reports high prevalence was scored in age ofold animals (31.8%) than age of young (13.90%) animals. But this result was different from the findings of [91] in Humbo district, SNNP who reports there was insignificant association (^{2} =0.2387, *p-value*=0.625) between ages. This variation may due to different cattle management system (old animals graze over the fieldwhere the tick burden were abundant, while young animals confined to the indoor) and immunogenicity of cattle (young animals get immunity from colostrum of her mother to resist the building up of infestation) [110].

In present study significantly different (^{2}=25.561, *P-value*=0.000) association were registered between three breeds of animals. Higher prevalence was seen on local breed (88.3 %) and lower prevalence was seen on crossbreed (73.6 %) and exotic breed (53.6%). The current study in line with the findings of [111] in and around Haramaya district, Eastern Ethiopia who reported that prevalence of tick infestation was significantly higher (*P-value*<0.05) in local breed cattle (58.18%) than cross breed ones (10.55%), and [112] in Dandi district, Western Shoa Zone reports higher in local breed cattle (57.6 %) as compared with cross breed cattle (11.20%). However the present finding not in line with the findings of [10] in and around Asella town, South Western Ethiopia who reported that the prevalence of tick infestation was higher in the cross breeds than local breeds. This variation might be attributed to the currently existing modified animal husbandry practice where crossbreed or high yielding animals are kept most of the time indoor with semi-intensive care, whereas local breed cattle are kept under extensive farming system. Therefore, the chance of occurrence in local breed cattle is greater than cross breeds. Furthermore, it can be assumed that itmight be due to the farmer taking more care to cross breed than local cattle.

Significantly different (^{2}= 28.875, *P-value*=0.000) association was recorded in different body condition of animals. Higher prevalence was seen on poor body condition (94.2%) as compared to medium (73.5%) and good body condition (73.3 %). The current study in agrees with findings of [99] in Wolaita Sodo, SNNP reports high prevalence of 94.8% in poor body condition than good body condition (36.2%). Howeverthe present result not related with the findings of [109] in Werieleke woreda, Tigray who reported that high prevalence of 71.00% in medium body condition than poor body condition (8.90%). This difference can be due to the fact that poor body conditioned animals had reduced resistance to tick infestation and lack of enough body potential to build resistance and they exposed to any kinds of disease when grazing on thefield and medium body conditioned animals were free ranging and relatively resistance todisease so they become less infested than poor body conditioned cattle and well feed animals were very resistance to any kinds of disease when grazing on the field [27].

In present study significantly different (^{2} = 24.553, *p-value* = 0.000) and associations wasregistered in season of tick collection. Higher prevalence examined during wet season (92.6%) and lower prevalence during dry season (73.5%). This result in line with the findings of [113] in Haramaya town, reports indicated that there was statistically significant (p*-value* < 0.05) differences between wet and dry season in whichhigher prevalence was registered during wet season. However the current finding in contrast with the findings of [99] in Sude district, Oromia region who reported that no considerable difference (p*-value*>0.05) in the prevalence of tick infestation within the wet and dry season. This variation may be environmental factors that influence the occurrence of ticks in a biotope include climate and rainfall such as temperature and relative humidity.

In present study sex ratio of tick infestation was examined. In this study there were a greater number of females (n=946) than male (n=781). This finding is differ from the findings of [105] in and around Chiro, who reports male tick was greater than female one. This variation might be due to the small size of male tick which may not be seen during collection.

The present study revealed that ticks select favorable site for their attachment on the bodyof cattle. Information on predilection sites of ticks is helpful in spraying individual animals since it gives a clue as to which part of the body requires more attention [94]. In present study different predilection site of attachments by tick infestation was examined. The most preferred site of *Rh. (Boophilus) decoloratus* were dewlap (7.86%) and head (7.59%). *A. variegatum* groin/hind leg (5.21%), *Hy. m. rufipes* dewlap (4.75%), *A. cohaerens* axillae/sternum (3.60%) and *A. gemma* axillae/sternum (3.18%) respectively. This result is almost collaborate with the findings of [95] in Bedele district. [38] indicated that different ticks have different predilection sites on the host's body. The favorable predilection sites for *Rh. (Booph) decoloratus* was the lateral and ventral side of the animal. [114] stated that short hypostome ticks like Rhipicephalus (Boophilus) and Hyalomma species usually prefer upper body parts which includes nape of neck and margin of anus and under tail while long hypostome ticks like Amblyomma attaches to lower parts of the animal body.

The present study also revealed lesion inflicted by ticks. *Rh. (Booph) decoloratus* was thedominant species inflicted by dermatitis (20.27 %), *A. variegatum* inflicted by bite mark (5.96%), *Hy. m. rufipes* was inflicted by skin keratinization (7.24%) *A. cohaerens* inflicted by abscessation (4.00 %) and *A. gemma inflicted by* abscessation (2.63%). *A. variegatum, A. gemma* and *A. cohaerens* was the most important tick species to inflict the bite mark (wound) and abscess in the present study (**Table 5**). This was probably due to their long mouth part that results in severe bite according to [18 and 104].

Conclusion and recommendation

The overall prevalence rate of ixodid ticks in the present study was 82.81%. Ticks hasgreat economic impact to the livestock population either by directly affecting the healthof animals besides aggravating the quality of their hide and skin or indirectly bytransmitting a wide variety of Tick-Borne Diseases (TBD). The most important species ofticks abundantly identified in the study area were: *Rh. (Boophilus) decoloratus*, *A.variegatum*, *Hy. m rufipes*, *A. cohaerens* and *A. gemma* in descending order. This studyindicated that different species of tick affect the health of cattle and also damage teats,hide and skin and reduce productivity of animals. Different risk factors aggravate theinfestation of tick which includes age, body condition, sex, breed, kebele, managementand season of tick infestation. The present study revealed that there was insignificant difference between sex and kebele, while the rest have significantly differenceassociation between them. Furthermore, predilection sites and lesion inflicted by ticks on skin of host are identified that helps in designing control methods. These all are theimpacts of tick infestation so to minimize tick impacts, appropriate and timely strategiccontrol measures are necessary. Therefore, based on the above conclusion; the following recommendations are forwarded:

- Research should be conducted on tick species and their epidemiology for the continuous understanding of improved control strategies
- Awareness should be given to animal breeder on problem of ticks and TBD
- Effective acaricides usage should follow to control tick species
- Efforts should be made to introduce community based tick control strategies
- Country wide effective tick control strategies should be designed

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- **ANNEXES**

Annex 1: Age determination based on teeth eruption.

No	Teeth	Age	Age groups
1	With teeth	< 1 year	Calf
2	I1 erupts	11/2 – 2 years	Young
3	I2 erupts	2-21/2 years	>>
4	I3 erupts	3 years	Adult
5	I4 erupts	31/2-4 years	>>
6	All incisor are weak	5	>>
7	I1 is level and the neck has emerged from the gum	6	>>
8	I2 is level and the neck is vis	7	>>
9	I3 is level and neck visible	8	old
10	I4 is level and the neck is vis	9	>>
11	The dental star is squire	10-11 years	>>
12	The dental star is squire in al direction	12 years	>>
13	The teeth become small roun peers	15 years	>>

Source: [83].

Annex 2: Body condition scores determination manual.

Score	Condition	Feature
1	P-	Marked emaciation (animal condemned at ant mortem examination)
2	P	Transverse process project prominently, neural appear sharply
3	P+	Individual dorsal spines are pointed to the touch, hip pins, tail, headribs are prominent. Transverse process visible ,usually common
4	M-	Ribs, hip and spins clearly visible muscle mass between hook spinesslightly concave and slightly more flesh above the
5	M	Ribs usually visible little fat cover dorsal spines barely visible
6	M+	All smooth and well covered dorsal spines cannot be seen ,but areeasily felt
7	G-	All smooth and well covered, but fat deposition are not mark spinscan felt I with firm pressure but rounded rather than sharp
8	G	Fat cover in critical area can be seen and felt transverse processcannot be seen
9	G+	Heavy deposited of fat clearly visible on tail, head, brisket and dorsal spine dorsal spines, ribs, hook and fully covered and cannotbe felt even with firm pressure

Note: Body condition scores; 1, 2 and 3 are poor body condition; 4, 5 and 6 are medium body condition; 7, 8 and 9 are good body condition
Source: [84].

Annex 3: Data record format for tick identification BCS: body condition score; Laboratory ex: laboratory examination; PA: Peasant Association.

									Number
									PA
									Breed
									Age
									Sex
									BCS
									Management
									Season
									Site Of Attach.
									Lesion Inflicted
									Result
									Laboratory Ex.
									Spp. Identified
									Female Count
									Male Count
									Total No

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