

## Mange Mites Infestation in Small Ruminants in Ethiopia - Review

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**Abstract:** Mites are tiny arthropods, usually less than 1 mm in size and can be difficult to see and identify without the aid of a strong microscope or at least a hand lens. There were more than 200 families of mites and many thousands of species. Some mites have evolved to become important ectoparasitic pests of animals. Some species of mites have become endoparasite invading ears, bronchi, lungs, nose and other tissues of small ruminants. Few of these species are the intermediate hosts of anoplocephalide cestodes. Mange mites is a disease with worldwide distribution and caused by the most important species were *Sarcoptes* spp, *Psoroptes* spp and *Demodex* spp affecting goats and only *Psoroptes* spp in sheep. Generally, mange mites are characterized by piercing the skin, suck lymph and feed on young epidermal cells. Their activity causes marked irritation, intense itching, rubs, partial or complete alopecia, restlessness, vesicles pustules and papules are formed. *Sarcoptes scabies*, *Psoroptes ovis* and *Demodex caprae* were the most economically important mange mites species affecting goats and sheep. This disease is treated by ivermectin, diazinon, phoxin coumaphos and dipping with insecticides, control is by hygiene in houses and avoidance of overcrowding will minimize the accumulation and spread of the mites.

**Key words:** Mange Mites • Small Ruminants • *Sarcoptes* • *Psoroptes* • *Demodex*

### INTRODUCTION

In Ethiopia, there are about 23.6 million sheep and 23.3 million goats, which served as an important source of income for the agricultural community and are one of Ethiopians major source of foreign currency through exportation of live animals, meat and skin. They are also a “living saving bank” and serve as insurance (financial reserve) for a period of economic distress and crop failure as well as a primary source to cash income [1, 2]. However, diseases had been stumbling block against the full utilization of this resource [3, 4].

Although small ruminants are known to adapt to harsh environments, the cumulative effects of overcrowding, poor nutrition and diseases could result in serious production losses [5]. Different causes of skin diseases of small ruminants in Ethiopia have been accountable for considerable economic losses particularly to the skin and hide export [6]. Among these disease sheep and goat pox, mange mite, tick, *Melophagus ovinus*, lice and dermatophilosis posed a great threat to skin and hide sector and livestock production [7].

Among the various etiological causes of skin diseases, parasitic causes of skin diseases played a great role in deteriorating the quality of the skin and the hide and productivity of the animal. From parasitic causes of skin diseases, mange mites worth due attention particularly in the tropic where favorable environmental conditions together with poor management could severely affect production [8-10].

Mange is one of the cutaneous diseases of domestic and wild animals of all ages and both sexes including human beings [9, 11]. It has become an important disease problem causing the mortality of small ruminants in severely affected areas of the region [12]. A recent report showed that mange in sheep and goat could kill about 60% of the affected livestock [13]. Wondowsen [14] also reported a mortality rate of 40 and 36.4% in 364 and 1386 sarcoptic mange infested goat and sheep in 33 weredas of Amhara Regional State, respectively.

The incidence of mange has increased during the past 10 years to a level of preventing farmers from keeping sheep and goat in some areas of the Amhara region, bordering Afar, Tigray and Sudan [13]. Besides, huge

losses that mange was causing due to mortality and poor production, it was also the main cause of skin rejection and downgrading in a tannery. In Ethiopia, 35% of sheep and 56% of goat skin was rejected annually, of which 33% of sheep and 21% of goat skin rejections were due to mange infection [15, 32].

Despite the huge economic losses incurred due to mange mite infestation, only a few studies have been conducted to show the extent of the disease in all regions of the country. Some of these studies include the works of Shenkutei [16] in Robe area, Bale Administration region; Teshome [17] in Sidama Zone, Gashaw [18] in Harerghe; Nigatu [19] in and around Addis Ababa; Mulugeta [20] in around Mekelle; and Zelalem [21] in DireDewa region. However, the studies conducted so far on mange mites and its distribution were insufficient and specific to small areas [22].

**Mange Mites:** Mange was a form of ectoparasitic dermatitis characterized by encrustation, alopecia and pruritis of the skin initiated and maintained by several parasitic mite species [22]. The generalized veterinary term for an infestation of mites in an animal was acariasis. Mange or scabies was one of the most common mites problems in animals. Mange is the deterioration of the skin's condition (pathology), leading to hair or feather loss, a rash, skin discoloration (inflammation) and, in severe cases, lethargy and weakness. The natures of the skin effects are determined by the location of the mites on the animal's body [23].

**Biology of Mites:** Mites are tiny arthropods, usually less than 1 mm in size and be difficult to see and identify without the aid of a strong microscope or at least a hand lens [24]. There were more than 2000 families of mites and many thousands of species. Most mites are free-living and feed on plant juices or prey upon other arthropods. Some mites have evolved to become important ectoparasitic pests of animals. Some species of mites have become endoparasites, invading the ears, bronchi, lungs, nose and other tissues of animals. Few of these species served as intermediate hosts of anoplocephalide cestodes including *Anoplocephala* spp, *Moniezia* spp and *Stilesia* spp. More than 50 species of mite live on or in the bodies of domestic animals. In general, mites can affect the health of animals in four ways: damage tissues and cause dermatitis, blood or body fluid loss, allergic reactions and create conditions for secondary bacterial infection [23].

**Host:** It affects different types of domestic animals, wild animals and also humans. Among this the Prostigmata (actinedide, possessing stigmata behind the gnathostome) and the Oribatide (cryptostigmata) are the main mange species that affect different mammalian species [24, 32]. All major mange mite species were contained within the orders Astigmata and Prostigmata. The Astigmata was a well-defined group of slow-moving, weakly sclerotized mites, including the families of medical or veterinary importance- Sarcopitidae and Psoroptidae. The Prostigmata was the most heterogeneous of acarine orders with adults ranging in size from 100  $\mu$ m to 16 mm [25]. Mange mite families included in the Prostigmata are Psorergatidae (*Psorobia* Spp.), Demodicidae (*Demodex* sp.) and Cheyletiellidae (*Cheyletiella* spp.) [24].

In general, most important mites of veterinary importance are grouped into two by considering them according to their location on the host as burrowing and non-burrowing mites [25, 26]. The non-burrowing mange mites, in contrast to the burrowing mange mite, do not form burrows in the skin. However, they infest animal skin and cause mange. These mites feed on lymph (clear body fluid) by puncturing the skin, or they feed on skin scales and debris. There are two important species of non-burrowing mange mites: *Psoroptes ovis* and *Chorioptes bovis*. *Psoroptes ovis* infests the skin of sheep causing infestations commonly called sheep scab. The entire body may be infested, but usually, the hairy areas are affected, particularly the back, shoulders and sides [6, 12].

The other important species of non-burrowing mange mite is *Chorioptes bovis*, which infests both sheep and goats. The veterinary term for infestation by these mites is chorioptic mange. Burrowing mites of the genus *Demodex* are microscopic cigar-shaped obligate parasites of mammals, including man and domestic animals that live in the hair follicles or sebaceous (oil) glands. *Sarcoptes* is another genus, well-known ectoparasite in both human and animals as a cause of mange, the disease in man generally known as scabies [22].

**Life Cycle:** The generalized life cycle of mites could be described as follows: mites mate and the females lay eggs; the eggs hatch and six-legged larvae emerge; these larvae feed and molt to the eight-legged nymph stage; later, after feeding, the nymphs molt and become adult male or female mites. This entire life cycle could take as little as eight days to as long as four weeks, depending on the species of mite and the temperature and humidity [27].

Table 1: Mites that cause mange in sheep and goats

Genus	Species		Disease
	Sheep	Goats	
<i>Sarcoptes</i>	<i>S. scabiei</i>	<i>S. scabiei</i>	Sarcoptic mange
<i>Psoroptes</i>	<i>P. ovis</i>	NR	Sheep scab
	<i>P. cuniculi</i>	<i>P. cuniculi</i>	Ear mange
<i>Chorioptes</i>	<i>C. bovis (C. ovis)</i>	<i>C. bovis (C. caprae)</i>	Chorioptic mange
<i>Demodex</i>	<i>D. ovis</i>	<i>D. caprae</i>	Demodectic mange
	<i>D. aries</i>	NR	Demodectic mange
<i>Trombicula</i>	<i>T. sarcina</i>	NR	Trombiculiasis
<i>Psorergates</i>	<i>P. ovis</i>	NR	Australim itch
<i>Kaillietia</i>	NR	<i>R. manfedu</i>	NP
	NR	<i>R. caprae</i>	NP
<i>Caloglyphus</i>	<i>C. berlesei</i>	NR	Contact dermatitis
<i>Acarus</i>	<i>A. farinae</i>	NR	Contract dermatitis

NR: Not recovered

NP: Not pathogenic

Source: [11]

The life cycle of sarcoptic mange mites is similar to different host animals. The mated female mites burrow deep into the skin and form a tunnel over an inch long where she feeds on lymph fluid (a clear body fluid) by piercing the skin. She lays 40 to 50 eggs in the burrow and then dies. Tiny, six-legged larvae hatch from the eggs, leave the female burrowed and wander on the animal's body. The larvae form new pocket-burrows in the skin, where they feed and molt to two succeeding nymphal stages. The nymphs may also move about and make new tunnels. Nymphs molt and become adult males or females, which mates [10, 22].

*Demodex* spp. live as commensals in the skin of most mammals including sheep and goat and exceptionally selects for particular skin site, the hair follicle and sebaceous glands. Most species spend their life cycle in the follicle or glands and spread when the animal immune system is compromised [12, 22].

### Epidemiology

**Etiology:** Several authors have reported the wide presence of various mange mites affecting small ruminants in different parts of the world. Mange mites with the potential of infesting these species of animals are summarized in the Table (2). The isolated mange mites of sheep in a survey in India included mites (*Sarcoptes*, *Psoroptes* and *Demodex* species) [29]. In Ethiopia varieties of mange mites belonging to four genera were reported to infest sheep and goats. Moreover, Fentanew [22] reported the occurrence of *Psoroptes communis* var. *ovis*, *Sarcoptes scabiei* var. *ovis* and *Demodex folliculorum* var. *ovis* in sheep and *P. communis* var. *caprae*, *Sarcoptes scabiei* var. *caprae* and *Demodex folliculorum* var. *caprae* in goats in the

administrative Region of Harraghe. Besides, Haffize [30] reported *psoroptes cuniculi* in sheep from central Ethiopia and Molu [31] identified *Chorioptes* spp. In goats around south rangelands of Oromiya.

**Mode of Spread and Occurrence:** The spread of mange was usually by close contact between clean and infested animals. Sarcoptic mange was highly contagious thus single cases are rarely seen in groups of animals kept together. The movement of keds from ewes to lambs in an important route of infestation [32]. Infestation by mites may also occur by indirect transfer since the mites are capable of surviving off the host. Inert materials such as bedding, blanket, grooming tool and clothing may act as carriers [10, 11].

The factors that influence the occurrence of the effects of mange mites can be classified into two groups; those controlling the prevalence of arthropods and those determining the susceptibility of the hosts [22]. Likewise, the levels of infestation of mites show seasonal periodicity. However, in contrast to flies and ticks, heavy infestations usually occur in the moist and cool temperatures of winter months and decline in the dry and hot conditions of summer. In summer, psoroptic mites take refuge in protected sites such as the axilla, eyes, ears, or even folds in the skin [11]. In addition to season and climate, those factors affecting the susceptibility of the hosts play a role in determining the effect of arthropod parasites [6, 12].

**Magnitude and Distribution:** Though mange mites were found widely distributed throughout the world, the frequency with which they occur varies from one area to the other. In Ethiopia, several studies have reported

Table 2: The prevalence of mange mite infestation in sheep and goats

Region	Prevalence %		Source
	Sheep	Goat	
North Ethiopia	NI	34.63	[33]
South Ethiopia	67.60	NI	[16]
South Ethiopia	NI	0.32	[36]
Central Ethiopia	32.81	NI	[19]
Central Ethiopia	2.63	3.96	[30]
North Ethiopia	30.30	31.08	[34]
South Ethiopia	1.25	4.07	[31]
North Ethiopia	0.40	6.70	[35]
East Ethiopia	0.73	6.83	[21]
East Ethiopia	7.85	11.81	[18]
South Ethiopia	2.07	4.27	[37]

various prevalence rates of mange mites of sheep and goats in different areas. *Sarcoptes* spp. and *Psoroptes* spp. were frequent among sheep and, *Sarcoptes* spp. and *Demodex* spp. were common among goats. Higher levels of infestations resulted from *Sarcoptes* spp. and *Psoroptes* spp. [16, 33, 34, 35].

**Pathogenesis and Clinical Features:** *Sarcoptes* spp pierce the skin, suck lymph and feed on young epidermal cells. Their activity causes marked irritation. There was intense itching and the animal rubs on hard surfaces and objects resulting in partial or complete alopecia. Alopecic patches are evident in the medial aspects of the rear limbs, axillae and on the brisket [10, 22]. The infection may also extend to the abdomen, udder and teats. Dry and bran-like scales are formed on the face, around the nostrils and ears. Later on, the scales transform into hard crusts which extend from the muzzle to the area between the eyes and nostrils; the region between the eyes and horns and, the inner and outer aspects of the ears. Cracks and fissures appear on the skin at the hock joint. The skin was thickened and wrinkled especially that of the scrotum and pinnae of the ears. Heavy dandruff was evident in hairy areas covering the neck and abdominal areas [27, 38].

*Psoroptes* spp are which was non-burrowing mites puncture the epidermis, suck lymph and stimulate a local inflammatory reaction. *Psoroptic* mange in goats is characterized by the accumulation of hyaline material in the external ear canal resulting in occlusion of the canal and deafness [22]. The skin of the pinna becomes wrinkled. Generalized lesions resembling sarcoptic mange may occur. *Psoroptes* spp infestation in sheep causes a highly contagious infection (also known as sheep scab) which is characterized by intense purities, restlessness, scratching and rubbing on objects and raised turfs of wool. Reddish or yellowish vesicles, pustules and papules

are formed and the exudates from papules result in the formation of crusts and matting of the wool. Letter on, tufts of wool fall leaving alopecic areas, which may cover the whole body. Thickening and cracking of the skin occur. Severely affected animals become, emaciated, anemic and may die due to exhaustion. Lesions first appear on the lumbar region and spread to other parts of the body [6,9].

*Chorioptic* mange in goats and sheep was characterized by intense erythema, itching, restlessness, scratching and rubbing which results in alopecia. Scales, crusts and wart-like growths, thickening and folding of the skin are common features. In goats, lesions appear on the interdigital clefts, coronet, muzzle, eyelids, udder, scrotum, anus and tail regions whereas in sheep lesions begin at the fetlock region and spread to the udder and scrotum [39].

*Demodectic* mange is rare in sheep and being mild in character. In goat formation of many pea-sized nodules, each containing caseous material and several thousand mites, which cause hide damage. The lesion initiated on the face and neck extend to and may involve the whole body, with the formation of a cutaneous nodule containing yellow creamy pus predisposed to secondary bacterial complication. Demodicosis decrease the cell-mediated immunity, which suppresses a normal T-lymphocyte responses and exhausts the immune compatibility of the animal [27, 40].

**Diagnostic Techniques:** The diagnosis of mange in small ruminants was based on clinical manifestations and the demonstration of mites or their developmental stages in skin scrapings [23]. Though the ELISA technique has been developed to monitor *Psoroptes* infestations of sheep, cattle and non-domesticated animals [38], none was currently commercially available. However, ELISA's are in routine use by researchers for the detection of specific antibodies to *S. scabies* [22, 27].

A firm diagnosis of scabies or mange must be based on the signs and identification of the large mites (e.g. psoroptes), but in most cases, it is necessary to take skin scrapings from the edge of visible lesions [10]. An indication of the presence of *Psoroptes* mites was the reaction of the host to scratching or rubbing of the affected skin by the operator, where it responds by a nibbling mouth reflex and/or scratching itself. The forced exercise followed by close penning will increase body heat and the associated percutaneous absorption of mite antigens/irritants inducing the presentation of clinical signs. Whereas in sheep lesions begin at the fetlock region and spread to the udder and scrotum [22, 39].

In diagnosing *Sarcoptic scabies*, wool or hair should be clipped and stored for the differential diagnosis of other ectoparasites or mycoses. The area selected for scraping should be the moist part or the edge of the lesion. If sarcoptic mange was suspected, the scraping should be taken from the hairless area or where pruritis or sheep (sheep scab), the areas selected were the edge of the progressing lesion [27].

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In general, for mites living on the skin surface (i.e. *psoroptes* or *Chorioptes*) scrapings should be taken with the scalpel blade held at an acute angle, shaving rather than scraping off the outer epidermis. *Demodex*, *Psorobia*, or *Sarcoptes* was found burrowing into the skin and the scalpel blade should be held at right angles and the skin scraped until it oozes blood. A drop of glycerine or liquid paraffin put on the skin or scalpel blade before the skin is scraped will aid in the collection of mites [27]. In pustular *demodectic* mange, mites are usually abundant and can be demonstrated on examination of the cheesy contents of an expressed or incised pustule. In the case of aqueous lesions, a deep scraping may be necessary [40].

**Identification of the Parasite:** Mange can be the result of infestation by the astigmatid mites, e.g. *Chorioptes*, *Psoroptes* and *Sarcoptes* or the prostigmatid mites, e.g. *Demodex* [22, 23].

**Astigmatid Mites:** The Astigmata are small thin-skinned mites, generally lacking obvious shields. Most mite species of small ruminants are in the division comprising Sacopitidae and Psoroptidae [23]. Sarcoptidae (sarcoptiform) mites are obligate parasites, burrowing into the skin of mammals. They are globose mites with the ventral surface flattened and the Cuticle finely striated. The chelicerae was an adapter for cutting and piercing [41].

The mite (*Sarcoptes scabiei*) was the cause of scabies, sarcoptic mange in humans and a wide range of domestic and wild mammals (Both carnivorous and

herbivores) throughout the world, generally affecting the sparsely haired parts of the body. The number of species within the genus are still open to debate. Studies of populations of *Sarcoptes*, mites from a wide range of hosts have suggested that there were only one type species (*Sarcoptes scabiei*) with some variants infesting a wide range of mammalian hosts [27]. An investigations based on molecular analysis of the rRNA gene suggest that the genus *Sarcoptes* was monospecific [41].

*Sarcoptes* can be identified based on size, shape and morphology. The body outline of adult mites was circular and approximately 250 um in length, but as ovaries develop in the female, she can increase in size to 3000 to 500um in length. The cuticle (integument) was striated, bearing a central patch of the raised tooth and peg-like structures on the dorsum that decreases in density postero- laterally. Legs were weakly developed and in both sexes, the pretarsi of legs I and II bear empodial claws but the ambulacral suckers were on long unjointed pedicles (stalks). The epimeres (apodemes) of the first pair of legs were fused in a 'Y' shape. Legs III and IV in the female (identified by the transverse egg-laying slit (oviparous) in the middle of the ventral surface) was short and end in long setae and lack a stalked pedicel. There were located on the ventral surface and are not visible in dorsal view. Males were smaller and distinguished by the presence of a stalked pedicel on legs IV, between which there was an obvious sclerotized genital apparatus. Nymphs were similar to the female, but smaller and without an oviparous. Larvae resemble nymphs but have only three pairs of legs. Secondary immune reactions may produce a rash at sites away from the infested area [12, 22].

Members of the family Psoroptidae was oval, non-burrowing mites, parasitic on mammalian skin. The cuticle (integument) was striated, legs III and IV are usually visible from Sarcoptidae, the epimeres (apodemes) of leg I are not fused and there are no vertical setae on the propodosoma [38]. The male had prominent adanal suckers that engage with the copulatory tubercles of the female tritonymph ('pubescent female'). The inverted U-shaped oviparous is prominent on the ventral of the ovigerous female, posterior to leg II. Two genera of the family Psoroptidae, *Psoroptic* and *Chorioptes* are common ectoparasite of small ruminants that causing psoroptic mange and chorioptic manage respectively [8, 12].

*Psoroptes* Spp. has strongly developed legs bearing, in all stages, funnel-shaped suckers on long three-segmented pedicels [25, 28]. The ovigerous mite is pearly white and 750 um in length. The male had a pair of

opisthosomal lobes and a pair of copulatory suckers. *Psoroptes* mites cause debilitating dermatitis involving wool/hair loss and a pruritic scab formation. Three species of *psoroptes* are recognized in small ruminants [42]: *Psoroptes ovis*, a body mite causing mange in sheep, *P. cuiculi*, the ear mite of goats and sheep and *P. Cervinus*, an ear mite of bighorn sheep, *P. cuniculi*, the ear mite of goats and sheep and *P. Cervinus* and ear mite of bighorn sheep. It is difficult to separate. *ovis* and *P. cuniculi* on morphological grounds. Like the genus *Sarcoptes*, the number of species in the genus *Psoroptes* was open to debate; *P. ovis* and *P. cuniculi* may be variants of the same species [22, 27, 38, 42].

Legs of *Chorioptes* mites have broad bowl-shaped ambulacra bone on very short unsegmented pedicles, except on legs III of the female, which terminate in two long setae. Ovigerous *C.bovis* is smaller than *psoroptes*, being 400um in length [25, 28]. The male *C.bovis* had pedicles on all four pairs of legs, a pair of squarish to rectangular-opisthosomal lobes and a pair of copulatory suckers anteriorly. The Opisthosomal lobes bear two spatulate (paddle-like) hairs, together with three normal states of varying lengths. The mouthparts are broad and rounded, adapted for chewing. *C.bovis* infests both goats and sheep and *C. texanus* had been recorded on goats. In goats, *C. texanus* generally inhabits the lower parts of the leg, as does *C.bovis* on sheep, on sheep, but in the latter case, the scrotum may also be infested and had been associated with infertility in ram [22].

**Prostigmatid Mites:** Prostigmatid mites were weakly sclerotized and the palpi were usually free and highly developed, either as pincer-like clasping or sensory organs. The chelicerae were usually modified for piercing [43].

*Demodex* is easily recognized by their annulate, vermiform ('worm-like') shape, but maybe overlooked on account of their small size 100-400 um. *Demodex* inhabit the hair follicles and the sebaceous glands of the skin of several wild and domesticated mammals, including humans. Male *Demodex* lives at or near the skin surface and females in the follicles. Different species occur on different hosts and more than one species may occur on the same host, e.g. *D. folliculorum* and *D. brevis* on humans [27, 43].

*Demodectic* mange was of great importance in goats and lesser importance in sheep. There was usually no irritation or pathological conditions, but in some individuals, the number and spread of mites on the hosts increase to form clinical demodicosis. Diagnosis of demodicosis was dependant on the recovery of mites from

deep skin scrapings. Mites can easily be identified as *Demodex*, but specialized keys are required for specific identification [9, 11].

**Differential Diagnosis:** The differential diagnosis of mange includes ringworm, dermatophilosis, contagious ecthyma, goat/sheep pox and scrapie. Circumscribed lesions that extend in a ringed fashion were characteristic of ringworm and the lesions. In fleece rot, there was no itching whereas, in strawberry footrot of sheep, a strawberry-like raw surface was evident after removal of the scabs. *Dematophilus congolensis* could be demonstrated in impression smears made from the undersurface of the scabs in fleece rot and strawberry footrot. Contagious ecthyma was characterized by large, hard and adherent scabs and, alopecia was not a common feature. In scrapie, itching was accompanied by muscle tremors and impaired locomotion, which was not observed in mange [6, 22].

**Treatment and Control:** *Sarcoptic* mange could be treated using ivermectin (0.2 mg/kg), 0.05% diazinon, 0.1% phoxin and 0.05% coumaphos [44]. Two applications of phoxim (0.05%) at 10 days intervals were effective against *chorioptic* mange and, permethrin (4%) could be used as a pour-on formulation. Propetumphos (0.005%) applied twice or thrice for 10 days interval had been used to treat *psoroptic* mange. Dipping with other insecticides was useful in the control of the parasites. Also, antibiotics were used to prevent secondary bacterial complications. Hygiene in houses and avoidance of overcrowding will minimize the accumulation and spread of the mites [8, 9, 22].

There were no commercial vaccines currently available to protect animals against mange mites [22]. The potential for the immunological control of *Psoroptes ovis* had been investigated for sheep [38, 40]. All these studies demonstrated that soluble fractions of *P.ovis*, under experimental conditions, significantly reduced the pathology of sheep scab and inhibited the *P. ovis* population increase [45].

## CONCLUSION AND RECOMMENDATIONS

Mange was one of ectoparasitic dermatitis reported in small ruminants. Those mange mites were which infest the body of animals is related to body condition and agroecology, which may have been indirectly related to the nutritional status of the animals. However, species of, age and sex of the animals were found unrelated to the prevalence of mange infestation in small ruminants.

In conclusion, further studies should be done to evaluate risk factors and the seasonal occurrence of mange in small ruminants in the area to devise effective control measures. Besides, several studies should also be conducted to assess the economic impact of mange in the productivity of small ruminants. Furthermore, the current good practice of spraying livestock with acaricide should be continued as it may have been one of the most important contributing factors for a lower prevalence rate of mange infestation in small ruminants of the area and may also contribute in the future control of ectoparasites.

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