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TICK CONTROL STRATEGIES IN DAIRY PRODUCTION MEDICINE

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INTRODUCTION

Ticks are economically the most important pests of cattle and other domestic species in tropical and subtropical countries. They are the vectors of a number of pathogenic microorganisms including protozoans (babesiosis, theileriosis), rickettsiae (anaplasmosis, ehrlichiosis, typhus), viruses (e.g., Kyasanur Forest Disease reported from Karnataka State of India; Crimean-Congo Hemorrhagic Fever reported time and again from Pakistan), bacteria (e.g., *Pasteurella*, *Brucella*, *Listeria*, *Staphylococcus*) and spirochaetes (Barnett, 1961; Jongejan and Uilenberg, 2004). The only food for the ticks is blood. They are voracious blood suckers; loss of blood for their rapid development impoverishes the hosts. In heavy infestation cattle must have more feed merely to meet the demands of the parasites; the growth of young animals is retarded, and they may remain thin, weak and stunted. In dairy cows, milk production is greatly reduced. Ticks belonging to genus *Ixodes* and *Ornithodorus lahorensis* are associated with tick paralysis which is a specific type of intoxication, resulting from the injection of a toxin by certain instars of ticks usually the adult females but sometimes by nymphs. Sweating sickness is a disease of cattle and other domestic species which occurs in South, Central and East Africa. It is associated with infestation by *Hyalomma truncatum* and has all characteristics of toxicosis (Barnett, 1961).

Although, economic losses due to ticks are mainly due to the diseases which they transmit (Garcia, 2003), financial losses associated with nagging irritation and depreciation of the value of skins and hides (upto 20-30%) are also significant (Biswas, 2003). In severely tick infested young cattle, sometimes ticks have been found in the oral cavity as well as in the stomach. They reach here as a result of constant licking induced by irritation. The present treatise attempts to review some of the pragmatic tick control measures in dairy cattle and buffaloes. Ghosh *et al*. (2007) have reviewed upcoming and future strategies of tick control. Similarly, Jongejan and Uilenberg (1994) have reviewed ticks and control methods.

Important species of ticks infesting cattle and buffaloes in Pakistan

Infestation rates of important genera of ticks infesting cattle in Frontier Region, Peshawar, Pakistan were as follows: *Boophilus* (43.40%), *Hyalomma* (36.65%), *Rhipicephalus* (16.88%) and *Amblyomma* (3.05%). Infestation rates by ticks of these genera in buffaloes were 53.12, 31.25, 15.62 and 3.05%, respectively (Manan *et al*., 2007). Khan *et al*. (1993) investigated the prevalence of ticks on different livestock species in Faisalabad (Pakistan). Infestation rates in cattle and buffaloes were 28.2 and 14.7%, respectively. Most livestock species carried more than one genera of ticks. Ticks of the genus *Hyalomma* were the most prevalent in cattle and buffalo, followed by those belonging to *Boophilus*.

Host-contact patterns of different tick species

Ticks show a variety of host-contact patterns during their life cycles. In one host tick species (e.g., *Boophilus microplus*), each developmental stage (larva, numph and adult) feeds upon the same host individual. In others, two or three individuals are used, with the ticks leaving the host when replete in order to moult. In three host tick species (e.g., *Hyalomma anatolicum anatolicum*), a different individual is used for each stage in the cycle i.e., larva, nymph and adult, and one blood meal is taken on each host (Wakelin, 1984).

CONTROL METHODS AND PRACTICES

An integrated control strategy based on the following measures is recommended for the control of ticks in cattle and buffalo:

Housing in tick proof buildings

To the extent possible, cattle and buffalo sheds should be tick proof especially for the housing of purebred exotic and crossbred cattle, as they are more susceptible to the tick infestation than native cattle and buffaloes. There should be no cracks and crevices in the buildings (as the ticks hide and breed there). Caulking of the walls (‘teep’ in Urdu’) of the animal’s sheds is an inexpensive measure that significantly reduces the tick burden. An acaricide channel should encircle the entire building. Heaps of dung cakes and stacks of bricks may also provide breeding places to the ticks in animal sheds and should therefore be removed regularly.

Slow burning of the wastes near the walls of the animal sheds

Since the female ticks generally lay their eggs in the cracks and crevices in the walls of the animal sheds, scrapping of the farm waste (feces and feed waste, etc.) against the walls of unoccupied paddocks and its slow burning over a period of one or two days is quite effective in reducing the tick burden on the animals. This practice should be periodically repeated. All common sense precautions should be exercised while resorting to this practice.

Separate housing of cattle and buffaloes

Cattle (in particular those with exotic blood) are more susceptible to tick infestation than buffaloes. Buffaloes do not usually carry cattle ticks except under exceptionally stressful conditions. They are not normal host of cattle ticks (Lemcke, 1997). When cattle and buffaloes are mingled together, the buffaloes sometimes also suffer from heavy tick infestation. Therefore, cattle and buffaloes should be housed separately.

Quarantine

Newly purchased animals should not be mixed right away with the already existing stock on the farm. If ticks are present on the bodies of new arrivals, they should be treated with acaricides so that they are free from ticks before adding them to the existing herd.

Pasture spelling and rotational grazing

Pasture spelling and rotational grazing have been shown to be capable of greatly reducing the population of one-host ixodid tick *Boophilus microplus* on dairy farms in Australia (David, 2005). If cattle are placed on spelled (i.e., divided) pastures early in winter when the ticks are producing few or no progeny and then alternated at 4-monthly intervals, the tick population can be controlled with a markedly lower number of acaricidal treatments. The spelled area to be grazed should first be checked by introduction of susceptible tracer calves. The practicability of the procedure depends upon the full-scale assessment of the increased weight gains relative to the costs of management. Duration of the spelling period varies from 2 to 3 months in summer and 3 to 4 months in winter, but these intervals need to be determined for each area. Even in countries where dairying is practiced with considerable pasture grazing (e.g., New Zealand), pasture spelling is rarely used for tick control. In developing countries like Pakistan, pasture spelling is not of much value because pastures and ranges are mostly communal with regards to ownership. Pasture spelling and rotation of pastures are not very effective for the control of multihost ixodid ticks (e.g., *Hyalomma anatolicum anatolicum*) or argasid ticks because of the long survival periods of the unfed nymphs and adults (David, 2005).

Manual removal of ticks

Where the number of tick infested cattle and buffaloes is very small, farmers remove the ticks manually generally at the time of milking. Ticks so removed are killed by putting them on a smoldering dung cake placed nearby. For manual removal of ticks, using the forefingers, first grasp the tick close to the animal's body and then twist it counter-clock wise. Entire tick can be removed in this way and with only little discomfort to the animal (Muhammad, 1994). Cattle enjoy manual removal of ticks. A caveat is pertinent with manual removal of ticks. When removing the tick manually, consideration should be given to the possible hazard to humans from pathogens present in these ticks. The most important and deadly human pathogen that has been recognized is Crimean-Congo Hemorrhagic Fever (CCHF) virus, usually associated with ticks of the genus *Hyalomma*. Several outbreaks of this disease have been reported from Pakistan (Athar *et al*., 2005; Jamil *et al*., 2005). CCHF is widely prevalent within the geographical distribution of *Rhipicephalus appendiculatus*. Investigators collecting ticks for experiments as well as the average farmers should, therefore, be made aware of the possibility of transmission of CCHF virus potentially associated with manual removal of ticks. Ticks should preferably be removed with the forceps and in no case crushed between the fingers (OIE, 2004).

Clearance of vegetation

Various stages of some ticks (e.g., *Boophilus* species) attach themselves to the blades of grass and other vegetation and stealthily attach to the cattle passing nearby. Though clearance of vegetation will annihilate their places of shelter, this type of action, however, may encourage soil erosion and may be detrimental to the ecosystem.

Use of acaricides

At present, periodic application of acaricides (agents used to kill ticks and mites) is the most widely used method of tick control in dairy farming. Control of ticks with acaricides may be directed against the free living stages of ticks in the environment or against the parasitic stages on host. Acaricides can be applied by dipping, washes, spraying, pour-on, spot-on or by injections. Insecticide ear tags are commercially available in some countries for the control of horn flies, face flies and spinose ear ticks. Dipping is an expensive operation but is desirable when a large number of cattle are to be treated or when a tick eradication programme is in place. The frequency of dipping depends upon the species of the tick infesting the cattle. In the case of *Boophilus microplus*, dipping every 21 day is recommended to break the life cycle because 18 days is the least time from the dropping off of an engorged female to time when larvae can be ready for infestation, and the dip gives protection for three days (Hungerford, 1990). The construction of a dipping tank varies according to the kind and number of animals required to be dipped. In tropical and sub-tropical countries, it is preferable to cover the tank with a roof, as it will avoid excessive concentration of the insecticides by evaporation or dilution by rain. The following precautions should be observed while dipping animals for tick control and treatment (Ruprah, 1985):

Wounds must be attended to thoroughly before resorting to dipping, otherwise dipping causes discomfort to animals and toxicity may occur.

Avoid dipping on cloudy, rainy, windy or cold days.

The animals to be dipped should not be thirsty.

Animals that are fatigued due to any reason should not be dipped.

To the extent possible, avoid contamination of the dipping tank with organic matter (e.g. dung) as it lowers the concentration of insecticides in the dip.

The animals must actually swim in the tank and have one or two dips of their heads in the acaricidal solution. For this purpose, two attendants with forked blunt sticks should direct the operation.

Let the animals drain properly before they are sent out to the fields, otherwise the insecticide will cause pollution of feed, fodder, or other items coming in contact with insecticides. Design the dipping area with a good drain back to the dipping bath.

The concentration of the dip should be very carefully adjusted and may be same as recommended for the spray but in no case higher than that.

Weak animals less than three months old should not be subjected to dipping.

Human safety against insecticides is of paramount importance. While handling any acaricide, avoid repeated or prolonged contacts with skin and inhalation of dust and mist. Wear clean clothing and wash hands and face before eating or smoking. Keep the antidote (generally atropine sulphate injection @ 0.2-2 mg/kg) ready for use in the case of acaricide poisoning.

Recommended drug withdrawal period should be observed.

The dimension of the dipping tank should be decided according to the number and type of dairy animals on the farm. The following dimensions for the cattle farms may be indicated (Ruprah, 1985):

Maximum depth – 10 feet, it includes 2-2.5 feet for splash walls.

Length – 50 feet, let at least middle half of it remain filled with 7-8 feet deep insecticide, with entrance and exit having slopes.

Width – 10 feet throughout the entire length.

A plunge-dipping tank should have a pucca, cemented, impervious, non-slippery internal lining The entrance and exit should have convenient slopes. It should be filled in such a way that the animals are in a position to swim a few feet on their way. Barnett (1961) recommends that cattle should pass through the dip in their age groups and not as mixtures of large and small animals. According to this author, one of the difficulties of treating buffaloes for ectoparasites is their propensity of frequent immersion in wallows, which washes off the acaricide. It has been suggested that the small wallows could be used, in which a suitable concentration of acaricide could be incorporated, thus acting as a voluntary dip for buffaloes. Incorrect or poor application of even a highly effective acaricide can result in less than satisfactory control and may contribute to the development of acaricidal resistance. This is because of reduction in the concentration of acaricide with the passing of each cattle through the dip tank and addition of organic matter in the form of dung and urine into the dipping solution. Concentration also reduces as the time elapses. One way to address the problem of falling concentration of acaricide is to use ‘head count system’ which has been practiced in some parts of Africa. With this system, replenishments of acaricide concentration are made not based on volume of wash used but on number of heads of cattle dipped (Mathewson, 1984).

For small number of animals (say 10-25), spraying with a bucket-pump hand sprayer is more economical. In order to effectively control ticks, it is necessary that every part of the body be sprayed and not only the hair but the skin be moistened (Kinsey, 1993). For farmers maintaining a very small number (say 1-6) of cattle/buffaloes, plastic spray bottles commonly used by barbers in hair cutting and by women in ironing clothes can be used. Two mL of Ecofleece^{TM} (Prix, Pharma) or Cyprin^{TM}20EC (Pameer, Pharma) can be added to 2L of water and sprayed on the tick infested body areas of cattle and buffalo with the help of spray bottle at interval of 5-7 days in summer months. Delta – 25^{TM} solution (Selmore, Pharma) is a proprietary preparation containing 2.5% deltamethrin. The recommended dilution of this preparation for tick control is 2mL/L of water. As per the personal perspective of the principal scribe of this treatise, this method is extremely economical, effective and environment friendly.

There are predilection sites for certain tick species on parts of the body which are not effectively treated by dipping or spraying. The inner parts of the ear are especially liable to escape treatment, and ticks such as *Otobius megnini*, the larval and nymphal stages of *Rhipicephalus evertsi*, and the adult stages of *Rhipicephalus appendiculatus* which feed there, as well as the larval stages of many tick species which are found in the inner fringes of the ear, will not be killed. Other sites escaping an effective contact with the dip are the under part of the tail where *Rhipicephalus evertsi* adults are found, the tail brush and the areas between the teats and the legs in the cattle with large udders. These sites need special attention and the application of acaricide selectively to these sites is known as "hand dressing". It is normally done as a supplement to ordinary dipping but is sometimes practiced by the owners on individual cattle to control objectionable ticks which occur in small numbers, such as various species of *Amblyomma* and *Hyalomma*. The acaricide is applied with a cloth, sponge, or even a hand spray, and either standard dip fluids are used, or an acaricide in an oily or greasy medium is employed (Barnett, 1961).

A variety of acaricides are available in the market. Pyrethroids are generally the safer, effective and easily degradable acaricides. Ecofleece™ (marketed in Pakistan by Prix Pharmaceutica) is a proprietary preparation containing cypermethrin 10 EC. The recommended dose of this acaricidal drug is 1:1000 (i.e., 1 mL for 1L of water) for filling and replenishment of the dipping tank. Crop insecticides containing cypermethrin (e.g., Cypermethrin™ 10 EC, Sawa-Ag Network, Sahiwal, Pakistan) are at least 4 folds cheaper and empirical experience of veterinarians at the Veterinary Medical Teaching Hospital, University of Agriculture, Faisalabad (Pakistan) shows that they are equally effective and safe for use on animals. Neguvon® (Bayer, Germany) is a proprietary product containing trichlorfon (an organophosphate). Recommended concentration of this drug for external application is 0.15% as dip or spray.

Pour-ons are acaricidal compounds, which are applied on the back of the animal. They are easy to use but may be more expensive than the other options. They are absorbed into the blood and thus work systemically. Ivermectin given subcutaneously @ 200 μg/kg (i.e., 1mL/50 kg) gives satisfactory results for *Boophilus microplus* for 21 days following an initial lag period of 2 days (Nolan *et al*., 1981). *Ixodes ricinus* is usually not killed by ivermectin. Worrisome recent reports of ivermectin resistance amongst ticks (e.g., Martins and Furlong, 2001), substantiated by empirical field experiences of veterinarians in Pakistan warrants search for another systemically acaricidal antibiotic. No matter what method of acaricidal application is adopted, the animal sheds should be simultaneously sprayed with insecticide (usually twice the strength used for dipping or spraying e.g., Ecofleece™ @ 1:500). Ticks are notorious for developing resistance against acaricides. The presence of residues in milk and meat and the risk of environmental pollution are other important pitfalls of the use of acaricides.

Tick vaccines

a. Crude vaccines

The use of ticks to produce resistance is effective but crude and the use of tick extract is preferred instead to induce the same response. Whilst, the extract of whole tick or its parts have proved to be very effective, the level of resistance produced has never reached the levels obtained by feeding ticks (Mathewson, 1984). Crude vaccines made from extracts (containing either particulate or particulate plus soluble components) of semi-engorged adult female *Boophilus microplus* gives effective immunity (Johnston *et al*., 1986). Antibodies destroy cells lining the tick's gut and allow blood to escape into the hemocele. Resultantly, some ticks die and the fertility of those remaining is reduced by up to 70%. The fertility of males is also reduced.

Allen and Humphreys (1979) demonstrated effective immunization of the calves against infestation with *Dermacentor andersoni* by prior injection of tick homogenate. Each calf was experimentally infested with 30 male and 100 female ticks 3 days after the third injection of 67 mg homogenate protein. Ticks were removed 10 days later when engorgement should have been completed. Table 1 depicts the results of this experiment.

Table 1: Efficacy of tick homogenate in the control of tick infestation by *Dermacentor andersoni* in cow calves

Group	Ticks recovered		No. of dead partially-fed female ticks	No. of female ticks laying eggs	Total egg production ($\times 10^{-3}$)
	Mean No.	Mean weight (g)			
Control	107	24	12	50	164
Immunized	97	4	44	15	28

Adapted from Wakelin (1984).

b. Genetically engineered and subunit vaccines

Production of an effective and safe anti-tick commercial vaccine presents several difficulties. Firstly, it is important to avoid induction of intense host reactivity to tick feeding. Secondly, salivary gland-derived molecules are introduced into the host during tick engorgement. Therefore, use of these moieties might not be an optimal immunization strategy. Thirdly, antigens not normally involved in acquired resistance can be used to induce anti-tick immunity. However, these ‘novel’ antigens, obtained from tick gut absorptive surface, are not introduced into the host during tick feeding, but are exposed to host-immunity effector elements in the blood meal, resulting in tick rejection and prevention of ova production and death of tick. In the case of ixodid tick (hard tick), anti-tick immunity is induced with microgram quantities of ixodid gut antigen preparation (Wikel, 1988).

According to Fuente *et al.* (2000), 5 protective antigens have been isolated from *Boophilus microplus*. The Bm 86 gut antigen is present throughout all tick stages. A recombinant vaccine based on a membrane-bounded glycoprotein Bm86 (derived from gut of *Boophilus microplus*) has been shown to be as effective as the native antigen. This vaccine is also effective against ticks which have developed resistance to acaricides. Its major effect is a progressive control in tick numbers in successive generations through a decrease in their reproductive capacity. Because the vaccine acts against an antigen in the tick’s gut to which cattle are never exposed, they must be given injections at regular intervals. This was the first recombinant parasite vaccine sold commercially. It was sold in Australia under the brand name of Tick-GARD™ (Hoechst Animal Health, Australia), copied in Cuba (Gavac™; Heber Biotec S. A., Havana, Cuba; Fuente *et al*., 2000) and has been evaluated in other countries (Radostits *et al*., 2007). Studies conducted in Cuba have shown partial cross protection against *Hyalomma* spp and *Rhipicephalus* spp (Fuente *et al*., 2000). A second antigen has now been added to the vaccine. This significantly enhances the efficacy and does not impair the response to Bm86. In the field trials, vaccination with Gavac™ controlled *Boophilus microplus* and *Boophilus annulatus* infestations (55-100% efficacy) 12-36 weeks after the first vaccination, increasing the time between acaricide treatments by an average of 32 ± 21 days (P = 0.0005; Fuente *et al*., 2000). Brazilian workers (Patarroyo *et al*., 2002) constructed 3 synthetic peptides (SBm4912, SBm7462 and SBm19733), derived from the Bm86 glycoprotein from *Boophilus microplus* gut, and used them to immunize cattle from a tick-free area. Researchers at the Department of Veterinary Parasitology, University of Agriculture, Faisalabad, Pakistan have reported a desirable immunogenicity of a *Boophilus* tick vaccine prepared from the midgut cells of the tick cultured *in vitro* (Akhtar *et al*., 1999; Akhtar and Hayat, 2001). Control of ticks and tick-borne diseases through immunological means was reviewed by Willadsen and Jongejan (1999), Willadsen (2005), Bowman and Nuttall (2004) and Ghosh *et al*. (2007).

Although, vaccines offer long-term control, they need to be used with pasture management, acaricidal dips, and tick-resistant cattle as a part of an integrated pest management control system. Kocan (1995) advocated that future strategies of immunological control of ticks should target both tick and pathogens transmitted by them.

Targetting endosymbionts of ticks

Like other parasites, ticks carry some microorganisms in their bodies. These microorganisms and ticks are essential for the survival of each other (endosymbiosis). Since endosymbionts are essential for the survival of ticks, elimination of the microorganisms would be deleterious for the survival, growth and development of ticks. Endosymbionts of ticks are almost unexplored thus far. They appear to be potential future targets for tick control (Ghosh *et al*., 2007). Unfortunately, only few studies (e.g., Noda *et al*., 1997; Benson *et al*., 2004) that involved the identification and characterization of endosymbiont microorganisms of ticks have been conducted.

Biological control

Ticks have numerous natural enemies, but only a few species have been evaluated as tick biocontrol agents. The most promising entomopathogenic fungi appear to be *Metarhizium anisopliae* and *Beauveria bassiana*, strains of which are already commercially available for the control of some crop pests. Entomopathogenic nematodes and parasitoid wasps of the genus *Ixodiphagus* have only a limited pragmatic role in tick control. Predators, including birds, rodents, shrews, ants and spiders play some role in tick control. Ox peckers *Buphagus* spp. eat ticks from the bodies of infested animals and tick burden is generally low in cattle and buffaloes that are tethered under the trees in summer due to predation of ticks by some birds. Raising poultry chicks in the cattle barns greatly reduces tick burden on the infested cattle as the chicks (particularly young ones) pick ticks from the bodies of cattle as well as ticks moving in barns. Practicing mixed poultry and dairy husbandry is associated with considerable wastage of cattle feed and hazard of infectious diseases like salmonellosis and crytococcosis. In the New World (North, Central and

South America), fire ants (*Pheidole megacephala*) are noteworthy tick predators. Engorged ticks may also become parasitized by the larvae of some wasps (*Hymenoptera*) but their role in tick control is not significant. Nematodes of the families *Steinernematidae* and *Heterorhabditidae* are endowed with insect killing abilities. The third-stage juvenile (infective or dauer) stage of these nematodes are able to actively locate, parasitize and kill a wide range of insect species. These nematodes owe their insecticidal activity to bacterial symbionts (*Xenorhabdus* spp. for *Steinernematids* and *Photorhabdus* spp. for *Heterorhabditids*) which they carry in their intestine and release these bacteria into the hemocele. Bacteria proliferate and kill the insect within 24-72 hours. Owing to success in mass rearing of entomopathogenic nematodes, they are now used commercially against insect pests in agriculture and gardens in Australia, China, Japan, USA and Western Europe (Samish *et al*., 2000). Fully engorged *B. annulatus* ticks are highly susceptible to infection by the entomopathogenic *Steinernematids* and *Heterorhabditids* with a LD_{50} and LD_{90} of upto 15 and 165 nematodes/tick/dish, respectively (Samish and Glazer, 1991). However, the results of practical application of nematodes in tick control are variable (Samish *et al*., 2000).

Certain *Stylosanthes* spp (tropical legumes) can kill or immobilize larval ticks and the use of these plants may simultaneously improve pasture quality (Fernandez-Ruvalcaba *et al*., 1999). *Brachiaria brizantha* has also been shown to be lethal to *Boophilus* larvae. Owing to development of acaricidal resistance and growing public concern about insecticidal residues in food of animal origin, biological control is likely to play a substantial role in future integrated pest management programmes for tick control (Samish *et al*., 2004; David, 2005).

Breeding cattle for tick resistance

The development of cattle lines or breeds with enhanced genetically based resistance is especially attractive prospect (DeCastro and Newson, 1993). Zebu (*Bos indicus*; e.g., Sahiwal) and Sanga (a *Bos taurus* × *Bos indicus*) cattle, the indigenous breeds of Asia and Africa, usually become very resistant to *ixodid* ticks after initial exposure. In contrast, European (*Bos taurus*) breeds usually remain fairly susceptible. The tick resistance of Zebu breeds and their crosses is being increasingly exploited as a means of tick control. The introduction of Zebu cattle (notably Sahiwal cattle) to Australia has revolutionized the control of *Boophilus microplus* on that continent. Use of resistant cattle as a means of tick control is also becoming important in Africa and the Americas. Resistance for ticks has been shown to be heritable and can be increased by breeding from cows and bulls selected for resistance (David, 2005). Brossard (1998) has reviewed the use of vaccines and genetically resistant animals in tick control. The observation that some individuals in the herd are more resistant than others, no matter what the breed, is the stimulus to cull out all breeding animals that are the most susceptible and carry the heaviest tick burden (Hungerford, 1990). Bonsma (1983) has mentioned the following factors as the basis of tick resistance/tick repellency of Zebu cattle: thick movable hides covered with short straight, non-medulated hair (in European breeds the skin is thin and covered with wooly hair); high skin vascularity; well developed panniculus muscle; sensitive pilomotor nervous system which moves their hides upon the slightest provocation high density of sweat glands; an efficient erector pili muscle which makes the hair stand up on provocation by flies, ticks, etc. and stimulates the secretion of sebum in the hair which is repellent for ticks

Ethnoveterinary practices against ticks

Several plants and herbs have been shown to possess anti-tick insecticidal, growth inhibiting, anti-molting and repellent activities. A number of reports are available on the effect of different extracts of plant material on tick species. Preliminary results obtained by Indian workers (Ghosh *et al*., 2007) with alcoholic extracts of sitaphal (*Annona squamosa*) and neem (*Azadirachta indica*) against different life stages of *Hyalomma* and *Boophilus* are highly encouraging. One of the fairly well established time honored practices for tick control in Punjab is to feed ground (powdered) Tara mira (Roquette, *Eruca sativa*) to cattle in summer. To this end, 5 kg of Tara mira is grinded. One fourth of a kg (250 gms) of this powder is soaked daily over night in water. In the morning, ice or ice cold water and salt (50-100 gm) are added. The mixture is churned or vigorously shaken for a few minutes and drenched to a tick infested cow/buffalo. This recipe is widely purported to reduce the tick burden, is considered to be galactagogue (i.e., milk yield booster) and widely touted to have a cooling effect and thus helps to sustain the rigor of heat in summer. Sometimes, farmers in Punjab resort to the external application of grated/powdered common salt for tick control.

In conclusion, ticks infestation is a significant cause of economic losses to the dairy industry all over the world. At present, the use of acaricide is the most commonly used method of tick control. To the extent possible, dairy farmers and veterinarians should make use of an integrated tick control strategy based on utilization of biological control method, breeding for tick resistance etc. The use of vaccines for tick control is on horizon.

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