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Review on the Impact of Ticks on Livestock Health and Productivity

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Abstract
Ticks are obligate haematophagous ectoparasites of domestic and wild animals as well as humans, considered to be second world-wide vectors of human diseases. They are the most important ectoparasites of livestock in tropical and sub-tropical areas, and are responsible for severe economic losses both through the direct effects of blood sucking and indirectly as vectors of pathogens. The present review is focused on impact of tick on livestock productivity and health. Loss of blood is a direct effect of ticks acting as potential vector for haemo-protozoa and helminth parasites. Blood sucking by large numbers of ticks causes reduction in live weight and anemia among domestic animals, while their bites also reduce the quality of hides and skin. The impact of ticks on livestock production and health includes tick borne disease morbidity and mortality, huge loss of milk and meat production, damage on the quality of skin and hide and cost for tick and tick borne disease control and prevention. The economic losses due to ticks can be expressed either in terms of body weight or milk production lost or treatment cost employed for its prevention and control. The implementation of rational and sustainable tick control programs in grazing animals is dependent upon the knowledge of the ecology and epidemiology of ticks. Major tick controlling techniques such as biological and chemical control methods, grazing management, genetic manipulation and vaccination could be employed. The prolonged and incorrect use of tick chemicals can lead to resistance in ticks, enabling the ticks to tolerate and survive chemical applications and making tick control in the future much more difficult. Therefore, appropriate method of control and prevention of ticks should be formulated based on the ecological and epidemiological study done ahead of time, appropriate tick drug handling and management should be practiced to prevent the drug resistance and deep investigation should be done on the preparation and application of vaccines which could be a successful prevention method in the future.
Keywords: Control, Health, Livestock, Prevention, Production, Ticks.

Introduction

Ethiopia is a resourceful country endowed with largest livestock resource in African continent with about 53.99 million cattle, 25.5 million sheep and 24.06 million goats, 1.91 million horses, 6.75 million donkeys, 0.35 million mules, 0.92 million camels, 50.38 million poultry and 5.21 million bee hives (CSA, 2013).

Livestock production is an important integral component of the Ethiopian agricultural production system and plays an imperative role in the development of the country's economy and for the food and nutritional security. The subsector contributes about 16.5% of the national Gross Domestic Product (GDP) and 35.6% of the agricultural GDP (Metaferia *et al.,* 2011).

Even though the livestock sub sector contributes much to the national economy, its development is hampered by different constraints. The most important constraints of cattle productions are wide-spread endemic diseases including parasitic infestation, poor veterinary service and inadequate drug supply. Livestock are highly affected by ectoparasites mainly ticks and tick borne disease which directly affect the socio-economic development of farmers in the area (Solomon, 2005).

Ticks are one of the most serious ectoparasites in Ethiopia. They cause the greatest economic losses in livestock production. It causes serious effects including reduced growth, milk and meat production, damaged hides and skins, transmission of tick-borne diseases of various types and predisposes animals to secondary attacks from other parasites such as streptothricosis (ESGPIP, 2010).

In Ethiopia, about 47 species of ticks are found on livestock and most of them have important as vectors and disease causing agents and also have damaging effect on skin and hide production (Anne and Conboy, 2006;Walker *et al*., 2007). Several species of ticks belonging to genus, Amblyomma, Boophilus, Rhipicephalus, Hyalomma and Haemaphysalis have been reported (Nibret *et al*., 2012). The major cattle tick borne diseases in Ethiopia are anaplasmosis, babesiosis, cowdrosis and theileriosis (FAO, 2011).

The general distribution of ticks is the principal indicator used to estimate the distribution of tick-transmitted pathogens. Therefore, the interest behind tick survey is not only faunistic because accurate tracking of the distribution of a tick may provide additional information regarding the ecological conditions, such as the climate and vegetation, to which they are exposed (Sonenshin *et al*., 2006).

Controls in regions where ticks are endemic include treatment with acaricides, pasture rotation, environmental modification, and integrated biological programs. Like all living things, cattle ticks have the ability to overcome adversity in order to survive. They can adapt genetically over time so that they and their offspring build up resistance to the normal tick treatments used. This is known as tick acaricide (chemical) resistance prolonged or incorrect use of tick chemicals can lead resistance in ticks, enabling the ticks to tolerate and survive chemical applications (Kearney, 2013). Therefore, the objective of this paper is to review the impact of ticks on livestock health and productivity.

Basic biology of ticks

All ticks are obligate temporary parasites of vertebrate animals in which they cannot survive without blood. Larvae, nymphs and adults, both males and females need to suck blood and are characterized by a complex developmental cycle. Ticks thus can become integrated into the epidemiological chain of pathogen transmission, by means of the so-called trans-stadial (stage-to-stage, also called horizontal) or transovarial (female-to-egg, also called vertical) passages (Kahl *et al*., 2002).

Ticks feed on concentrate blood meal by removing the excess water. This helps to accommodate the large blood intake (several milliliters) in the relatively small body. The engorgement and blood sucking habit, longevity, high reproductive potential, relative freedom from natural enemies and highly sclerotized bodies that protect them from environmental stress contributed to their successful life (Estrada-Peña *et al*., 2013).

Ticks may have multi-year life cycles, long starvation tolerance and various stages may survive over winter. Slow intracellular digestion of blood allows for pathogens to escape digestive process in the ticks' gut and protects pathogens in an intracellular location. An early painless bite, saliva containing pharmacologically active compounds mediating the host immune response and anticoagulant compounds allowing continued blood flow into feeding lesions all contribute to effective tick parasitism (Gary and Lance, 2009).

Taxonomic Classification of ticks

Ticks are ectoparasites of livestock which are belong to the Phylum Arthropod, Class Arachnida and order Acari (Barker and Murrell, 2004). Three families are currently recognized: Ixodidae (hard ticks 692 species), Argasidae (the soft ticks, with 186 species) and the recently identified Nuttalliellidae which exhibits intermediate characteristics in comparison which contains only one species (*Nuttalliela namaqua*) (Naval *et al*., 2010).

The first two families comprise tick species that are important vectors of disease causing agents to animals and humans. These zoonotic agents are maintained in cycles between ticks and reservoir hosts, where humans can develop clinical illness but usually are "dead-end" hosts because they do not contribute to the transmission cycle (Swanson *et al*., 2006).

Developmental stage and morphology of ticks

Ticks develop through four stages which include egg, larvae, nymph, and adult. All tick species and all their development stages (larvae, nymphs, adults) are obligate blood sucking parasites (Taylor *et al.,* 2007).

The family Ixodidae tick species have an inflexible, dorsal scutum covers the idiosoma of the male and the anterior part of the idiosoma of the female; mouth parts are terminal and visible from above; stigmata are located posterior to coxae IV; the body is usually wrinkled and they are relatively large ticks (between 2 and 20mm) flattened dorso-ventrally. All ixodid ticks have a chitinous covering or scutum or a conscutum as a hard plate on the dorsal surface which extends over the whole dorsal surface of the male, but covers only a small area behind the gnathosoma in the larva, nymph or female (Walker *et al*., 2007).

In the Argasidae family tick species, the scutum is lacking; mouthparts are ventral and not visible from above; stigmata are usually located between coxae III and IV; the body is often smooth (Marquardt *et al.,* 2000).

Epidemiology and host range of ticks

Ticks are blood-feeding ectoparasites of mammals, birds and reptiles and more than 800 tick species have been found throughout the world, but they tend to flourish more in countries with warm and humid climates because low temperatures inhibit their development from egg to larva (Barker and Murrell, 2004). Those of their host broad-scale factors that limit the ranges of tick species have not been definitively established. Given that most tick distributions are not limited by species, it can be inferred that a primary factor preventing expansion of tick species ranges is a direct effect of climate (Cumming, 2002).

The microclimate in the layers of vegetation populated by ticks is an important factor regulating the abundance of their population. The weather also regulates the periods of the year when ticks are active. In the summer in temperate areas, long periods of high temperatures (together with a high desiccating power of the air) may promote a rise of the mortality rates of molting or questing stages (Childs and Paddock, 2003). Generally, the prevalence of tick borne livestock diseases are attributed to environmental and climatic conditions, poor nutritional status, and poor management pattern (Duguma *et al*., 2012).

Life cycle of ticks

Ticks have a simple life cycle in which eggs hatch into six-legged larvae, an immature stage. Depending on the kind of tick, the larva can be extremely active or lay in wait for a host to come. Once on the host, the larva will begin feeding. After the tick is full of blood, it will either fall off the host or stay on, depending on the type of tick. The next step for the tick is to turn into a nymph. From this point on, the tick will have eight legs. Some ticks go through many nymphal stages, while some only have one (Jonathan, 2015).

The life-cycle of each tick species involves a characteristic number of host individuals which vary considerably. Members of 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. During the two-host life cycle, the tick molts from larva to nymph on the first host but, will leave the host between the nymphal and adult stages. The second host may be the same individual as the first host, the same species, or even other species (Andrew *et al.,* 2004).

Feeding and reproduction system of ticks

All feedings of ticks at each stage of the life cycle are parasitic. Once on the host, ticks actively search for a favorable place for feeding. They then probe the skin and insert their mouth part; these consist of chelicerae, hypostome and the palps. The chelicerae and hypostome form a tube which penetrates the host's skin; the chelicerae consist of moveable rods with sharp claws at the end, these cut a hole in the dermis and break the capillary blood vessels very close to the surface of the skin, forming a feeding lesion (Mandal, 2006).

The first step in feeding is the secretion of a substance that solidifies in contact with the skin of the hosts. It contributes to the fixing of the tick, and is called "cement". The feeding tick begins a series of peristaltic movements that inoculate the saliva through the mouthparts into a so-called feeding cavity. At the same time, a dramatic series of changes occur in the salivary glands, whose cells are deeply transformed, adapting its physiology and pharmacological secretive properties to the new active status (Nuttall and Labuda, 2008).

The impact of ticks on milk and meat production

The impact of ticks on cattle milk production includes a decrease both in quantity and quality. Different reports has revealed that ticks are causing huge loss to cattle milk production conjugated with nutritional status, and poor management pattern (Duguma *et al.*, 2012). Female tick is capable of ingesting 1.0 ml blood from the cow during its parasite phase which cause the loss weight about 1 gram and thus reducing and affecting the product of milk by about 8.9 ml (Jonsson *et al*., 1998).

Each tick bite causes stress and weakens the host's immune responses which affect the performance of the animals. The economic losses due to ticks can be expressed either in terms of body weight or milk production lost per engorged tick or in terms of average financial loss (production loss plus cost of control) per animal per year (Jonsson, 2006).

Ticks can reduce potential yield, which mean that significant infestations of *Boophilus microplus* reduce the cattle's ability to reach its full weight potential (Stewart and De Vos, 1984). When animals infested with an average of 40 ticks /day could lose weight equivalent to 20 kg/year and when infested with more than 200 ticks for a period of six weeks could die if not treated (Frisch *et al*., 2000).

Skin and hide quality

Hide and skin accounts for 12-16% of the value of export in Ethiopia. More than 60 species of ticks infesting both domestic and wild animals have been recorded in Ethiopia. However, hide and skin which is emanating from East and Central African countries including Ethiopia have low value in the international market which is mainly associated with tick marks (Abunna *et al*., 2012).

Ticks can affect skin and hide quality through penetration of skin by piercing mouth parts makes holes which are defects in processed skin. When feeding, ticks can allow bacteria to pass through the skin leading to the development of local abscessed which damage skin quality more expensively than the hole caused by feeding (Taylor *et al*., 2007).

Mortality and morbidity of livestock due to tick borne diseases

Around a billion cattle, mainly located in tropical regions, could be afflicted by various tick species or by the diseases they transmit, which could lead to significant loss in production system. In these regions, infection by these parasites, besides reducing production, could cause the death of the more susceptible animals (Pegram *et al*., 1991).

In eastern Africa, where cattle and buffalo share grazing lands, East Coast fever has been reported to cause half a million deaths in cattle each year in both large-scale and small-scale production systems, as well as significant productivity losses associated with the reduced lactation of recovering cattle. The mortality rate has been reported to be as high as 90% in susceptible animals or epizootic situations (Minjauw and McLeod, 2003).

Tick infestation is significantly higher in zebu breed cattle as compared with cross borena cattle. This is may be attributed to the currently animal husbandry practice where crossbreed are kept most of the time indoor with semi intensive care, whereas zebu breed cattle are kept under extensive farming system (Morka *et al.,* 2014).

Tick borne diseases (as vector of pathogens)

Tick-borne diseases affect 80% of the world's cattle population and are widely distributed throughout the world, particularly in the tropics and subtropics they represent an important proportion of all animal diseases affecting the livelihood of poor farmers in tropical countries. The complex of vector-borne diseases directly or indirectly constrains the growth of the livestock industry, which is of fundamental importance to rural people in sustaining not only their food supply, but also their daily income and other agricultural activities (FAO, 2011).

Cattle are free ranging and they graze extensively which makes them prone to diseases and parasites (Marufu, 2008). Ticks acquire pathogens from an infested host during a blood meal, maintain infested through multiple life stages by the means of transtidial passages and transmit it on to other hosts when feeding again (Klareenbeek, 2010).

Cost for treatment and Control of tick and tick borne diseases

A complex of problems related to ticks and tick-borne diseases of cattle created a demand for methods to control ticks and reduce losses of cattle (George *et al*., 2004). Control of tick infestations and the transmission of tick-borne diseases remain a challenge for the cattle industry in tropical and subtropical areas of the world. Tick control is a priority for many countries in tropical and subtropical regions (Lodos *et al*., 2000).

For most tick borne diseases, early treatment is essential. However, this is seldom possible because the first signs of infection are often rarely perceptible and farmers rarely undertake a thorough daily examination of their animals (Minjauw and McLeod, 2003). The lack of available estimates of the prevalence and incidence of each tick-borne disease makes it difficult to determine their impact. However, since TBDs (tick-borne diseases) are each vectored by particular tick species, the potential distribution of each disease can be estimated from the distribution of its vectors tick distribution is the principal indicator used to estimate the distribution of TBDs (Rajput *et al.*, 2006).

Public health importance of ticks

Ticks were the first arthropods to be established as vectors of pathogens and currently they are recognized, along with mosquitoes, as the main arthropod vectors of disease agents to humans and domestic animals globally (Colwell *et al*., 2011).

Moreover, the incidence of tick-borne diseases (TBDs) is increasing worldwide. For instance, more than 250, 000 human cases of Lyme borreliosis were reported from 2000 to 2010 in the United States, and the disease is also increasing in Europe, where over 50, 000 cases are reported each year in humans. The risk of TBDs is increasing worldwide, and this situation seems to be driven by several interacting factors. Wildlife populations can naturally migrate, bringing ticks and tick-borne pathogens from one area to another (Piesman and Eisen, 2008).

Ixodes ticks can be infected with more than one agent and co-transmission and infection can occur. Alternatively, multiple infections can occur from multiple tick bites. Animals, especially dogs, because of their close proximity to humans and the fact that they often present with similar signs of tick-borne disease, are often sentinels for human TBDs (Stafford, 2007).

Tick resistance to accaricides

Tick resistance to acaricides is an increasing problem and real economic threat to the livestock and allied industries. The resistance of ticks to acaricides is an inherited phenomenon. It results from exposure of populations of ticks to chemical parasiticides (acaricides) and survival and reproduction of ticks that are less affected by the acaricides. The higher reproductive rate of ticks that have heritable resistance factors and the resulting increase in the proportion of the population of ticks that carry genes for these factors is known as selection (Carvalho *et al*., 2013).

Host resistance to ticks

Studying the mechanisms of resistance to ticks among different breeds of cattle may contribute to the development of alternative control methods (Gasparin *et al*., 2007). Exhibition of coat characteristics that are unfavorable for tick attachment is an important mechanism of resistance to tick infestation in cattle. Phenotypic coat characteristics such as hair length, coat thickness, coat smoothness, and coat color have an influence on tick counts (Marufu *et al*., 2011).

Control and prevention of ticks

The successful implementation of rational and sustainable tick control programs in grazing animals is dependent upon a sound knowledge of the ecology or epidemiology of the parasite as it interacts with the host in specific climatic condition. Tick control demands the attention of researchers because many important livestock diseases are transmitted by ticks and this can be achieved by controlling ticks. The most widely used method for the effective control of ticks is the direct application of acaricides to host animals (Sudhakar *et al*., 2013).

Chemical control Methods

The main weapon for the control of ticks at present is the use of chemical acaricides Individual animals can be effectively treated by the application of any one of a number of acaricides applied either as a spray or by dipping. The choice of acaricide depends largely on persistence of the compound on the skin and hair coat; likelihood of residues toxic to man appearing in the milk or meat and whether or not the ticks in the area have developed resistance to the particular acaricide (Radostits *et a*l, 2006).

Biological control method

Biological control is a component of an integrated pest management (IPM) system. It is defined as, introduction of one microorganism into the environment of other to obtain control of target parasite. Thereby, it reduces the population growth of the latter below the threshold, above which causes clinical diseases and economic losses. It involves an active human role and is not having any negative impact (Abdigoudarzi *et al*., 2009).

Grazing management

Pasture rotation combined with acaricide application is one economical method for controlling ticks on beef cattle, and it reduces tick densities on a large scale. Areas with good vegetation and high rainfall, however, produce more ticks than those with poor vegetation and erratic rainfall. Pasture burning can also be used to effectively control ticks as it significantly reduces tick populations on pasture (Mandal *et al*., 2013). Development of cattle lines or a breed with enhanced, genetically based disease resistance is an especially attractive prospect (De Castro and Newson, 1993).

Vaccination

There may be many alternative tick control measures; immunization against ticks at present seems both practical and sustainable due to their cost effectiveness, reduction of environmental contamination and the prevention of drug-resistant ticks caused by repeated acaricide application (Suarez and Noh, 2011).

Conclusion

Ticks are blood feeding ectoparasites of mammals, birds and reptiles which tend to flourish more in countries with warm and humid climates because low temperatures inhibit their development from egg to larva. All ticks are obligate temporary parasites of vertebrate animals in which they cannot survive without blood. Tick infestations in livestock may have both direct and indirect impact as far as production and health of animals and impact to the herders is concerned. The impact of ticks on livestock production and health includes tick borne morbidity and mortality, huge loss of milk and meat production, damage on the quality of skin and hide and cost for tick and tick borne disease control and prevention. Each tick bite causes stress and weakens the host's immune responses which affect the performance and productivity of the animals. The economic losses due to ticks can be expressed either in terms of body weight or milk production lost or treatment cost employed for its prevention and control. Ticks can act as vector of pathogens transmitted to both humans and animals. The implementation of rational and sustainable tick control programs in grazing animals is dependent upon the knowledge of the ecology and epidemiology of ticks. Major tick controlling techniques such as biological and control methods, grazing management, genetic manipulation and vaccination could be employed. The prolonged and incorrect use of tick chemicals can lead to resistance in ticks, enabling the ticks to tolerate and survive chemical applications and making tick control in the future much more difficult. Therefore, ecological status and epidemiology of ticks should be continuously studied before any control measure is employed, appropriate method of control and prevention of ticks should be formulated and applied to reduce its impact on livestock health productivity and deep investigation should be done on the preparation and application of vaccines which could be a successful prevention method in the future.

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