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Review Article

Status of Economic Losses and Health Impact of the Tick Bites on Farm, Field and Dairy Animals

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Abstract

This review article outlines the current situation regarding the economic losses and health impacts associated with tick bites on farm, field, and dairy animals. Ticks have developed the ability to consume the blood of their hosts, which is essential for their survival and reproduction. They are not merely passive vectors; rather, they transmit pathogens during blood feeding that can lead to severe illnesses in animals. The toxins present in tick saliva facilitate blood feeding and compromise the multi-layered defense mechanisms against foreign pathogens, resulting in blood loss and triggering immune responses in the hosts. These effects extend beyond the animals themselves, affecting the quality of meat, milk, and wool, among other animal products. Ticks aggressively feed on cattle, leading to anemia and illness, which in turn affects their milk production and reproductive behaviors due to blood loss. This review article addresses the global issue of tick bites and the annual damage they inflict. Additionally, it emphasizes the challenges of acaricide resistance and the presence of chemical residues in food and the environment. There is a critical need for the development of effective vaccines to achieve comprehensive control over tick populations.

Keywords: Ticks; Blood Feeding; Economic Losses; Animal Products; Milking and Reproduction

Introduction

Ticks are ectoparasitic arthropods that feed on blood and are widely distributed across tropical and subtropical regions globally. They contribute to economic losses through diminished blood, meat, and dairy production, as well as the transmission of various pathogens [1]. Ticks are obligate hematophagous parasites, relying on host blood for essential nutrients necessary for their survival, growth, and reproduction. However, during the feeding process, they also transmit pathogens. They serve as significant vectors for a range of diseases caused by bacteria, viruses, rickettsia, and protozoa, leading to substantial economic impacts that are often difficult to quantify. The direct consequences of their bites include skin injuries, severe pain, inflammation, irritation, and psychological distress for the host. Ticks can transmit infectious agents to vertebrate hosts, posing serious challenges to both public health and livestock welfare. The financial implications of mortality, treatment, and reduced productivity are considerable. Ticks have adapted to a blood-feeding lifestyle following the evolution of a complex vertebrate immune system designed to combat foreign invaders, including pathogens and ectoparasites. Overtime, ticks have developed mechanisms to suppress the immune responses of the invertebrate hosts, which can be particularly detrimental to exotic and crossbred cattle. The host's genetic composition is a significant role in determining its immune response to ticks and the pathogens they carry [2]. The increasing prevalence of ticks and tick-borne diseases poses a growing threat to global public health, driven by the rising populations and expanding ranges of both vectors and pathogens, as well as the emergence of new tick-borne infectious agents. A deeper understanding of the interactions among ticks, hosts, and pathogens is essential for the development of innovative strategies for tick control and disease prevention. Modern agriculture currently faces two significant challenges: the emergence of resistance in vector populations and pathogens. These issues primarily affect not only plant and animal production but also pose serious threats to the economy and global food security. For livestock, including cattle, small ruminants, swine, and poultry, maintaining adequate health is crucial for productivity. Excessive blood-feeding by ticks leads to severe anemia in animals, adversely impacting the quality of animal products, particularly milk. The health of these animals is compromised by both the direct and indirect effects of ticks, resulting in substantial losses in the production of meat, milk, eggs, and leather, and in some instances, the death of the affected animals. This situation also disrupts the market prices of livestock products such as milk, meat, and wool due to diminished quality. Direct losses stem from the damage inflicted by ticks during blood feeding, while indirect losses arise from the transmission of infectious agents and associated costs of treatment and control. This article discusses the economic and health impacts of ticks on animal production, highlighting the need to explore methods to mitigate the overall damage caused by the parasites [3]. Consequently, assessing the projected economic losses due to vector and vector-borne parasitic diseases in livestock is a critical concern in India [4]. Ticks transmit a large number of infectious agents and generate babesiosis, anaplasmosis, theileriosis and heartwater diseases. These make severe loss per capita economic loss of sheep or goats infected by these tick-borne pathogens is at least 2 USD, and it is estimated that tick-borne illnesses cause over 70 million USD in losses in small ruminants each year. Enumeration of loss occurred by ticks are highly important i.e. Economic Threshold Level (ETL) and Economic Injry Level (EIL) are crucial prerequisites.

Vectors in a geographical area, percent losses produced, total livestock population.

Sixty-eight percent of the entire loss was due to theileriosis, thirteen percent to each of anaplasmosis and babesiosis, and six percent to cowdriosis. Infection and treatment approach milk loss and weight loss accounted for 1%, 6%, and 9% of the total predicted annual TBD losses, respectively, while costs related to death, chemotherapy, and acaricide application contributed for 49%, 21%, and 14% of the total. [5]. Other than ticks damage is also caused by flies such as *Culicoides spp.* and *Musca spp.* and various species of mosquitoes is included in list of losses to know the real time situation for survival of dairy cattle and farmers. Moreover, disease transmission and its direct effects on cattle and human must be enumerated inclusively. For control of vectors, best solution must develop to replace acaricide resistance and environmental protection from hazardous chemicals [4]. However, to there is immense need to use eco-friendly methods and green technology for control of each vector species, based on the economic threshold level (ETL) and the economic injury level (EIL), two monitoring benchmarks. Estimating EIL and ETL for a variety of vector species and situations seems challenging. Under such circumstances, an approximate estimate—albeit one that may not be precise—can be obtained by considering a number of factors, including the percentage of losses generated, the total number of livestock, the prevalence of vectors in a given geographic area, and the current costs of livestock products such as milk, meat, and wool that are out of reach for the impoverished [4]. Ticks irritate milking and non- milking dairy animals by making sharp skin bites and blood sucking. These cause animals in deep stress, disease, and discomfort negatively affect milk productivity in India. TTBDs have a major effect on the production system and the dairy industry's bottom line. According to FAO (2004), tick infestations pose a threat to over 80% of cattle populations worldwide; nevertheless, in order to develop and execute efficient tick control measures, the incidence of tick infestations in the Indian cattle population must be as curtained [7-12] toxic residues in livestock products and environmental pollution [13,14]. *Boophilus microplus* larvae infestation reduces the amount of secreted milk in mid-lactation Holstein-Friesian cows. These affect both milk yield and composition (comprising packed cell volume, dry matter intake, live weight, and Somatic Cell Count (SCC). (PCV) and Total Plasma Protein (TPP) [15]. Tick infestation may influence estrus cycle by induction of prostaglandins that affects oxytocin level and finally lactation in dairy animals [16]. The daily milk yields in the estruses decrease by an average of 300 g, which decrease to 400 g by continuing 1 day after the estruses. According to the results of this study, daily Changes in milk output could not be interpreted as an indication of estrus [17].

Effect on Livestock productivity

India is blessed with the world largest population of 192.52 million cattle and 109.85 million buffaloes [18]. The two most prevalent tick species among the 106 species known to exist in India are *Rhipicephalus microplus* and *Hyalomma anatolicum* [19], which have a significant negative economic impact on animals productivity system through reduction of productivity and profitability to livestock industry [20]. In such a situation, an approximate estimate albeit one that may not be precise can be obtained by considering a number of factors, including the percentage of losses generated, the total number of livestock, the prevalence of vectors in a given geographic area, and the current prices of livestock products like milk, meat, and wool [4]. India is a fast-growing developing country with more than 2.8 billion of animal population. Agriculture based social sector is a major wage providing sector that solely depends on livestock health and nutrition. From assessment report heavily tick-infested cattle faces loss of appetite and loss of body weight by 65% due to tick infestation and blood feeding. From surveys it was noted that the cumulative direct losses (such as decreased milk production, treatment expenses, and leather depreciation) and indirect losses (including milk loss and treatment costs) was 46199.31 million INR (USD595. 07 million) India. Loss due to tick infestation was a combined total of 61,076.46 million INR (approximately USD 787.63 million). This reduction in milk production in milking buffalo was affected by *Hyalomma spp.* and *Rhipicephalus spp.* infestations, the estimated loss was 20.10 and 7.01 liters of milk per lactation, respectively. Additionally, the projected losses in milk production attributed to clinical theileriosis, babesiosis, and anaplasmosis were 57.96, 30.96, and 59.22 liters, respectively. Worldwide, TTBDs are causing an estimated loss of US$22–30 billion/annum [21], whereas, 32.4 million US$loss/anuum Brazil has calculated that *R. microplus* alone is responsible [22], 3.0 million in USA [23], 573.16 million in Mexico and 168.0 million in Colombia [24], 250.0 million in Australia (Meat and Livestock Australia report 2020), 364.0 million in Tanzania [25], 6.7 million in Puerto Rico and 5.0 million in Zambia [26]. It is revealed how much it costs to control TTBDs in India each year to be 498.7 million USD [27]. The cattle tick *Rhipicephalus microplus* generates an estimated $3.24 billion in annual economic losses to the Brazilian cattle industry [4]. The cumulative tick infestation-related losses (milk loss, treatment costs, and leather loss) total 46199.31 million Indian rupees (USD595.07 million), whereas TBD-related losses total 14877.15 million Indian rupees (USD191.15 million) = 61076.46 million Indian rupees (USD787.63 million).

There was estimated a high cumulative loss of 787.63 million USD due to ticks and tick-borne diseases (TTBDs) can be minimized. Economic impact of *Theileria annulata* theileriosis that heavily affect commercial dairy industry productivity mainly reduction in milk production, morbidity, mortality, and tick control costs. Milk yield and composition (includes packed cell volume, dry matter intake, liveweight, and Somatic Cell Count, or SCC), (PCV) and Total Plasma Protein (TPP) are markers of *Boophilus microplus* infection.

Direct and indirect losses

Direct and Indirect losses in small ruminants area significant source of milk and meat in several nations and are essential in food security, on added to the funds that were gained from the selling of wool and skins. However, as with other species, ticks can limit the production systems of small ruminants, causing direct and indirect losses [28]. Although no tick is a both hard and soft ticks parasitize sheep and goats, which are their specialized hosts [29]. While certain tick species produce toxicosis, others cause paralysis. Ticks have been observed to stick to the goats' coronary band, causing intense lameness [30]. Because ticks harm the leathers and skins of sheep, goats, and cattle, they cause significant financial losses in some nations' livestock industries, including Ethiopia. Lamb skins are especially prone to deterioration. The extent of the harm is increased by a secondary bacterial infection following a tick bite [31]. Some infestations by ticks such as *Otobius megnini* and *Ornithodoros coriaceus* can generate irritations and injuries at the ear level, which can lead to permanent nerve damage and death from meningitis [29]. As per 20th livestock census, India possessing 193.46 million cattle and 109.85 million buffaloes in organized and unorganized sectors [32]. Tick infection affects these animals nearly all year long, resulting in both direct and indirect losses. The formation of acaricide-resistant tick populations, pesticide residues in cattle products, and environmental contamination were the outcomes of the repeated use of chemical acaricides for tick control.

However, it was calculated that the infestation of *Hyalomma spp.* and *Rhipicephalus spp.* was 20.10, 7.01L milk/buffalo/lactation. [33]. In the TTBDs complex, Uganda loses more than USD 1.1 billion annually in total losses (direct and indirect) [34]. Tick-borne infectious pathogens can be transferred from ticks to vertebrate hosts, posing serious health risks to both humans and animals. Economically speaking, the expenses of death, recurrence, therapies, and lower output yields are substantial [13]. In reaction to feeding ticks, resistant breeds' skin also had increased concentrations of eosinophils, mast cells, and basophils along with up-regulated proteases, cathepsins, keratins, collagens, and extracellular matrix proteins [13]. Milk composition, PCV and TPP were not significantly affected by cattle tick infestation. In week 12, control cows consumed 0.83 kg more dry matter than infected cows [13]. Microscopically, hemiparasites were found in 28.7% of cows. The herd incidence (new cases) of *Theileria annulata* was 2.8%, whereas the disease was detected in 8% of cases. A total of US $74.98 per animal and 13.83% of agricultural expenses were spent on theileriosis. Thus, theileriosis resulted in a substantial financial loss for this Holstein Friesian dairy of US$ 18,743.76 (0.02 million) [35]. The most common and economically significant tick-borne disease (TBD) in Uganda is East Coast fever (ECF), which is brought on by the protozoan hemiparasite *Theileria parva*. The brown ear tick (*Rhipicephalus appendiculatus*), which is its vector, is extensively dispersed. Heartwater, babesiosis, and anaplasmosis are among the other common TBDs in Uganda [36].

These diseases cause significant economic losses in cattle and dairy farm industries mainly affect milk, leather and meat yields. The final set back is increase in treatment costs of anemic animals and finally loss of animals due to death [37]. Ticks as hematophagous parasites deliver pathogens in anemic animals which severely invade animal cells and tissues and generate various immune responses [37] (Table 1; Figure 1). For providing a greater protection against tick bites a series of novel immune antigens, vaccines and quick immunological and molecular diagnostic methods are being required. These can reduce the invasion of pathogens, increase the resistance and decrease the susceptibility [37]. Naturally, this resistance against ticks is found in resistant breeds of cattle [37].

Tick bites and diseases

Tick-borne diseases, namely, anaplasmosis, babesiosis, cowdriosis and theileriosis are more common in cattle yards which affect production and quality of animal products. Thus, infestation caused due to uncontrolled population of ticks making considerable economic losses which are increasing every year at global levels. The additional factor is emergence of resistant strains of tick-borne pathogens. However, for estimation of the economic losses production losses, treatment and control costs must be included in surveillance of tick-borne diseases (TBD) and losses. The national cow population reported TBD morbidity, mortality risk, chemotherapy, and control methods were all incorporated in the model parameters. The second reason is the emergence of tick acaricide resistance, which calls for extension services and farmer education regarding tick control methods. Frequent use of chemical acaricides to control ticks led to environmental contamination, pesticide residues in cattle products, and the emergence of acaricide-resistant tick populations.

An estimated 364 million USD was lost annually nationwide as a result of TBD, which included an estimated 1.3 million cow deaths. Tick infestation also affects quality of beef as ticks eat upon nutritious part that is blood. The development of a tick control policy should thus be integrated into the entire animal health program, taking into consideration differences in agro-ecological zones, farm conditions, and local technical expertise [34].

Gross economic loss in the dairy and agricultural sectors

India has 109.85 million buffaloes and 193.46 million cattle in both the organized and unorganized sectors, according to the 20th livestock census. Nearly all year long, these animals suffer from tick infestation, which results in both direct and indirect losses. Frequent use of chemical acaricides to control ticks led to environmental contamination, pesticide residues in cattle products, and the emergence of acaricide-resistant tick populations. Under low, moderate, and high tick infestation conditions, the estimated milk production loss was 13.91, 56.91, and 85.34 L/cross-bred cow/lactation, respectively. However, it was calculated that the infestation of *Hyalomma spp.* and *Rhipicephalus spp.* was 20.10, 7.01L milk/buffalo/lactation. Similarly, it was calculated that clinical theileriosis, babesiosis, and anaplasmosis caused 57.96, 30.96, and 59.22 L of milk production loss, respectively (Table 1; Figure 1).

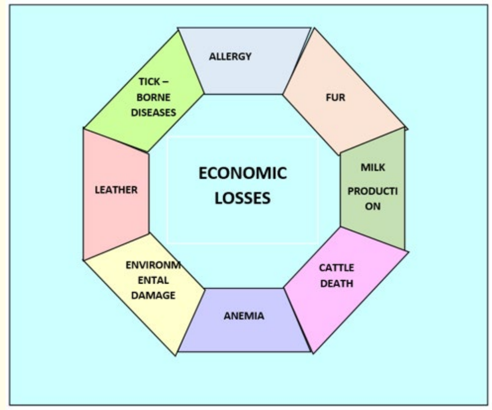

Figure 1: Economic losses caused by tick infestation.

Scientific name	Disease caused	Annual Economic loss	Loss in geographical area	Reference
		Loss in Dairy industry		
Rhipicephalusmicroplus	Bovine babesiosis	32.4 million US$	Brazil	[22]
Theileria annulata	Theileriosis	3.0 million	USA	[23]
Rhipicephalus	Babesiosis	573.16 million	Mexico	[24]
Ixodesscapularis	Anaplasmosis	168.0 million	Colombia	[24]
		Loss in Meat industry		
Hyalomma,	Crimean-Congo hemorrhagic fever	250.0 million	Australia	[25]
Anaplasmamarginale	Anaplasmosis	364.0 million	Tanzania	[25]
Rhipicephalus sp	Babesiosis	6.7 million	Puerto Rico	[26]
Amblyomma	Cowdriosis	5.0 million	Zambia	[26]
RhipicephalusSanguineus	Hepatozoonosis	498.7 million USD	India	[27]
		Loss in Leather industry		
H.anatolicum	Theileriosis	595.07 million USD	India	[69]
Hypodermabovis	Hypodermosis	153.86 million	Pakistan	[70]
Rhipicephalus	Babesiosis	25.8 million USD	Ethiopia	[71]
Rhipicephalus appendiculatus	Anaplasmosis	1.1USD billion	Uganda	[72]
		Human Health and Diseases		
Francisella tularensis	*Tularemia*	13.9-19.7 Billion USD	USA	[73,74]
*Anapla**smaphagocytophilum***	anaplasmosis	7.3 USD	China	[75]
R. sanguineus,	Mediterranean spotted fever	8.5 million USD	Central america	[76]
Ixodes holocyclus	Tick paralysis		Australia	
T. annnulata	Theileriosis	384.3 million US$	India	[27]
Borrelia burgdorferi	Lyme borreliosis	786 million	North america	

Table 1: Showing infestation rate and economic losses in last one decade in India and world.

Tick infestation in buffaloes develop reduce productivity and fertility

Being a hematophagous ecto-parasite ticks and ticks borne parasites may cause diseases, which reduced productivity and fertility and often result in mortalities of livestock [38,39]. These affect growth of animal and milk production [13]. It only due to increase in transmission that has increased spectrum and damage caused due to tick-borne diseases [40]. Thus, heavy infestations have devastating effects on productivity [39,41]. Tick infestation and vector-mediated transmission of pathogens there of challenge the production and health of extensively reared farm animals. Its, reflects maturity and variations in age of the animal, body weight, skin surface temperature, the interactions between indicators of maturity as significant sources of variation for tick concentrations on cattle. It is very difficult to face infestation of *Amblyomma variegatum* and *Boophilus* in cattle in field conditions [42]. Throughout the spring and summer, ehlichiosis, an illness spread by ticks, can cause symptoms that resemble cancer or a severe hematologic condition. Serum antibody titers or polymerase chain reaction are required for the diagnosis [43]. Fever, pancytopenia, and hepatosplenomegaly are its primary symptoms. The canine rickettsia Ehrlichiacanis causes an acute infection in humans that manifests as anemia, leukopenia, idiopathic thrombocytopenia, and Lyme disease [44]. Neonatal tick bites place infants at risk for acquiring infections, it causes multiple erythema, fever, irritability, fever, and worsening anemia [45] (Table 1; Figure 1). *Babesia divergens,* an Apicomplexan parasite spread by tick bites, is the primary cause of bovine babesiosis in Europe. Bovine babesiosis causes financial losses in the agro-business sector, and the intra-erythrocytic development of *B. divergens* merozoites causes hemolytic anemia [46]. Effector-activated NLRs connect, in various ways, to a conserved basal resistance network in order to transcriptionally boost defense programs [48]. Ticks effectively make pharmacomodulation by its saliva host innate and adaptive immune defenses [49]. Acute and cumulative exposures, both internal and exterior to the host (i.e., the exposome), must be understood in order to understand how they affect the host's physiology and reaction to therapy [47]. A polymorphic family of intracellular nucleotide-binding/Leucine Rich Repeat (NLR) receptors that identify effector interference in various cell regions is essential for resistance success. The theory that ticks and tick-borne pathogens work together to produce host immune tolerance, which makes it easier for ticks to infect and feed, provides an ideal environment for pathogen introduction, alters cutaneous and systemic immune defenses to establish infection, and helps ensure long-term infection. The following aspects of ticks, hosts, and pathogens are examined: how ticks and pathogens target vertebrate host defenses that result in various modes of interaction and host infection status (reservoir, incompetent, resistant, and clinically ill); how ticks' innate immunity and microbiome interact with tick-borne pathogens; how ticks modify host cutaneous defenses before pathogen transmission; tick saliva bioactive molecules as crucial factors in determining those pathogens for which the tick is a competent vector; and the need for translational studies to further this field of study. There are recognized gaps in our knowledge of these interactions that, if filled, can help create methods to effectively stop the spread of pathogens and tick feeding [49] (Table 1; Figure 1). Due to the expansion of both tick and pathogen geographic ranges, tick population growth, the rise in tick-borne disease incidence, the emergence of tick-transmitted pathogens, and ongoing difficulties in achieving effective and long-term tick control, ticks and tick-borne pathogens are becoming more and more important for medical and veterinary public health. Over the past several decades, there has been a growing interest in using vaccinations to manage tick infestations and the spread of pathogens. More than a century ago, it was discovered that recurrent infections might cause bovine tick resistance.

Immunological techniques are required to identify tick infestation resistance; host immune defenses must be countered; and complicated tick-host-pathogen relationships must be dissected using genomics, functional genomics, and proteomics. In addition to reducing exposure to sick ticks in humans, companion animals, domestic animals, and wildlife, anti-tick and transmission blocking vaccinations that target disease reservoirs may also disrupt enzootic cycles [51]. The methodical blending of at least two control strategies with the goal of lowering selection pressure in favor of acaricide-resistant individuals while preserving sufficient levels of animal output is known as integrated tick management. Better knowledge and management of resistant ticks, with a focus on *R. microplus* on cattle, can be achieved by the use of conventional acaricides and macrocyclic lactone resistance [52]. Alternative strategies must therefore be developed, which may involve the use of animal husbandry techniques, synergized pesticides, acaricide rotation, pesticide mixture formulations, tick removal by hand, host resistance selection, nutritional management, the release of sterile male hybrids, environmental management, tick-unfavorable plant species, pasture management, plant extracts, essential oils, and vaccination [52]. Due to their capacity to spread a wide range of tick-borne illnesses, ixodid ticks are recognized as one of the most significant hematophagous arthropods. The most significant ectoparasite issue affecting cow productivity in tropical and subtropical countries globally is infestations of the bovine tick, *Rhipicephalus microplus,* which cause significant financial losses. Ticks release saliva that is a complex mixture of bioactive compounds that modulate host immunological responses when they are feeding on vertebrate hosts. The host immune responses decrease tick-borne infection risk and disease burden [53]. But these responses could not stop engorgement for feeding. Only a gradual decrease in engorgement is possible *I. ricinus* by using vaccines for impairment of tick feeding. Tick feeding success depends on zinc metalloproteases, which establish complex molecular links between the host's immunological, inflammatory, and hemostatic processes—all of which are absent in in vitro feeding. This basic concept can be used to develop an effective "anti-tick" vaccine [53].

Effect of estrous cycle in female cows

Ticks cause great economic losses to livestock host in several ways. Numerous ticks' blood sucking lowers domestic animals' live weight and promotes anemia; their bites also degrade the quality of skins. Tick blood feeding affect luteolysis, preovulatory follicular development, and ovulation, and estrous cycle in animals. It might be disturbed due to a sharp decline in progesterone level [54]. Tick infestation generates anemia that causes hormonal and behavioural changes in milking cows during estrous cycle. Heavy infestation not only affects milk production in cows but also affect amount of fat, protein, and lactose in milk [55].

Diagnosis

For treatment, prevention and control of ticks, tick infestation and incidences of tick-borne diseases diagnosis of tick secreted molecules, antigens and serum antibodies is highly essential. Signs and symptoms, travel history, potential tick contact, and laboratory testing of blood, spinal fluid, and sero-mucous fluid can all be used to diagnosis disease in individuals. In the absence of disease symptoms, this testing can be a helpful tool in determining whether or not to treat, but it cannot replace a doctor's diagnosis of a condition.

Travel history (domestic and international) to are as where RMSF is endemic.

Indirect immunofluorescence

Various serodiagnosis tests are widely used for diagnosis for tick-borne diseases. Tick tick-borne encephalitis is diagnosed relies by testing presence of antibody in blood serum, cerebrospinal fluid. Direct and indirect ELISA are used to detect anti-tick antibodies (IgG, IgM, and IgE). The diagnosis of TBEV and TBE can be verified by the CSF-serum antibody index. Additionally, viral neutralization and recovery in TBEV patients are assessed based on the presence of antibody in blood and CSF fluid. These IgG ELISAs are not highly specific and need to be confirmed by virus neutralization. TBEV encephalitis is confirmed by the presence of brain-derived IgM in CSF [56]. Moreover, immunoblots (IBs) are utilized to identify antibodies in patient serum in order to distinguish between Lyme disease (LD) and tick-borne relapsing fever (TBRF) [57]. Colorado tick fever immunological serum is dedifferentiated using cross fixation assays, and heterologous antigens of rickettsial and viral origin show that Colorado tick fever. It is further tested by using complement-fixation and mouse neutralization tests with human convalescent sera. Rocky Mountain spotted fever (RMSF) is challenging to identify because of the vague symptoms and indicators in the early stages of the disease. More specifically, a cell-free antigen of the human granulocytic ehrlichiosis agent is determined by using Immunofluorescence assay (IFA).

Indirect immunofluorescence, is used for presence of IgM antibodies (Abs) against *Rickettsia conorii* and of IgG/IgM against *Borrelia burgdorferi sensu lato*. This one-step antigen based IFA test easily evaluate sera from patients bitten by ticks. This standard serologic test is used for diagnosis of RMSF. Antibody level is determined by the indirect immunofluorescence antibody *R. rickettsii* antigen is used in the immunoglobulin G (IgG) test (IFA). To show proof of a four fold seroconversion, IgG IFA tests should be run on matched acute and convalescent blood samples obtained two to four weeks apart. During the first week of sickness, antibody titers are often negative. Results from a single acute antibody test cannot be used to confirm RMSF. Although some reference laboratories provide immunoglobulin M (IgM) IFA tests, the findings may not be as specific as those of IgG IFA assays for identifying a recent infection.

Polymerase Chain Reaction (PCR) amplification is performed on DNA extracted from whole blood. A negative PCR test does not rule out the diagnosis, thus therapy should not be stopped because of it, even while a positive result is useful. Additionally, DNA from a skin biopsy of a rash lesion or from post-mortem tissue samples may be amplified using PCR. Refer to the guidelines for obtaining a skin biopsy. Skin biopsies of rash lesions or post-mortem tissue samples can also be used for culture and immunohistochemistry (IHC) tests. Only specialist labs can perform *R. rickettsii* culture isolation and IHC tests; standard hospital blood cultures are unable to identify the pathogen. A two-step process should be used for the serological diagnosis: a sensitive enzyme-linked immunosorbent analysis should be performed first, and if reactive, an immunoblot (IgM and IgG) should be performed. The use of recombinant antigens rather than whole cell lysates has improved immunoblot sensitivity and uniformity. Epidemiological research on the prevalence and geographic spread of Colorado tick fever may benefit from the use of the complement-fixation and mouse neutralization tests.

Additionally, the tests might be used to investigate the ecology of Colorado tick fever if the results obtained with animal sera are similar to those obtained with human sera. Human complement-fixing and neutralizing antibodies develop in the blood around nine to fourteen days after a disease is diagnosed, and they may continue to be detectable for up to thirty-four months after that. Human anaplasmosis febrile patients are diagnosed by using leukocyte and platelet counts with analysis of levels of C-reactive protein after exposure to tick bites need earlier molecular detection based on rapid and reliable diagnosis [58]. Further, lipid nanoparticle–containing nucleoside-modified mRNA sen coding 19 *I. scapularis* salivary proteins(19ISP) is used in recognition of a tick-bite [59].

Losses to leather and meat industry

Ticks are parasitic bloodsuckers that cling to both humans and animals. Ticks consume a lot of food after they are linked to a host. Although most tick species have a preferred feeding spot on a host, in extensive infestations, ticks may cling to any available feeding spot. The head, neck, shoulders, and pubic region are the primary food sources for some ticks. The host skin is mostly harmed by these hard ticks. More immediate chemical and immunological management is needed for these ticks, which have been identified in tropical regions as major cattle ixodid ticks (*Hyalomma, Boophilus, Rhipicephalus,* and *Amblyomma*) [60]. The significance of ticks and how they regulate cattle chemically and immunologically Tick bites have several effects on the skin that is subsequently turned into leather. Tick bite causes multiple damages to skin and create defects in raw leather. Leather lost its hardness, stiffness, color and tensile strength because of porous and fragmented spots with dislodged skin. All it is caused by ixodid ticks. Bovine, goat and Yak leather becomes so defective that tanning methods could not give natural coloration and other physical properties to processed leather. For every thousand of completed box-calf leathers, the tanning industry loses between 1.6 and 3.7 thousand roubles.

An overall loss of 65-75% is seen in milking animals. Leather industry is facing problems due to defective leather with pores and other surface defects. Because major supply of raw leather comes from developed countries where ixodid ticks are large in numbers and heavy infestation is still available. This led to shift in raw material origins that have prompted the industry to use more hides with surface defects or other structural deficiencies [61]. Besides this, infected dead animal skin also provides surface to various microbes hence, it entails a higher danger of diseases and epidemics. Pig origin red meat consumption is declining percapitain China and many other countries. The larger market demand is of buffalo and bovine leather. More than 10% of the leather produced worldwide today is manufactured from pig skin. Furthermore, pig skin is the leather raw material most directly related to the food business. As a result, the skin is frequently left on the carcass or utilized to make gelatin for cultural or financial reasons [61]. The current study was created to look at tick-related skin and hide damage at the microscopic level because of the economic significance of ticks and the money they cause to the leather industry. Samples of naturally tick-infested hide and skin tissue were gathered from slaughter house. Epidermal edema and surrounding dermal edema were seen in primary lesions at tick feeding sites.

The quality of leather depends on the grain (outer) surface skin/hides. Tick infestation damages the outer surface through bites, inflammatory reactions, and secondary bacterial infections that frequently establish at feeding sites. The epidermal and subdermal layers frequently showed focal necrosis infiltrated with neutrophils and mononuclear cells at tick bite sites. Hyperplasia of keratinocytes was also observed at sites of ruptured epidermis [62]. For tick control animal dip methods are used to control infatuation of ticks. This is much better than pour-on method that provides very little control. Fr a very successful control integrated control of ticks is highly essential for tick management. It will help to preserve enzootic stability. Tolerance against tick bites is a slow process of but it help to avoid tick feeding due to genetic makeup of indigenous breeds [63]. Tick feeding harms lactating cows and affect their fertility traits [64]. Tick also need hormone their reproduction hence they attack bovine more during estrous cycle [65]. Hence, their, external control or more feeding deterrence is required to save the livestock [66].

Clinical treatment

Heavy infestations will not only severely damage the skin, but can also cause anemia, paralysis, or other complications. Your veterinarian is in the best position to provide a heavily infested cat with the care it needs. A clinic stay for such pets may be likely. Even if your pet has acquired only a few ticks, you should have your pet checked for the many diseases spread by these parasites. Monitor the site(s) from which you have removed ticks. If a tick bite turns red or swollen, a prompt trip to the veterinarian is warranted.

Alternative methods of tick control

Gene transfer technology against tick saliva toxins may is a more preferable methods. Chemical acaricides are also used for tick control but they are harmful to lactating animals and human being. These are released inside milk and poison the milk products. Resistance is an acquired characteristic and each animal develops its own level of resistance in response to tick challenge; the level may be high (as in most zebu cattle) or low (as in most European cattle), but a wide range of resistance occurs in all breeds of cattle.

It is heritable, and selection and cross breed methods can solve the problem of tick infestation. Use of sprays and burning of grasses in pasture are considered for tick control. Farmers also alternative methods such as used engine oil (12%), Jeyes fluid (24%), chickens (4%) and de-ticking (2%). Furthermore, using entomopathogenic fungi to eliminate ticks may lessen the necessity for treating tick-borne illnesses and the frequency of using chemical acaricides. Additionally, they come to the conclusion that mycopesticides are less harmful to the environment than traditional acaricides.

Vaccine-based immunological control

Bovines have been actively immunized against the cow tick using a variety of methods. Complex tick extracts were used in the initial experiments. Vaccines have been created or are currently being developed for ticks and tick-borne illnesses. Other elements, such as administration, adjuvant, animal age, etc., also affect the production of a protective immune response. Finding protective tick antigens continues to be a big scientific difficulty and a key barrier to the development of new anti-tick vaccinations. observed that the Bm95 antigen from strain A of *B. microplus* was capable of providing protection against infestations with both Bm86-sensitive and Bm86-resistant tick strains. [67] reported the isolation of the Bm95 gene from strain A. In order to shield cattle against infection by *B. microplus* strains from various geographic locations, he proposed that Bm95 may be a more universal antigen. [68] studied the use of cDNA expression library vaccination to identify protective antigens for the management of Ixodes scapularis infestation.

Precautions

The most efficient strategy to limit exposure is to keep animals away from tick-prone regions. The majority of ticks inhabit certain microhabitats, such long grass or the space between lawns and forested areas. Tick populations are decreased when these microhabitats are cleaned and cleared. Your animal's safety can be enhanced by clearing your yard of weeds, thick grass, and other plants.

An estimated 364 million USD was lost annually nationwide as a result of TBD, which included an estimated 1.3 million cow deaths. Tick danger can be somewhat decreased by treating plants with insecticides. However, due to environmental contamination and the expense of treating huge regions, widespread use is not advised. Individuals can lessen their likelihood of acquiring or engaging in the following: When strolling through wild regions, stick to routes and trails. To prevent running into weeds and shrubs, stay in the middle of trails. Instead of sitting on stone walls or the ground. Wearing long pants and tucking them into boots or socks, Wearing light-colored clothing, which makes ticks easier to see, Applying an insect repellent containing permethrin to clothing or wearing clothing commercially pretreated with permethrin, Applying an insect repellent containing contact with ticks frequently results in tick infestation. Animals that spend time outside, particularly in natural settings, are more likely to be impacted. Therefore, although any horse spending time outside might pick up ticks, horses who are riding in wilderness regions or wandering the wild are more likely to be contaminated. IN order to give immediate relief from tick bites, doctors provide corticosteroids and antiseptics to the affected region to stop more skin damage and infection. Using curved forceps, grip the tick to remove it. They may be removed and separated from the skin by tugging directly. Since it can result in chronic inflammation, the tick's head, which might not emerge with the body, should be removed. The majority of traditional tick removal techniques, such using petroleum jelly, alcohol, nail polish, or a hot match, are useless and may harm the skin or cause the tick to release contaminated saliva into the bite site.

Conclusion

Compared to other groups of arthropods, ticks are found to parasitize a wide variety of vertebrate hosts, transfer a greater diversity of harmful pathogens, and cause significant economic losses to livestock worldwide. The existing state of affairs is unacceptable owing to issues with acaricide resistance, chemical residues in food and the environment, and the incompatibility of tick-resistant cattle for all production methods. Although a lot has been accomplished in the field of tick management, much more work has to be done.

As the present situation indicates that severity of tick bites and economic losses is increasing day by day and the availability of vaccine is very small. Conclusively annual TBD losses are increasing and costs on chemotherapy, vaccination and acaricide application have been accounted very high. Therefore, a tick control policy should be developed at global level based on country wise indigenous technical knowledge, for improvement of overall health of animals in farm, field and cattle yards. The ability to induce an effective, sustained immunological response is crucial but needs improvement. Lastly, to combat the risky situations, there is need of development of effective vaccines for absolute control of tick menaces and reduces the economic losses.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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