ADDIS ABABA UNIVERSITY

FACULTY OF VETERINARY MEDICINE

INVESTIGATION ON ECTOPARASITES OF SMALL RUMINANTS IN SELECTED SITES OF AMHARA REGIONAL STATE AND THEIR IMPACT ON THE TANNING INDUSTRY

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TEFERA SERTSE DESTA

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DEBRE ZEIT, ETHIOPIA

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A thesis submitted to Faculty of Veterinary Medicine, Addis Ababa University in partial fulfillment of the requirement for the Degree of Master of Science in Tropical Veterinary Epidemiology

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ABBREVIATIONS

AAU	Addis Ababa University
BoA	Bureau of Agriculture
CACC	Central Agricultural Census Commission
CI	Confidence Interval
DVM	Doctor of veterinary Medicine
EEA	Ethiopian Export Agency
FAO	Food and Agricultural organization of the United Nations
FVM	Faculty of Veterinary Medicine
GDP	Gross Domestic Product
Km	Kilometer
masl	Meter above sea level
mm	Millimeter
MoA	Ministry of Agriculture
MSc	Master of Science
OAU	Organization of African Unity
°C	Degree Celsius
OIE	World Organization for Animal Health
OR	Odds Ratio
QSAE	Quality and Standards Authority of Ethiopia
UNIDO	United Nations Industrial Development Organizations
USD	United state Dollar
Vs	Versus
W	Wald Test
WoA	Woreda Office of Agriculture
χ^2	Chi-square Test

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ABSTRACT

The objectives of this study were to determine the prevalence of ectoparasites on sheep and goats, assess the effect of major ectoparasites on the quality of skin processed in the tanneries and identify the type and magnitude of defects that cause down grading and rejection in pickled sheep and wet blue goat pelts. The study was carried out through questionnaire survey, clinical examination and analysis of pickled and wet blue skin defects in Kombolcha and Dessei tanneries. Out of 752 sheep and 752 goats examined 50.5% of sheep and 56.4% of goats were found infested with one or more ectoparasites. The major ectoparasites identified on sheep were *D. ovis* (38.5%), *M. ovinus* (12.5%), tick infestations (3.4%) and *Linognathus* spp. (2.4%). The major ectoparasites recorded on goats were *Linognathus* spp. (28.3%), ticks (22.2%), sarcoptic mange (6.1%) and *Ctenocephalides* spp (8.1%). In sheep, there was significant difference ($p<0.001$) in prevalence of *M. ovinus* and *D. ovis*, between lowland and highland and midland and highland. There was also significant difference in prevalence of *Linognathus* spp. between midland and lowland ($p<0.01$) and tick infestations between lowland and midland ($p<0.01$), and between lowland and highland ($p<0.001$) but no significant difference ($P>0.05$) was detected in prevalence of sarcoptic mange and *Ctenocephalides* spp. In goats, the risk of sarcoptic mange infestation in lowland (Odds ratio (OR) =4.6, $p<0.001$) and midland (OR=5.0, $p<0.05$) was 4.6 times and 5.0 times, respectively higher than the highlands. There was also significant difference in prevalence of *Linognathus* spp between lowland and highland ($p<0.01$) and *Ctenocephalides* spp. infestations between midland and highland ($p<0.001$) and between midland and lowland ($p<0.001$) agro climate, the risk being higher in midland. Both in sheep and goats no significant difference ($p>0.05$) was recorded in prevalence of all ectoparasites except *D. ovis* infestation by age. *D. ovis* was found to affect more significantly ($p<0.05$) the adults (42.2%) than the young (29.9%) sheep. Analysis of body condition showed no significant variation ($p>0.05$) to ectoparasite infestation in sheep. However, poor body condition goats were 4.3 times at risk from sarcoptic mange (OR=4.3, $p<0.001$), *Linognathus* spp. (OR=2.1, $p<0.001$) and tick (OR=1.6, $p<0.05$) infestation than good body condition goats. The prevalence of *M. ovinus* was significantly higher in wooly sheep (41.2%) than wooly sheared (0.8%) and hairy (0%) indicating the importance of wool size for the parasite abundance. The prevalence of 'ekek' at pickled stage on each group of 20 pickled sheep pelts infested with *D. ovis* and *M. ovinus* and each group of 20 pickled goat pelts infested with sarcoptic mange and *Linognathus* spp. were 100% and 95% and 100% and nil respectively. However, the prevalence on apparently free control groups 20 sheep and 20 goat

pelts were 15% and nil respectively. There was a strong association ($p<0.001$) between 'ekek' and infestation of sheep with *M. ovinus* and *D. ovis* and infestation of goats with sarcoptic mange. Besides this, the severity of infestation of sheep with *D. ovis* and *M. ovinus* and goats with sarcoptic mange were found to correlate significantly ($p<0.05$) with severity of 'ekek' defect. Study on 1000 pickled sheep pelts and 1000 wet blue goat pelts indicated 'ekek' was the predominant defect both in pickled sheep (70.8%) and wet blue goat pelts (42.3%) followed by scratch, scars and technical defects. There was significant difference (OR=3.3, $p<0.0001$) in proportion of 'ekek' between pickled sheep and wet blue goat pelts. Moreover, a strong association ($p<0.001$) was observed between 'ekek' and scratch, and 'ekek' and scars both on pickled sheep and wet blue goat pelts. The economic loses due to drop in quality of exported skin in Kombolcha and Dessie tanneries because of 'ekek' was estimated to be 1.6 million for pickled sheep and 0.6 million for wet blue goat pelts per year. Favorable climates, poor level of management, poor awareness of farmers and poor animal health extension services are believed to have contributed for widespread occurrences of ectoparasites. The increasing threat of ectoparasites to small ruminant production and the tanning industry necessitate urgent control intervention.

Key Words: Ectoparasites, Skin defects, Skin Quality, Sheep, Goats, Tannery, Amhara Region.

1. INTRODUCTION

Agriculture is the mainstay of the Ethiopian economy. It employs over 80% of the adult population and account for 45% of the GDP and 85% of the export earnings (Asfaw, 1997). The livestock share of agricultural output in Ethiopia is about 40% (Kyomo, 1997). Small ruminants constitute about 30% of the total livestock population of Ethiopia (Gryseels and Anderson, 1983). The small ruminant population of Ethiopia is about 14.7 million sheep and 13.7 million goats (CACC, 2003). Self-sufficiency in food production, increases in rural income, and increase in foreign currency earning of the country through improving the quality and quantity of export items are among the main objectives of agricultural development policy in Ethiopia.

Small ruminants are important contributors to food production in Ethiopia, providing 35% of meat consumption and 14% of milk consumption (Asfaw, 1997). In central highlands, where mixed crop livestock production system is practiced, small ruminants' account for 40% of cash income and 19% of the household meat consumption (Zelalem and Fletcher, 1993). Owing to their high fertility, short generation interval and adaptation even in harsh environments, sheep and goats are considered investments and insurance to provide income to purchase food during seasons of crop failure and to meet seasonal purchases such as improved seed, fertilizer and medicine for rural household. Hides and skins account for 12-16% of the total value of exports (Asfaw, 1997). The current utilization of hides and skins is estimated to be 48% for cattle hide, 75% goatskin and 97% sheepskin with expected off take rate of 33%, 35% and 7% for sheep, goats and cattle respectively (Mahmud, 2000). The share of sheep and goat skin from total value of export is about 85% (EEA, 2004, personal communication). Besides these, wool and manure are also important products of small ruminant keeping.

Even though small ruminants are important components of the Ethiopian farming system, their contribution to food production, rural income and export income are far below the expected potential. This is because small ruminant production in Ethiopia is constrained by the compound effects of diseases, poor feeding and poor managements (Getachew, 1995).

Skin diseases caused by lice, keds, ticks and mange mites; are among the major diseases of small ruminants causing serious economic loss to small holder farmer, the tanning industry and the country as a whole. Skin diseases cause mortality, decreased production and

reproduction and down grading and rejection of skins. In addition to these, currently skin diseases caused by lice, keds and mange mites are affecting the tanning industry very seriously causing enormous down grading and rejection of skins and hides. According to tanneries report, skin diseases due to external parasite causes 35% sheepskin and 56% goatskin rejections (Bayou, 1998). Even though deterioration in quality of skin is evident from all parts of the country; Wollo was cited as providing the country's worst skin (Asfaw, 1998). The former Wollo include South Wollo, North Wollo, Waghimra and Oromiya zones of Amhara regional state.

The small ruminant population of Amhara region is estimated to be 5,320,330 million sheep and 3,815,859 million goats (CACC, 2003b), which represents 24.6% and 22.1% of the national sheep and goat population, respectively. A skin supply to the central market from Amhara region is estimated to be one third of the national production (ABoA, 1999). However, due to skin diseases the regional small ruminant production and productivity and skin quality have been affected seriously, and the problem is worse in drought prone parts of the region where the small ruminant populations constitute more than half of the livestock population and play a significant role in food security. According to Demissie *et al.* (2000) in some part of Amhara region bordering Afar, Tigray and the Sudan, skin diseases due to mange mites have prevented many farmers from keeping small ruminants and other parasitic skin diseases are common in many area of the region causing serious threat to sheep and goats production. But there are no detailed studies that indicate the types of parasites involved, their magnitude and their relative importance for the farmers and the tanning industries. The objectives of this study are therefore:

1. Determine the prevalence of ectoparasites on small ruminants in different agro climate;
2. Assess the effect of major ectoparasites on the quality of processed skin;
3. Identify the magnitude and type of skin defects due to skin diseases on the wet blue and pickled skin in tanneries.

2. LITERATURE REVIEW

2.1. Ectoparasite Host Relationship

Ectoparasites are organisms, which inhabit the skin or out growth of the skin of the host for various periods (Hopla *et al.,* 1994). The presence of external parasites on the host is termed as infestation. The association between arthropod ectoparasite and vertebrate hosts may take on variety of forms. In some cases the parasite may be totally dependent on the host, alternatively, the parasite may feed, or live only occasionally on the host, without being dependent on it (Wall and Shearer, 1997).

The host provides a number of important resources for the parasite, most vitally, the host supplies a source of food, which may be blood, lymph, tear or sweat or the debris of the skin, hair or feather. The host's body also provides the environment on which ectoparasites live, generating warmth, moisture and within the skin or hair; a degree of protection from the external environment. The host may also provide transportation from place to place for the parasite, a site at which to mate and, in many cases, the means of transmission from host to host (Wall and Shearer, 1997).

Despite a benefit of a close association with the host, there is a considerable variation in the amount of time spend on the host by various types of ectoparasites. Some ectoparasites such as many species of lice live in continuous association with their host throughout their life cycle and are therefore, highly dependent on the host. The majority of ectoparasites, however, has only intermittent contact with their hosts, and is free-living for the major portion of their life cycles. In some cases, ectoparasites, such as many species of mite, are highly host specific; only one host species is exploited and in some instances, the parasite can exist only on one defined area of the host. Other species are able to exploit a wider range of hosts (Wall and Shearer, 1997).

2.2. Ectoparasites Damage

As a result of their activity, arthropod ectoparasites may have a variety of direct and indirect effects on their hosts. The effect of skin parasitism usually depends on the size of invading

population, on the manner on which the parasite ekes out its existence and the state of nutrition of the host animal when infected (Peter, 1995). The damage ectoparasite inflict may be mechanical, but the situation is complicated also by host reactions to the presence of the particular parasite, their secretion and excretion (Peter, 1995). Young animals are generally more susceptible to ectoparasites because of higher ratio of accessible surface to the body volume and poor grooming behavior (Lehmann, 1993).

According to Wall and Shearer (1997), the direct and indirect harm caused by ectoparasites on the host includes;

- Blood loss: although each individual ectoparasite only removes a small volume of blood from a host, in large numbers the blood removed by feeding may be directly debilitating and anemia is common in heavily infested hosts. In one study in USA over 90 kg of blood was estimated to have been removed by ticks from a cow over a single season.
- Myiasis: the infestation of the living tissues with fly larvae causes direct damage to carcasses or skin.
- Skin inflammation and pruritus: various ectoparasite infestations cause pruritus, often accompanied by hair and wool loss (alopecia) and occasionally by skin thickening (lichenification). The presence of ectoparasite on or in burrowing into the skin can stimulate inflammation.
- Toxic and allergic responses: caused by antigen and anticoagulant in the saliva of blood feeding arthropod.
- Disturbance: the irritation caused, particularly by flies as they attempt to feed or oviposit, commonly result in a varieties of behaviors such as head shaking, stamping, skin twitching, tail switching or scratching. These activities may result in reduced growth and loss of conditions because the time spent in avoidance behaviors is lost from grazing or resting.
- Self wounding: the activities of particular ectoparasites, such as warble flies, may cause dramatic avoidance responses in the intended host, known as gadding. The madly panicking animals may cause serious self injuries following collision with fence and other objects.
- Social nuisance: large number of flies may breed in animal dung, particularly in and around intensive husbandry units. The activities of flies may cause considerable social problems. Adult flies and their feces may also decrease the esthetic appearance and

values of farm facilities and produce, such as hens' eggs, and cause irritation and annoyance to employees.

In addition to these effects, one of the most important roles of ectoparasites is in their action as vector of pathogens acting as either mechanical or / and biological vectors (Bay and Harris, 1988; Wall and shearer, 1997). The direct damage caused by most ectoparasites is directly proportional to their abundance. This is not the case, however, for disease vectors, where even very low numbers of infected vectors may cause considerable economic and welfare problems.

2.3. Major Ectoparasites of Small Ruminants

2.3.1. Sheep ked (*Melophagus ovinus*)

Keds are brown wingless biting flies about 6-7mm in length. Ked live their entire life cycle on the host but able to move from one host to another rapidly within the flock (Sewell and Brockesby, 1990). Adult keds are permanent ectoparasites and feed on the blood of sheep and sometimes goats.

A single egg is ovulated at a time. The egg hatches inside the body of the female and the larva is retained and nourished with in the female during its three larval stages, until it is fully developed and ready to pupariate (Bay and Harris, 1988; Wall and Shearer, 1997). The single larva is deposited on the host and pupates within a few hours. The larva is attached to the wool fiber some distance above the skin and many larvae and pupae are removed during shearing. The young keds usually emerges in 20-22 days but this period may be prolonged for up to 35 days in winter. The complete life cycle takes 5-6 weeks in optimum warm conditions. Young female may mate several hours after emergence but their ovaries are not mature until they are, 6-7 days old, and the first larvae is not deposited until they are 12-14 days old (Bay and Harris, 1988). The female ked live for 4-5 months and lays 10-15 larvae during this time (Radostits *et al.*, 1994) thus build up of infestations is slow.

The parasite is mainly seen in colder and wetter areas and infestations may be lost when sheep are moved to hot dry areas. Keds are most active in cooler months and are common on coarse rather than fine woolen breeds. Sheep in poor conditions suffer most from infestation and

goats may also be infested. Resistance is acquired in time and resistant sheep grow better and produce more wool. Keds dislodged from the host can live for up to 2 weeks in mild moist condition but most die in 3-4 days and probably do not play a part in re-infestation of sheep (Radostits *et al.*, 1994).

The spread of sheep keds is mainly through contact and the movement of keds from ewe to lamb is an important route of infestation (Wall and Shearer, 1997). The predilection sites of infestation are the neck, around the tail and ventral part of the body (Urquhart *et al.*, 1996).

Although the degree of infestations usually encountered cause only irritations (Radostits *et al.*, 1994), the resulting scratching, biting, and rubbing themselves against fences, stones, shrubs, and other things causes severe damage to the skin and wool (Urquhart *et al.*, 1996). Furthermore, both sexes are blood feeders and feed several times each day and therefore very heavy infestations may cause sever anemia (Sewell and Brockesby, 1990; Urquhart *et al.*, 1996). Skin puncture made by blood sucking keds cause development of "cockles" in the finished sheepskin (Health *et al.*, 1995b; Bayou, 1998). Cockle is an inflammatory response of the skin to the presence of keds and their saliva which is recognized after the wool or hair has been removed from the skin. Staining of the wool by the feces of the keds reduces its value and gives it a peculiar musty odor (Radostitis *et al.*, 1994; Wall and Shearer, 1997). The keds may transmit *Trypanosoma melophagium* and the *Ricketsia melophagi*, which are harmless blood parasites of the sheep.

The total annual devaluation of sheepskins in the USA due to cockle is estimated at about US$ 4 million and the overall losses in USA due to keds are estimated to be about US$ 40 million per year (Wall and Shearer, 1997).

2.3.2. Louse Infestations

The lice belong to the order *Phthiraptera* which is divided into four suborders; *Anoplura, Amblycera, Ischnocera and Rhynchophthirina*. *Rhynchophthirina* is a very small sub order that include just two species, one of which is a parasite of elephants and the other warthogs. *Amblycera* and *Ischnocera* are known as chewing lice while *Anoplura* are derscribed as sucking lice (Wall and Shearer, 1997). Both biting and sucking lice affect small ruminants. The important species in sheep and goats are found in the genus *Damalina* and *Linognathus*.

Lice usually are unable to survive for more than 1-2 days off their host and tend to remain with a single host animal throughout their lives. Most species of louse are highly host specific and many species specialize in infesting only one part of their host body (Wall and Shearer, 1997) and transfer to new hosts is by body contact, particularly under condition of close confinement (Sewell and Brockesby, 1990; Peter, 1995). To allow them survive as permanent ectoparasites, lice show a number of adaptations which enable them to maintain a life of intimate contact with their hosts. They are small insects, about 0.5-8 mm in length, dorsoventrally flattened, wingless and possess stout legs and claws for clinging tightly to fur, hair and feathers. They feed on epidermal tissue debris, parts of feathers, sebaceous secretions and blood (Wall and Shearer, 1997).

Life cycles of all lice are similar (Peter, 1995; Radostits *et al.*, 1994). In their life cycle, lice hatch from the eggs (nymphs) are tiny replicates of the adults, they change several times but under go only minor changes in appearance (Sewell and Brockesby, 1990; Bowman and Lynn, 1999). The eggs are laid attached to the coat fiber and there are three nymphal stages before mature lice appear. The life cycle of most species varies from 2-4 weeks under optimum conditions.

Lice respond to warmth, humidity and chemical odors. Many receptors are located on the antennae but heat and humidity receptors are located over the entire body. Lice have a tightly defined band of humidity and temperature preference and respond to humidity and temperature gradients by showing increased rates of turning in favorable microclimates which tend to keep them in favorable areas (Wall and Shearer, 1997). When temperature is cooler than optimum, eggs do not develop while hotter temperature prevent egg laying and kill the lice (Radostits *et al.*, 1994). In addition, they usually move away from direct light towards dark objects (Wall and Shearer, 1997). In the flock, there are often carrier animals that stay heavily infested all year round (Urquhart *et al.*, 1996).

The effect of lice is usually a function of their density. A small number of lice may present no problem and in fact may be a normal part of skin fauna. However, they have massive potential for increase (Wall and Shearer, 1997). All species cause irritation of the skin and stimulate scratching, rubbing, and licking leading to restlessness, damage to the fleece and skin and milk production. The saliva and feces of the lice contains substances, which are capable of

causing allergies, giving rise to severe irritations, followed by the skin thickening and sometimes self trauma (Peter, 1995).

While there is disagreement on the effect of lice on the weight gain, animals in poor conditions, improperly fed and exposed to cold and debilitating diseases carry heaviest infestations. Such animals may benefit from removal of the lice while animals in good conditions and well fed may not show increased weight gain after treatment (Radostits *et al.*, 1994). Reduction in the value of the wool clip is economically the most important consequence of ovine pediculosis, but additional hazards in warm countries is that the fleece and skin damage by the rubbing and soiled by louse feces, is an attractant for blow flies strike (Urquhart *et al.*, 1996).

2.3.2.1. Damalina

There are a number of morphologically similar host specific species, the species that affect small ruminants are *Damalina ovis* on sheep; *Damalina caprae, Damalina limbata and Damalina crassiceps* on goats. The sheep chewing lice, *Damalina ovis,* is one of the most common lice found on sheep. It is a small species, about 1 mm in length, pale colored louse that have a rounded head with a pair of three segmented antennae (Bay and Harris, 1988; Wall and Shearer, 1997).

D. ovis has typical life cycle. The female deposits about two eggs, attached to the wool or hair next to the skin by a viscid substance, every three days. The egg hatch in 9 - 10 days, and the nymph matures in about 21 days (Bay and Harris, 1988). Infestations with *D. ovis* occur over all areas of the body but the upper sides of the animal are favored. This species move rapidly over the wool fiber but is usually found near the skin (Bay and Harris, 1988).

Being highly active, *Damalina ovis*, is usually considered to be most pathogenic in sheep and it can cause great irritation so that the sheep are restless and have their grazing interrupted. Exuded serum from the bite wounds cause wool matting. Rubbing leads to wool loss. Wound may attract blowflies (Wall and Shearer, 1997). Like keds, *D. ovis* is also associated with the development of cockle (Heath *et al.*, 1996).

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2.3.2.2. Linognathus

Out of more than 50 species of *Linognathus* described, six occur on domestic animals the species that parasitize sheep and goats includes; the face louse *Linognathus ovillus*, the foot louse, *linognathus pedalis;* the goat sucking louse, *Linognathus stenopsis;* and the closely related species, *Linognathus africanus* on sheep and *Linognathus stenopsis* and *Linognathus africanus* on goats (Wall and Shearer, 1997).

In species of *Linognathus* the thoracic sternal plate is absent or weakly developed. Paratergal plates are absent from the abdomen (Wall and Shearer, 1997). Adult female lay a single egg per day. Eggs hatch in 10- 15 days; giving rise to nymph which requires about 2 weeks to pass through three nymphal stages. The egg to adult life cycle requires about 20 – 40 days (Wall and Shearer, 1997).

The face louse, *L. ovillus*, usually occurs in colonies on the ear and face of sheep. The preferred sites for *L. pedalis* are the feet, legs and scrotum. At high densities however, both species may spread over the entire body. *L. pedalis* can survive for several days off the host. So the infestation may be picked up of contaminated pasture (Wall and Shearer, 1997).

The damage caused is due to irritation which interferes with feeding causing decreased weight gain, scratching result in wool loss, cuts and bruises. Excretion of the lice soils the wool. In goats, the blood sucking species are more injuries than the biting lice because they may cause the formation of scabby, bleeding area (Bay and Harris, 1988). Sucking lice are also notorious for transmission of typhus and relapsing fever for humans (Sewell and Brockesby, 1990).

2.3.3. Mange mite

The ectoparasitic mites of mammals and birds inhabit the skin, where they feed on blood, skin debris or sebaceous secretions, which they ingest by puncturing the skin, scavenging from the skin surface or imbibe from epidermal lesions. Most ectoparasitic mites spend their entire lives in intimate contact with the host. Infestation by mites is called acariasis and can result in sever dermatitis, known as mange. Mange is a widespread and most important ectoparasitic disease of animals, which may cause significant welfare problems and economic losses (Wall and Shearer, 1997).

In their life cycle female mites produce relatively large eggs, from which a small, six legged larva hatch. A few species are ovoviviparous, producing live offspring. The larva moults to become an eight-legged nymph. There may be between one and three nymphal stages, known as the protonymph, deutonymph and tritonymph. At least one of these nymphal stages is usually inactive and development proceeds without feeding. The nymph then moults to become adult (Wall and Shearer, 1997). The number of egg produced per female is highly variable but lifetime reproduction output may be as low as 16 eggs per female. Nevertheless, the life cycle of many parasitic species may be completed in less than 4 weeks and in some species may be as short as 8 days. Hence these mites have the potential for explosive increases in their population size (Wall and Shearer, 1997).

The transmission of mange mite from host to host is primarily by physical contact and all the three stages: the larvae, the nymph and the adult are capable of migrating and inert materials such as bedding and grooming tools can act as a carrier. Adult mites do not usually survive more than two weeks away from the host, but in optimum conditions, they may remain alive for up to three weeks (Radostits *et al.*, 1994).

High temperature, humidity and sunlight favor mange mite infestations (Pangui, 1994). Problems with mite infestations and dramatic increases in mite populations occur more commonly in animals in poor condition and more often seen at the end of winter or in early spring. Some forms of mange such as demodectic mange, are the result of underlying diseases or immunosuppression (Wall an Shearer, 1997). The disease affects all age groups and runs a more chronic course in adults than younger animals. According to Wall and Shearer (1997), the effects of mite infestations are:

- direct epidermal damage leading to inflammation; this result in skin erythema, pruritus, scale formation, lichenification (thickening) and crust formation (inflammatory exudates) formation;
- the production of cutaneous hypersensitivity (especially type 1 hypersensitivity);
- loss of blood or other tissue fluid;
- Mechanical or biological transmission of pathogens.

The clinical signs of erythema, pruritus and scale or crust formation are due to the inflammatory response of the skin and resulting excoriation. This response is stimulated by feeding, burrowing or the production of antigenic material by the mite (Wall and Shearer, 1997).

Mange cases due to *Sarcoptes* and *Psoroptes* are often fatal. The mortality rate is higher in younger and in poor condition animals (Sewell and Brockesby, 1990; Olubunmi, 1995). Death may be due to dehydration, a direct result of the feeding of huge number of mites, inability to move and feed due to severe lesions on the face, muzzle and on the joints or to secondary cases such as pneumonia or bacterial septicemia introduced through self inflicted bite and scratch wounds (Roberts and Meleney, 1971). In infections, which do not end fatally, a marked regression of lesions, with healing of the skin and re-growth of the wool or hair occurs during dry season. Exposure of lesion and mite to direct sunlight and desiccation may reduce the survival potential of mite populations. The major species that cause mange in small ruminants belongs to the four genera of mite, namely *Sarcoptes, Psoroptes, Chorioptes* and *Demodex*

2.3.3.1. Sarcoptic Mange

Sarcoptic mange occurs in all species of animal and is caused by mite *Sarcoptes scabiei* that has a number of host adapted sub species, distinguished by presence or absence of patches of dorsal and / or ventral spine, that affect different hosts but this host specificity is not complete and transference from one host species to another can occur (Radostits *et al.*, 1994). *Sarcoptes* may be transmitted to unusual host in which it might borrow in to the skin and set up a typical mange lesion (Ibrahim and Abu-samra, 1987). Fain (1968) as cited by Ibrahim and Abu-samra (1987), reported that the frequent interbreeding of mites in zoological remote mammals has on the other hand prevented speciation and on the other hand provided new genetic characters which have enhanced the adaptability of the mite to infest other hosts.

Sarcoptes mites are economically the most important cause of mange in goats but rare in sheep. Sarcoptic mange in sheep and goats is caused by *Sarcoptic scabei var ovis* and *Sarcoptes scabei var capri* respectively (Okoh, 1982; Olubunmi, 1995). Sarcoptic mites are highly specialized for life with in the skin. Female mites burrow into the skin and lay eggs in tunnels they made. Mating takes place on the surface of the skin (Sewell and Brockesby, 1990). The life cycle from egg to egg laying female may take 10-14 days (Radostits *et al.*, 1994). The feeding activity of *Sarcoptes* causes intense itching and scratching due to a marked irritation, which causes self inflicted lesions that aggravates the conditions (Jackson, 1991). Sarcoptes mange usually start on relatively hairless part of the skin and may latter generalize (Bowman and Lynn, 1999). The course of Sarcoptic mange is rather more acute

than the other forms of mange and may involve the entire body surface in a short time (Radostits *et al.*, 1994).

Sarcoptic mange is highly contagious and the spread of *S. scabiei* is usually by close physical contact. As a result single cases are rarely seen in groups of animals kept together. Infestation may also occur by indirect transfer, since the mites have been shown to be capable of surviving off the host for short periods. The length of time that *S. scabiei* can survive off the host depends on environmental conditions but may be between 2 and 3 weeks (Wall and Shearer, 1997).

Sarcoptic mange was noticed throughout the year but the incidence was higher during the wet cold months where the moistness and temperature is optimum condition for mites' development (Olubunmi, 1995).

2.3.3.2. Psoroptic Mange

Psoroptic mange, known as sheep scab, is highly contagious disease of sheep and goats. It is caused by the mite, *Psoroptes ovis* in sheep and *Psoroptes caniculi* in goats. The mite migrates to all part of the skin and prefers areas covered by wool or hair. The whole life cycle is completed in 3 weeks (Soulsby, 1982). Infestation by these mites is always superficial on the epidermis, but the piercing of the skin by the mites lead to exudation and exfoliation, causing scabs to form (Sewell and Brockesby, 1990). In sheep, the cutaneous lesions may occur on any part of the body, but characteristically in badly affected sheep, they are most obvious on sides. In goats, lesions can vary from a dry crusty scab on the external ear canal with no clinical signs to severe lesions covering much part of the body and causing death (Jackson, 1991).

Sheep scab can affect sheep of all ages but may be particularly severe in young lambs. Mites are usually more active in winter and the oviposition rate is higher at lower temperatures. In summer the disease progress more slowly, lesions are not obvious and can be missed. The disease can become latent in summer, apparently disappearing, with mites taking refuge in protected sites (Wall and Shearer, 1997). Some observers suggest that infra-orbital, inguinal pouches, scrotum, under tail, ears, inter digital pouches, perineum, and skin folds are foci for

mites and serve as potential dry season hiding places where the mites tend to migrate to the general body surface with the onset of cold season (Roberts and Meleney, 1971).

The short life cycle can contribute to a very rapid build up of *P. ovis* populations. Scab mites are spread by direct contact and can survive for a period of up to 10 – 14 days off their hosts (depending on the environmental conditions), allowing clean animals to become infested from contaminated housing (Wall and Shearer, 1997).

2.3.3.3. Chorioptic Mange

Chorioptic mange (tail, leg, scrotum mange) those on cattle, horse, and goats and sheep are now considered to be one species; *Chorioptic bovis* (Radostits *et al.*, 1994). The life cycle of *Chorioptic bovis* is similar to that of *Psoroptes* and is completed in 3 weeks and transmission is by direct contact and contaminated materials, but *Chorioptes* does not survive off the host for more than a few days (Peter, 1995). In goats, lesions of these conditions are usually confined to lower part of the leg and crusty lesions may be found behind fetlock of all four limbs (Jackson, 1990). In sheep, it affects the scrotum and may cause decrease in fertility (Radostits *et al.*, 1994).

2.3.3.4. Demodectic Mange

Demodectic mange mites of *Demodex species* infest hair follicles of all species of domestic animals. *Demodex* live as commensals, embedded head down hair follicle, sebaceous and meibomian glands of the skin where they spend their entire lives. For the most part they are nonpathogenic and form a normal part of the skin fauna. Species of *Demodex* are unable to survive off their hosts (Wall and Shearer, 1997). The disease cause little concern. But in cattle, there may be significant damage to the hide and rarely death due to gross secondary bacterial invasion. The disease may also be severe in goats. The important signs of the disease in goats are the appearance of small nodules and pustules which may develop into larger abscesses from which large number of *Demodex* mites may be expressed (Jackson, 1991). The disease spreads slowly and transfer of mite is through contact probably early in life (Radostits *et al.*, 1994).

2.3.4. Tick Infestations

Ticks are obligate, blood feeding ectoparasites of vertebrates, particularly mammals and birds. They belong to three families *Ixodidae*, *Argasidae* and *Nutelielidae*. *Ixodidae*, kown as hard ticks, contain almost all the species of ticks of veterinary importance. The second family, *Argasidae* known as soft ticks, contains relatively small number of species of veterinary importance (Wall and Shearer, 1997; Okello-onen *et al.*, 1999). Ticks are primarily parasites of wild animals and only about 10% of species feed on domestic animals, primarily sheep and cattle (Wall and Shearer, 1997).

Ticks are vectors and potential reservoir of infectious diseases, tick bite may be directly debilitating to domestic animals, causing mechanical damage, irritation, inflammation and hypersensitivity and, when present in large numbers, feeding may cause anemia and loss of production (Radostits *et al.*, 1994; Wall and Shearer, 1997). Some species cause tick paralysis and it is possible that others will elaborate toxins other than those causing paralysis. Heavy tick burden cause sufficient worry to interfere with feeding which may lead to loss of production and weight gain. They also cause greater morbidity and mortality during periods of drought, and delays in fattening so that animals are held longer before they can be sold (Radostits *et al.*, 1994).

Ticks cause damage to hide and skin. Damage on sheep skin is primarily found along the belly area or where the fleece is thinner. Lamb skins are particularly susceptible to skin damage. Secondary bacterial infection of the bite increases the severity of the damage. Skin injuries can attract blowflies and screwworm flies that deposit eggs on the wound and produce a fatal, cutaneous myositis (Bowman and Lynn, 1999). Ticks produce marks that look like hole, pinpricks on the grain or scars that mostly occur in the belly (Soulsby, 1982).

Although many ticks favor a particular host, they are usually not completely host specific and may parasitize a wide variety of animals. The life cycle of ticks vary widely. Some species pass their entire life on the host, others pass different stages of the life cycle on successive hosts, and others are parasitic only at the certain stages. Most ticks spend more time off the host, but are totally dependent on the host for sustenance. They are subjected to microenvironment condition when on the ground and thus tend to be more endemic in specific types of area. Ticks can exist for a very long period of time without feeding (Peters, 1995).

2.3.5. Blowfly Strike (Cutaneous Myiasis)

Myiasis is the infestation of the organ or tissue of the host animal by the larval stage of dipterous flies, usually known as maggots or grubs. Myiasis of sheep and goats may be caused by screwworm flies; *Cochliomyia hominivorax* (Nearctic and Neotropical region), *Chrysoma bezziana* (Afrotropical oriental regions) and *Wahlfrtia magnifica* (eastern palaearctic) and genera of *Lucillia, Calliphora, Pharmia* and *Protophormia.* Cutaneous myiasis of goats by species of *Lucilia,* or other *Calliphoria* blowflies is less common than in sheep, probably because of the more open hair of sheep (Wall and shearer, 1997). The fly larvae feed directly on the host's necrotic or living tissue (Bay and Harris, 1988; Wall and Shearer, 1997).

The life cycle of blowflies pass through four stages: egg, larvae, pupa and adults. Though the species have similar life cycle, the stages vary in period length. Under favorable conditions of food, temperature and moisture, the entire life cycle is completed in 10 to 20 days (Kimberling, 1988).

In sheep, screwworm myiasis occurs largely as a consequence of skin damage due to trauma; shearing, tail-docking or castration wounds. The main predisposing host factors for sheep myiasis by species of *Lucilia* are fecal and urine soiling, bacterial dermatitis (especially dermatophilosis) and foot rot (Kimberling, 1988; Wall and shearer, 1997).
The direct pathological effect of myiasis may vary considerably and depends on the species of ectoparasite, the number of larvae and the site of infestation. In many cases infestation by small number of fly larvae may have little or no discernible clinical effects ranging from irritation, discomfort and pruritus, resulting in reduced feeding, weight loss, reduced fertility and loss of general conditions. However, heavy infestation may lead rapidly to host death from direct tissue damage, hemorrhage, bacterial infection, dehydration, anaphylaxis and toxemia (Wall and Shearer, 1997). Myiasis from a range of species also has been shown to produce a marked immunological response in the host and the maggots produce enzyme that digest the skin and produce large open wounds (Kimberling, 1988). The wound secretions then attract further flies. Open wounds produced cause severe scarring of the skin, which grossly affect the appearance of the final leather.

2.4. Diagnosis of Parasitic Skin Diseases

In making a diagnosis of ectoparasitic infestation or an ectoparasite associated dermatosis it is important to have an idea of the parasite involved and its life cycle. Some parasites live in intimate relationship with the host's skin, however, visiting parasites, may be on the skin only for a short period of time and a diagnosis is often made by implication. Hence a working knowledge of the clinical sign of the skin diseases is usually also required (Wall and Shearer, 1997).

The ideal approach to diagnosis of skin diseases is a logical progression from history to an overall clinical examination, to a detailed examination of the skin, and finally to confirmatory testing or diagnosis by response to treatment (Jackson, 1991; Smith and Sherman, 1994).

2.4.1. History

According to Jackson (1991), the main points to be noted during history taking includes: Date when symptoms first appeared, symptom observed by the owner, contact with other flock, spread with in the flock, previous health history of affected animals, other disease problems with in the flock past and present, response to treatment (including home remedies) so far and detailed management including feeding worming, etc.

2.4.2. Clinical Examination

Simple observation allows identification of most external parasite infestations and clinical signs of skin diseases, thus many conditions can be diagnosed with reasonable certainty (Smith and Sherman, 1994). The entire skin surface of the patient should be examined for parasites and lesions and the elasticity of the skin, its temperature, thickness, color and consistency should be noted and response of the animal to palpation of affected area should be observed (Jackson, 1991). The appearance and location of lesions are the basis for diagnosis. The primary lesions include papules, vesicles, pustules and nodules. Secondary lesions such as scales, crusts and alopecia are the result of self trauma or superimposed bacterial infections (Smith and Sherman, 1994).

During clinical examination unidentified external parasites or their eggs are collected, fixed and stored in 70% alcohol or 10% formalin and identification can be made with the help of an identification key (Soulsby, 1982). Many of the larger ectoparasites, such as blowfly larvae and ticks, may be collected directly of the host using appropriately sized forceps. Small specimens may be pickled up with the end of moistened paintbrush. Unattached mites and ticks can be removed by combing or brushing of the host anima over a white enamel tray or sheet of paper. Brushing over moistened white blotting paper or paper towel may help to identify flea infestations (Wall and Shearer, 1997).

Hairs collected by coat brushing and plucking should be mounted in a mineral oil, such as liquid paraffin, and examined microscopically for evidence of ectoparasites. Eggs of some parasites, such as lice may be found attached to the hair shaft and adult ectoparasites, such as lice and various mites, may be also found by this method. The hair bulb and lower third of the shaft should be examined for evidence of follicular mite *Demodex*. In cases of alopecia it may be useful to examine the upper portion of the hair for evidence of fracture, which occurs with self-induced alopecia due to pruritus (Wall and Shearer, 1997).

To insure that the mouth pars are not left behind, embedded living ticks may be removed most effectively by dabbing the ticks and the surrounding skin with alcohol. This relaxes the tick, allowing it to be pulled out intact. Alternatively, the tick ca be covered with a layer of petroleum jelly, which prevent respiration and, after about 30 minutes, the tick will drop off (Wall and Shearer, 1997).

2.4.3. Acetate Strip Examination

Short strip of acetate tape (e.g. Sellotape or Scotch 3M tape) can be applied repeatedly to either the hair coat or clipped skin surface. Material and parasites in the coat or in the surface of the skin become attached to the tape which is then mounted onto the glass slides and examined microscopically. This is a useful technique for identifying mites (Wall and Shearer, 1997).

2.4.4. Skin Scraping Examinations

Examination of skin scrapings is essential in the diagnosis of mange. In longstanding cases mites are often very few in number and extremely difficult to find and their absence from the skin scraping doesn't negate a diagnosis (Jackson, 1991). Multiple sites should be scrapped to increase the likelihood of ectoparasite detection. Superficial skin scraping (epidermal surface examination) after removing coat hair by gentle clipping can be used to identify surface mites while deep skin scraping (deep epidermal examination) until capillary ooze occurs is useful in the diagnosis of burrowing and follicular mites such as *Sarcoptes scabiei* and *Demodex spp.* (Wall and Shearer, 1997).

A few drop of 10% potassium hydroxide solution or liquid paraffin are added to the sample, a cover slip applied and cleansing of debris allowed to proceed for 15-30 minutes before microscopic examination. Large samples may be processed by boiling 10 minute in 10% potassium hydroxide solution, centrifuging and performing sugar flotation on the sediment (Smith and Sherman, 1994).

2.4.5. Collection of Free Living Ectoparasites

Mobile free living mites, ticks and fleas can be extracted from bedding, nests and fecal material by careful search or by shaking the material through a tier of sieves of decreasing mesh-size. They may be swept from vegetation using a hand net. Most commonly used for collecting ticks, however, is a blanket drag. This is a woolen blanket or cotton towel, about 1m square, attached to a bar at one side. The drag is pulled across low-lying vegetation and questing ticks attached to the cloth (Wall and Shearer, 1997).

Adult flies can be collected using hand nets, usually consisting of a deep bag of fine mesh netting with a circular, wire stiffened, opening on a pole. Flies may be picked off as they visit their host or baits of rotting carrion or feces, using either a hand net or, more simply, by inverting a glass tube over them as they feed or rest (Wall and Shearer, 1997).

2.4.6. Biopsy and Histopathology

Although these indirect techniques are not as useful as direct identification for the diagnosis of ectoparasite dermatosis, they may be valuable in some circumstances, such as insect and arthropod bite lesions (Wall and Shearer, 1997). Small whole thickness strips of skin 25mm*5mm are taken from normal and abnormal area and the skin strip should be fixed in formol saline (Jackson, 1991).

According to Wall and Shearer (1997), histological changes often associated with ectoparasites include:

- an eosinophil-rich dermal infiltrate;
- collagen degeneration usually associated with dermal eosinophil infiltration;
- focal dermal necrosis, which occur in tick bite lesions;
- eosinophilic pustule formation, which occur in cases of flea bite dermatitis and *Sarcoptes scabiei* infestations.

2.4.7. Serology

An enzyme linked immunosorbent assay (ELISA) techniques have been developed to monitor *Psoroptes* infestations of sheep, cattle and non domesticated animals, but none is in routine use. ELISAs are in routine use by researchers for detection of *Sarcoptes scabiei* (OIE, 2002).

2.5. The Status of Small Ruminant Parasitic Skin Disease in Ethiopia

Reports on skin diseases of small ruminants in Ethiopia are scanty and if present are also very fragmented. Studies conducted at various localities of the country and tanners report on magnitude of skin pelts damage due to skin disease especially ectoparasites indicate that small ruminants skin disease are becoming growing threat for small ruminants production and export of skin in Ethiopia. The main parasitic skin diseases reported in Ethiopia are:

Mange

Mange of small ruminants was reported from different areas of the country with different magnitude ranging from 0 % to 7.85 %in sheep and 3.96 % to 11.8% in goats. Higher prevalence up to 67.7 % in sheep and up to 31.8 % in goats was recorded but these are prevalence on animals with visible skin lesions (Table 1).

Table 1. Overall prevalence of mange in different areas

Location	Prevalence in %		Source/year
	Sheep	Goats	
Hararghe	7.85*	11.8	Tekele, 1986
Bale Robe	67.7*	**	Ashine, 1987
Addis Ababa	32.7*	**	Kebede, 1992
DireDawa	0.73	6.8	Tadesse, 1994
Mekelle	1.5	**	Gaime, 1994
Wolayta	0	6.87	Nigussie, 2001
Central Ethiopia	2.69	3.96	Mohammed, 2001
Sidama zone	2.07	4.27	Worku, 2002
Selected zone of Tigray	30.2*	31.8*	Musema, 2002

*Study on animals with visible skin lesion

** The study do not include the species

The disease was reported to occur in lowlands and midlands of 59 Woredas of Amhara region (Demissie *et al.*, 2000) and has become an important disease causing a loss of up to 93% of the small ruminants in Yeku water shade development project area of Amhra region (Mekonnen *et al.*, 1999). For this reason, lack of small ruminant flock was identified as top ranking problem of the area. According to Demissie *et al.*, (2000) the incidence of mange has increased during the past 10 years to a level preventing farmers from keeping sheep and goats in some areas of Amhara region bordering Afar, Tigray and Sudan.

Different species of mange mite were recorded from different part of the country. Of the mange mite affecting sheep and goats, *Sarcoptes* is the most prevalent species in Ethiopia (Sherman, 1998). *Sarcoptes* was reported to have prevalence of 2.37 % in goats and 0.44% in sheep in Sidama zone (Worku, 2002); 6.13% in goats and 0% in sheep from Wolayta

(Nigussie, 2001). From clinically diseased animals with visible skin lesion the prevalence of *Sarcoptes* was 33.27% in goats from Kombolcha (Abdulhamid, 2001); 4.46% in goats and 2.33% in sheep from Hararghe (Tekele, 1986); 30.3% in sheep and 31.8% in goats from Tigray (Musema, 2002) and 52.2% in goats &0% in sheep in Diredawa (Tadesse, 1994).

Records for Psoroptic mange were 0.95% in sheep and 1.63% in goats in Sidama zone (Worku, 2002); 2.59% in goats & 1.8% in sheep in central Ethiopia (Mohammed, 2001). Relatively higher prevalence of 6.15% in goats & 4.67 % in sheep from Harrarghe (Tekele, 1986), 67.6% in sheep from Bale Robe (Ashine, 1987), and 32.87%from Addis Ababa (Kebede, 1994) was recorded. However, these are from clinically skin disease affected animals.

Demodectic mange was reported to occur in Sidama at 0.95% (Worku, 2002) and in Wolayta at 0.74 %(Nigussie, 2001) in goats, in central Ethiopia 1.37% in goats and 0.8% in sheep (Mohammed, 2001), in the southern range land of Oromia 3.5% in goats and 0.88% in sheep (Nura, 2002) and in Harrarghe 0.99% in goats and 0.84% in sheep (Tekele, 1986).

Lice

Lice infestations in small ruminants were reported with overall prevalence of 1.52% in goats and 2% in sheep (Mohammed, 2001) from central Ethiopia; 0.52% in goats 0% in sheep (Nura, 2002) from southern range land; and 14.25% in goats from Kombolcha (Abdulhamid, 2001). The louse species identified were 0.8% *D. ovis* and 1.2% *Linognathus species* in sheep and 1.52% *Linognathus spp.* in goats in central Ethiopia (Mohammed, 2001) and 11.54% *L.stenopsis* and 2.71% *D. caprae* in goats from Kombolcha (Abdulhamid, 2001). However, examination of sheep pelt showed a much higher infestation rate of 89.5%.

Both lice and keds are considered as a cause of ''ekek'' in Ethiopian sheep pelts (Bayou, 1998). However, information on prevalence and distribution of Keds are scarce but examination of fresh sheep pelts indicates 32. 7 % infestation rates (Yesehak, 2000).

Ticks

Reports from different area indicate that ticks are also among the skin diseases affecting small ruminants in Ethiopia. The over all prevalence of ticks' infestation ranges from 0.96%

to 66.5% in sheep and 1.81% to 33.2% in goats. Table 2 shows the prevalence of ticks in the different areas.

Table 2. Prevalence of ticks in various localities

Location	Prevalence in %		Source/ year
	Sheep	Goats	
Dire Dawa	66.5	33.2	Tadesse, 1994
Central Ethiopia	0.96	1.81	Mohammed, 2001
Southern range land	5.27	9.54	Nura, 2002
Sidama zone	23.8	10	Worku, 2002

The species identified were *Amblyomma spp.*(11.4%), *Hyaloma spp.*(5.3%), *Boophilus spp.*(7.1%) from sheep and *Amblyoma spp.*(6.8%) and *Boophilus spp.* (9.2%) from goats in Sidama zone (Worku, 2002); *Amblyomma spp.*(4.58%) from goats in Kombolcha (Abdulhamid, 2001).

2.6. Skin Production, Processing and Export

2.6.1. Skin Production

In Ethiopia small ruminants are reared in all agro climatic zones. The highland area comprises 70% of the sheep and 30% of the goat population, while the lowland pastoral and agro pastoral area have 30% of the sheep and 70 % of the goats' population (Deguma, 2002). The annual off take rate for small ruminants is estimated to be 33% for sheep and 35% for goats (MoA, personal communication). In Ethiopia, the potential supply of hide and skins depend on the scale of meat production, not on the size of livestock population. This means that hide and skin supply does not respond to price change (FAO, 1998). The demand for meat is influenced by many factors some of these include; size of the population, per capita income, price of the meat and share in household expenditure, economic development and export opportunities. Although skin is a byproduct of meat production, it is a major export commodity and raw material for local industries. Besides these, skins with their hairs serve as sitting rugs, clothing, water carrier and grain sacks. The overall yield of skin in relation to the slaughtered animal is approximately 10% for small ruminants (Sansousy 1995 cited by

Kyomo, 1998). The relative value of sheepskins varies from 7% for medium weight to 2% for heavy weight sheep in Ethiopian markets (FAO, 1998). According to FAO (1992) estimate, Ethiopia produce 14,958 metric tone sheep skin and 14,310 metric tone goat skin annually. About 90-95% of the skin production is derived from urban as well as rural backyard slaughter and the remaining 5-10% from major urban slaughter houses and export abattoirs and the amount of the skin captured by the tanneries is about 75% and 98% for goatskin and sheepskin respectively (Mahmud, 2000). Ethiopian highland sheep skin is estimated to comprise 70% of the total sheep skin production.

2.6.2. Skin Processing and Export

The major regions that supplies sheepskin are Amhara, Oromia, SNNP, and Addis Ababa accounting for 34.5%, 32.9% 16.6% and 7.9% of the central market sheepskin supplies and 45%, 26.4% and 11.7% of the goatskin originate from Amhara, Oromia and SNNP regions respectively (Mahmud, 2000). It is estimated that 8% and 92% of the sheepskin are fresh and wet salted respectively and 25, 23% and 75% of the goat skin are fresh, air dried and wet salted respectively (Mahmud, 2000). Air dried and salted skins enter the central market and the tanneries through legal and illegal collectors' and skin traders. The tanning industries receive and process 14.3 million skin annually (Mahmud, 2000). There are now 20 tanneries that process hide and skin from pickled up to crust and finished leather. Pickled and wet blue skins are the major export forms. Ethiopian highland sheep skins have international reputation for their unique natural substance of fineness, flexibility, strength, and compactness of texture. They are suitable for production of high quality dress gloves, sport gloves and garments. Besides these, Bati genuine and Bati type sheep skins are characterized by thick, highly flexible and clean inner surfaces and are in high demand for production of suede fashions (Asfaw, 2002).

2.7. Skin Defects and Their Nature

Skin is the outer covering of small animals such as sheep, goats and calf in raw and /or un-tanned form (FAO, 1995). Skin quality is primarily defined by the absence of damage to the grain layer of the skin (Hadly, 2001). The quality of finished leather is related to number of surface and structural defects hide and skin acquire during the life of the animal, slaughtering,

storage and transportation stages (Chekol, 2001). Top quality leathers, known as Aniline, are produced from hides and skin having few or no visible defects. Aniline leathers are generally soft, full in substance, and visibly display the attractive grain patterns of the natural skin and are produced by direct drum dyeing of skins with out passing grain correction process (Chekol, 2001).

2.7.1. Types of Skin Defects

Skin defects may be classified into those acquired during the life of the animal (pre-mortem defects) and those that occur during and after slaughter (postmortem defects).

2.7.1.1. Pre-Mortem Defects:

Pre-mortem defects include; 'ekek', scratches, scars, brand marks, old age defects and poor substances. Pre-mortem defects may arise from natural or acquired causes. The various affecting factors and causes include:

1. Age, sex and breed of the animal: breed sex and age of the animal have significant effect on quality of the leather. The skin of sheep breed types of Ethiopian highlands and goats from some parts of low lands of Ethiopia, are considered to have fine grain with strong fiber structure (Chekol, 2001). In domestic and international markets, Ethiopian skin qualities are identified as 'Hair/selale sheep skin type 'and 'Bati genuine goat skin' (Mahmud, 2000). Breeding Ethiopian sheep with European and Australian sheep to increase the carcass yield has generated skin quality inferior to the local sheep (Chekol, 2001). Skins from older animals have coarse grain and thicker substance. The younger the animal; the better the quality and the fine the grain. Thinner, finer and stronger leather are likely to be made from female animal skins (Chekol, 2001).
2. Climate and feeding: animals with poor nutrition yield skin of poor substance and lesser area than well fed healthy animals. Climate has also sizable impact on quality of the skin with respect to substance of the skin and exposure to parasitic damage; high-land skins are a bit better, less greasy and much stronger than skin from low Landers (Chekol, 2001).

3. Diseases and mechanical damages: the diseases that affect skin quality include bacterial (Dermatophilosis); viral (pox, warts, foot and mouth disease); parasitic (lice, keds, mange, ticks) diseases. Scratches are very common types of lesions caused mechanically by thorns, barbed wires and horns (FAO, 1995). Branding is made by owners for animal identification purposes. Demodectic mange lesions can be detected fairly easily by examining the flesh side of air dried skins, noting the round 'cheesy' yellow spots and the dried lesions in the hair. During early tanning process this cheesy mass is washed out leaving empty pockets, thus producing a pitted and scared grain surface (FAO, 1995). Other mange lesions (Scabies) produce a coarse grain and lesions and scratch scars. Ticks damage takes the form of small holes or small more or less healed scar but secondary infections leads to more extensive damages (FAO, 1995). Lice and ked causes scars and damage the grain surface by inflammatory setup (FAO, 1995).

2.7.1.2. Postmortem Defects:

Postmortem defects comprise; bruises, gouge marks, flay cut, bad bleeding, putrefaction, hair slip and beetle damages. These defects can occur due to faulty procedures during slaughter, preservation, storage and transportation of skins.

1. Slaughter defects: these are defects due to flaying and poor bleeding during slaughtering. Inadequate bleeding causes rapid development of bacteria along the blood vessels as a result of bacterial spread from the blood vessels, skin fibers in the vicinity are destroyed, and open channels following the course of the blood vessels are formed through the skin surface. These defects show up in the final stage as a groove on the grain surface following the patterns of the damaged blood vessels (FAO, 1995). Beating of animals causes bruises on the meat, but also leads to blood extravasation in the skin in the bruised area. The smaller blood vessels rupture and the flesh side of the skin appears red. This will putrefy and causes the blemish or weak spots on the final leather (FAO, 1995). Bad pattern skin occurs due to incorrect method of opening the carcasses.
2. Preservation, storage and transportation defects: delays in cleaning, drying or curing cause damage through putrefaction. When skins are laced to a frame for drying they should be under light tension just sufficient to stretch them to their normal shape otherwise overstretching and distortion may occur. Folding of dry skins leads to

rupture of fibers and development of cracks (FAO, 1995). Rubbing during transport, wetting, vermin damage and insect damages are also damages that occur due to incorrect storage and transportation of skins. Preservation methods such as salting or frame drying are not fully practiced by farmers, collectors and hide and skin traders, as a result hide and skin suffer from hair slip, mould and bacterial attacks (Chekol, 2001).

Major defects seen on Ethiopian sheep and goats skin includes: parasitic damage, putrefaction, scratches and scares, flays defects and poor substance. The major Ethiopian sheep and goats skin defects and their percentage proportion are shown in Table 3. According to Chekol (2001) defects due to parasitic damage particularly 'ekek' has increased dramatically in the past 10-15 years and is currently holding number one position as cause of skin down grading and rejection.

Table 3. Proportions of the major Ethiopian sheep and goatskin defects

Defect Type	**% on Sheepskin**	**% on Goatskin**
Parasitic	85	86
Scratch and Scars	80	75
Flay	35	28
Putrefaction (Heat)	22	19
Poor substance	20	4

Source: Chekol, 2001

Also studies conducted at Sebeta tannery on sheep skin and Kombolcha tannery on goats skin on routine production system indicate 89% 'ekek', 51% scratch, 49.5% technical defects, 39.5% disease scars and 24.1% heat defects in pickled sheep pelts (Yisehak, 2000); 71.16% 'ekek', 56.3% scratch, 41.1% technical defects, 33% disease scar, 19.56 % crack and 10.25% beetle damage in pickled goat pelts (Abdulhamid, 2001).

2.8. Impacts of Skin Diseases on the Tanning and Leather Industry

The economic impact of skin disease in Ethiopia is not well documented; however, these must be certainly high, judging from poor condition of affected animals, deaths, damage of the

skins and cost of treatments. It also take some time before disease affected treated animals could return to their normal body condition.

Nowadays, skin diseases due to various origins are considered to be the most important factors responsible for deteriorating the quality of skin in tanning and leather industry implying huge economic loss to the country. The direct and indirect effects of the various skin diseases on the leather and tanning industry are:

2.8.1. Shortage of Raw Material

The annual tanning capacity of the existing 20 tanneries is 1.65 million hide and 36.4 million skins but the annual potential of purchase is 1.07 million hides and 14.3 million skins (Mahmud, 2000). This illustrate that the tanneries are utilizing only 64.8% and 38.6% of their tanning potential respectively due to shortage of raw material. Skin diseases such as mange which damages the skin seriously can be observed on skins by farmers and skin and hide traders. Hence, such skin will not enter the market leading scarcity of supply to the tanners.

2.8.2. Down Grading or Rejections of the Skin

Cockle is a nodular condition of the skin arising in response to infestation with *D. ovis* and is possibly a hypersensitivity reaction on the part of some sheep to antigen of louse origin (Heath *et al.*, 1996). It is detectable after depletion of the hair or wool where they present as numerous small raised nodules on the grain surface of the pelt (Dempsy *et al.*, 1972 cited by Pfeffer, *et al.*, 1996). A similar lesion known as 'ekek' was associated with keds and lice infestations on Ethiopian sheep pelt (Bayou, 1998; Yesehak, 2000) & in goat pelts with mange and louse infestations (Abdulhamid, 2001).

'Ekek' in sheep and mange in goats are causes of down grading and rejection of sheep and goat skins (Bayou, 1998). According to Chekol (2001) in the past 10-15 years defects from the diseases and other causes have reached very significant level especially in sheep and goats skin dropping aniline leather (Grade 1-3) and increasing rejections. Table 4. shows comparison of grades of skin currently and 10-15 years back. Tanneries reported that 35% of sheep skin and 56% of goats' skin are rejected due to external parasites. And out of the reject

groups of the processed skin, about 80-90 % defects were believed to be due to external parasites. According to Chekol (2001) the estimated economic loss due to drop in quality of sheep and goat skin is around US $14 million per year.

Table 4. Comparison of grades of skin currently and 10 - 15 years back

Period	**Sheep skin selection in pickled form**			**Goat skin selections in wet blue form**			
	Top 1-3	Middle 4	Rejects	Top 1-3	Middle		Rejects
					G4	G5	
Current	25%	25%	50%	15%	20%	30%	35%
10-15years back	50%	35%	15%	50%	20%	20%	10%

Source: Chekol (2001)

2.8.3. Increase in Cost of Labor and Chemicals

Aniline leathers are produced by direct drum dying of leathers to increase resistance to stains, heat and mechanical damage with out passing through grain correction process (Chekol, 2001). Defects like "'ekek'" are detected only after removal of the hair/wool in tanneries, due to this raw skin selected as top grades may end up into dawn grades and rejects. Low quality finished leathers are produced from hides and skins suffering from different defects; most of them are finished covering their defects with pigment or synthetic coating materials (Chekol, 2001). The grain correction, which requires special skill and the chemicals used, will definitely increase the cost of leather production.

3. MATERIALS AND METHODS

3.1. Study Area

The study on small ruminant ectoparasites was conducted in three woredas (Kutaber, Kalu and Jiletimuga) of eastern part of Amhara regional state, northeast Ethiopia some 430, 375 and 260 km away from Addis Ababa, respectively (Fig 1). The livestock in the woredas are indigenous breeds with small number of cross breed cattle kept around the towns and exotic poultry breeds distribute through poultry improvement packages. The production system of the area is mixed crop livestock in Kutaber and Kallu and Agro pastoral in Jilietimuga. Livestock are managed under extensive system in all the three woredas. Table 5 shows the detailed description of the study areas.

Table 5. Description of the study area for sheep and goats ectoparasites

Description	**Name of the study area**		
	Kutaber	Kallu	Jilietimuga
Altitude range	1759 – 3455 masl	1500 – 1800 masl	1200 – 1800 masl
Rainfall Range	674 – 990 mm	750 – 900 mm	930 mm average
Temperature range	10 -28 °c	25 – 30 °c	20 – 34 °c
Agro climate Percentage			
Highland	42.3%	10%	-
Midland	57.7%	54%	18%
Lowland	-	46%	82%
Livestock population *			
Cattle	67,996	115,006	61,539
sheep	72,077	13,125	13,083
Goats	43,247	67,909	23,156
Equines	19,505	13,863	9,050
Camels	-	2,048	905
Poultry	107,478	205,431	33,222

*Source: CACC, 2003.

Other Information source: WoA

The study on pickled and wet blue skin defects were conducted in Kombolcha and Dessie tanneries. Dessie and Kombolcha tanneries are located in Haik and Kombolcha town about 430 and 375 km northeast of Addis Ababa respectively. Both Kombolcha and Dessie tanneries have a capacity of about 6 000 skin per day. The tanneries obtain raw skin from different parts of the country, however, Tigray region, South Wollo, North wollo, Waghamra and Oromia zones of the Amhara region and Addis Ababa town are the main supplies. The tanneries process and export pickled sheepskin and wet blue goatskin to different European and Asian countries.

Fig 1. Map of Ethiopia showing Ahmhara region and map of Amhara region showing the study Woredas

3.2. Study Population / Material

The study was conducted from November 2003 to March 2004. Smallholders' indigenous sheep and goats managed under extensive management system in different agro climate (Table 6), pickled sheepskins and wet blue goatskins processed in Dessie and Kombolcha tanneries and fresh sheep and goat pelts purchased from the local markets were used as subjects of the study.

Table 6. Study population and peasant association

Woreda	Study Agro climate	Total PAs	PAs having the selected Agro climate	Sheep and goat Population in the study agro climate	
				Sheep	Goats
Kutaber	Highland	16	11	30,169	13,283
Kallu	Midland	34	24	10,563	20,480
Jilietimuga	Lowland	16	13	9,400	18,900

3.3. Study Design

3.3.1. Sample Size Determination and Sampling Methods

The study of ectoparasites on small ruminants involved woredas, Peasant association (PA) and sheep and goats as a sampling unit. The woredas were selected purposively based on their representation of different agro climate; five highlands, midlands and lowlands PAs were selected randomly from Kutaber, Kallu and Jilietimuga woredas respectively from corresponding highland, midland and lowland PAs in the woreds. Sheep and goats in selected PAs were also selected randomly from animals that came for vaccination against Peste des petites ruminants (PPR).

The sample size for the study was determined using Win Episcope 2 software program taking estimated prevalence of the diseases 20% in each agro climates, accepted error 5% and confidence level 95%. Based on this and the livestock population of the study area (Table 6), the minimum sample size for the study was 246 sheep and 246 goats from each agro climate.

For cross-sectional study on pickled and wet blue skin defects; pickled and wet blue pelts were selected randomly from sheep and goatskin of different area origin that were processed in Dessie and Kombolcha tanneries respectively. In Ethiopia, it is estimated that 65% of the defects observed in the skins are pre-slaughter defects developing in the live animals (FAO, 1998). Of pre-slaughter defects; defects due to 'ekek' are the major one. The sample size was determined from estimated prevalence of 'ekek' defect 63%, accepted error 3% and level of confidence 95%. Based on this the minimum sample size for the study was 995 pelts from each stages.

For longitudinal study to assess the effect of each disease on the quality of raw and pickled skin, a group of 20 pelts each affected by louse, keds, mites and apparently disease free skin of sheep and goats were purchased from the local market. Since keds are very mobile parasites keds affected skins were purchased by examination of the infested sheep before slaughter.

3.3.2. Study Types

The study consisted of a questionnaire survey, a cross-sectional clinical study on ectoparasites of small ruminants wet blue and pickled skins defects and a controlled longitudinal study on effects of ectoparasites on quality of processed skin.

3.3.2.1. Questionnaire Study

A structured questionnaire format (Annex 1) was prepared in an attempt to obtain general information on livestock ownership pattern, importance of small ruminant keeping, awareness of ectoparasites that affect small ruminants and their effect on small ruminant production and market value of the skin, and ectoparasite control practices exercised in the area.

Five sheep and goat owners were selected from each peasant association and thus a total of 76 individuals were interviewed from different localities: 25 respondents were from midland, 25 from highland areas and the rest 26 were inhabitants of lowland area.

3.3.2.2. Clinical Examinations

1504 animals (752 sheep and 752 goats) randomly selected from the three agro climates were clinically examined for presences of ectoparasites and/ or lesions. Before clinical examination, the age, body condition and hairiness of the selected animal was recorded and body condition score of the animal was made as poor and good; by modifying the system described in Gatenby (1991) for sheep and Steele (1996) for goats. Poor body condition score was given to sheep and goats which were extremely thin to those with smooth and less prominent spinous process, transverse process in which finger can be pushed and moderate depth loin muscle. Good body condition score was given for sheep and goats in which the spinous process only stickup very slightly; smooth, rounded and well covered transverse processes and those having full loin muscle and very fat. Age categorization into young (lamb/ kid) and adult was performed as described by Gatenby (1991) for sheep and Steele (1996) for goats. Accordingly those sheep and goats under 1 year were categorized as young and the rest as adult.

The clinical examination was performed by multiple fleeces parting in the direction opposite that in which hair or wool normally rests and visual inspection and palpation of the skin for parasites and/or lesion on all parts of the animals including the ears and the digits. Those sheep and goats found infested by parasites were considered positive, the sites of infestation on the animal body were recorded and the parasites were identified on the bases of their morphological structure as described in Wall and Shearer (1997).

3.3.2.3. Specimen Collection and Examination

Those ectoparasites and their larvae unidentified during clinical examination, and scrapings of mange like lesions from clinically suspected animals were collected in a clean container, for detailed laboratory examination.

Samples of mange like lesions were collected by clipping the hair around affected area, scrapping the edges of the lesion with scalpel as described by Soulsby (1982) until capillary bleeding is seen in such away that the blade is being held at an angle that the material scraped falls on paper held underneath. The lesion was then dressed and the scrapped material transferred to a clean container and carried for laboratory examination. Ectoparasites such as

ticks, lice and fleas were collected by hand from their attachment site, put into container and preserved with 70% alcohol as described by Urquhart *et al.* (1996).

Collected ectoparasites were examined by stereomicroscope and identification was performed according to the identification key given by Okello-onen *et al.* (1999) for tick; and Shearer and Walls (1997) and Urquhart *et al.* (1996) for lice and flea. Skin scrapings were processed according to the method described by Cole (1986). In this method, a few drops of 10% potassium hydroxide was added to the sample, allowed to stand for 30 minutes, and the sediment was examined under different microscopic magnification for mites, their eggs and fragments. Mites were identified according to the key described by Wall and Shearer (1997).

3.3.2.4. Study on Effects of Ectoparasites on Quality of Skin and skin Defects in the Tanneries

A total of 120 sheep and 120 goatskins with a known and registered ectoparasite infestations including non infested control skin were processed in Kombolcha and Dessie tanneries and the corresponding pelt defects were analyzed. For the study, three groups of 20 sheepskins each (one group infested by *D. ovis,* one group infested by *M. ovinus* and a control group of ectoparasite free sheepskins) and three groups of 20 goatskins each (one group infested with sarcoptic mange, one group infested by *Linognathus spp.* and a control group of ectoparasite free goatskins) were used.

Before purchase, each skin was examined for the presence of ectoparasites and / or lesions by multiple fleeces parting at six sites (neck, shoulder, belly, flank, back and rump) on each side as described by Heath *et al.* (1995a). Due to the mobile nature of sheep ked, affected skins are purchased only from sheep that were positive on clinical examination prior to slaughter. On each groups of skin infested by the ectoparasites a subjective assessment scores were made on the basis of ectoparasite count and distribution of skin lesion (Mange) (Annex 16). Accordingly, a sub grouped of light, moderate and severe infestations score was assigned to each skin in each groups and all the skins were individually identified using punch marks and salted until processed.

At the tanneries, raw skins were graded as good and reject grades and processed in a test drums which have a capacity of about 20 pelts at a time to pickled stages, sorted by size

according to the criteria of QSAE (2001) and examined in natural light by two senior skin selectors and graded into seven grades according to the criteria of QSAE (2001) (Annex 4). The extent and severity of ''ekek'' and other lesions were recorded and given a subjective grading of light, moderate and severe based on the distribution and density of lesions per unit area adopting Heath *et al.* (1996) and Pfeffer *et al.* (1996) cockle scoring method. A score of clean was given when no 'ekek' is detected, light represent low number of scattered lesions in localized area, while severe represents a high density of lesion over two third of the pelt or more. The goat pelts were further processed to wet blue stage (export form of the tanneries) and examined again by the selectors under the same conditions.

In addition to this, 1000 pickled sheep and 1000 wet blue goat pelts that were processed in Dessie and Kombolcha tanneries respectively were randomly examined to identify the type and magnitude of pelt damages in the tanneries. During examination each selected pelt was sorted by size and examined for defects in natural light by skin selector and defects on each pelt were recorded and the pelts were graded into seven grades as per the criteria given in QSAE (2001).

3.3.3. Data Management and Analysis

Microsoft Access and Microsoft Excel were used for data management. Statistical software Stata 7 and SPSS for windows were used for data analysis. Descriptive statistics such as percentages and 95% confidence interval were used to summarize the proportion of infected and non-infected animals and proportion of defects on the wet blue and pickled skins. The effects of different epidemiological risk factors on prevalence of ectoparasites in sheep and goats were analyzed by logistic regression using SPSS for window by entering all variables at once. Chi-square test computed using stata 7 was used to test association between 'ekek' and scratch, and 'ekek' and scar on pickled sheep and wet blue goatskin and to test the difference between ectoparasite infested and control skin on development of 'ekek'. Correlation of the severity of ectoparasite infestation and severity of 'ekek' on pickled skin were made by spearman correlation and Kendall's tau-b test, computed using SPSS for window. Statistical significance was set at $p<0.05$.

4. RESULTS

4.1. Questionnaire Study Outputs

The responses of questionnaire administered to sheep and goat owners were summarized by agro climate (Annex 7). Response on livestock ownership pattern indicates that small ruminants are the major species of animals kept by farmers for various reasons. The major reasons for keeping sheep and goats were 70/76 (92.1%) for income generation and insurance as priority number one, 60/76 (78.94%) home meat as priority number two, 49/76 (64.47%) skin as priority number three. Of the 76 sheep and goat owners interviewed, 23/25 (92%), 20/25 (80%) and 24/26 (92.3%) respondents from highland, midland and lowland area respectively knew one or more skin diseases on sheep and goats. The main skin diseases mentioned by respondents were keds in highland and mange in midland and lowlands.

Mange and keds were observed to affect mainly goats and sheep respectively. The age groups commonly observed to be affected by mange, keds, lice and ticks were all age groups (28/45), adults (15/23), adults (7/11) and all age groups (6/12) respectively. Seasonality in occurrence of mange and keds were observed by 57.7% and 65.2% of the respondents respectively. The season of occurrence of these diseases was reported as late rainy (cold) season for mange and dry season for keds.

Table 7. Response on effects of ectoparasites on sale of affected animals and their skin.

Ectoparasite	Effect on animal sale		Effect on skin sale	
	Yes	No	Yes	No
Mange	45	0	45	0
keds	7	16	2	21
Lice	4	7	2	9
Ticks	1	11	0	12

All respondents believe that mange has effect both on sale of live sheep and goats and affected skins (Table 7). While the majority of the respondents do not believe keds, lice and ticks have effect either on the sale of the affected animal or its skin. Even though modern veterinary service delivery is available in their nearby only 42% of them use modern treatment to control ectoparasites (Fig. 2).

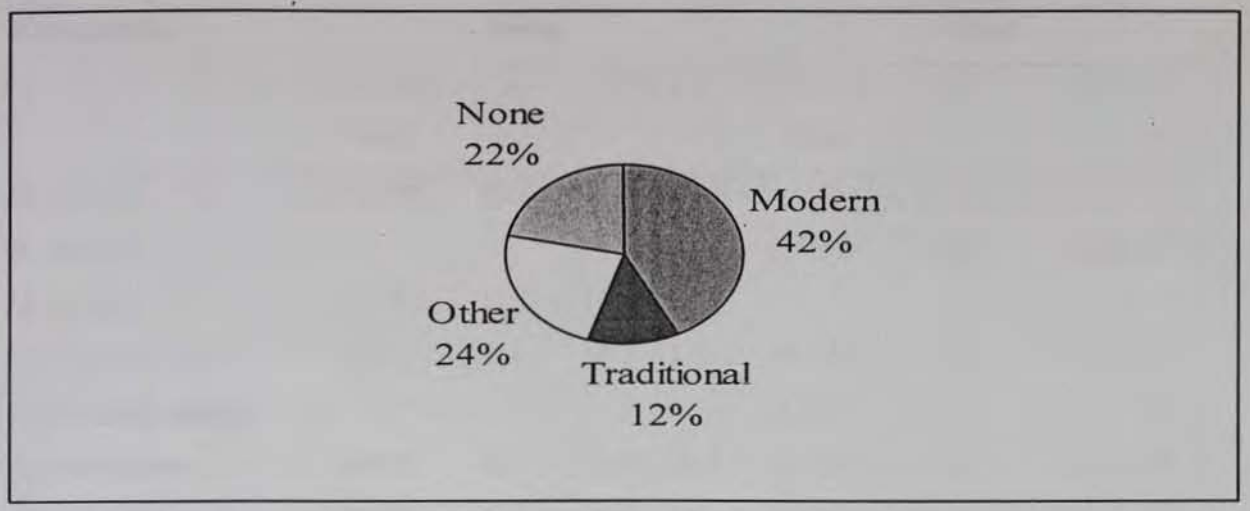

Fig. 2. Proportions of respondents in different groups of ectoparasites control options

4.2. Results of Clinical and laboratory Examination of Sheep and Goats for Ectoparasites

Out of 752 sheep and 752 goats examined for ectoparasites; 380 (50.5%) sheep and 424 (56.4%) goats were infested with one or more ectoparasites (Table 8). The major ectoparasites identified on sheep were *D. ovis* and *M. ovinus* on 290 sheep (38.5%) and 94 sheep (12.5%) respectively. The ectoparasites identified on goats were *Linognathus species*, tick infestations, *Ctenocephalides* spp. infestations, Sarcoptic mange infestations and *D. caprae* infestation at prevalence of 28.3%, 22.2%, 8.1%, 6.1% and 0.9% respectively. *L. ovillus* and *L. africanus, and L. stenopsis* and *L. africanus* were the *Linognathus* spp. recovered from sheep and goats respectively. The tick species identified on sheep were 0.1% *B. decoloratus*, 1.7% *A. variegatum*, 0.4% *A. gemma*, 1.6% *R. pulchellus* and 0.7% *R. evertsi evertsi,* and the tick species identified on goats were 3.7% *B. decoloratus*, 9.97% *A. variegatum*, 2.79% *A. gemma*, 6.64% *R. pulchellus* and 1.46% *R. evertsi evertsi.*

Table 8. Prevalence of ectoparasites on sheep and goats

Ectoparasite	sheep			Goat		
	Positive/ Total	%	95% CI	Positive/ Total	%	95% CI
D. ovis	290/752	38.6	35.1 – 42.1	-	-	-
D. caprae	-	-	-	7/752	0.9	0.4 – 1.9
M. ovinus	94/752	12.5	10.2 – 15.1	-	-	-
Sarcoptic mange	3/752	0.4	0.1 – 1.2	46/752	6.1	4.5 – 8.1
Demodectic mange	-	-	-	4/752	0.5	0.1 – 1.3
B. decoloratus	1/752	0.1	0.003 - 0.7	26/752	3.4	2.4 – 5.0
A. variegatum	13/752	1.7	0.9 – 2.9	75/752	10.0	7.9 – 12.3
A. gemma	3/752	0.4	0.08 – 1.2	21/752	2.8	1.7 – 4.2
R. pulchellus	12/752	1.6	0.8 – 2.8	54/752	7.2	5.4 – 9.2
R. evertsi evertsi	5/752	0.7	0.2 – 1.5	11/752	1.4	0.7 – 2.6
Linognathus spp.	18/752	2.4	1.4 – 3.7	213/752	28.3	25.1 – 31.7
Ctenocephalides spp.	2/752	0.3	0.03 – 0.9	61/752	8.1	6.3 – 10.3
Overall	**380/752**	**50.5**	**46.9 – 54.2**	**424/752**	**56.4**	**52.7 – 60.0**

The common sites of *D. ovis* infestation on 290 sheep were the shoulder, the neck, the sides and the back with proportion of 60.7%, 50%, 42.4% and 34.1% respectively. In *M. ovinus* infested sheep the sites commonly parasitized were the shoulder (60.6%), the neck (50%), the rump (41.5%) and the sides (33.0%) in order of importance. The major tick attachment sites on the sheep were head/ear (44.4%) and the tail (18.5%) while the rest are found to attach at other sites of the body.

In goats, sarcoptic and demodectic mange infestations were recorded as generalized forms in 32.6% and 75 % of the cases. Ear/ head (58.7%) and groins (56.5%) were the major sites infested by sarcoptic mange. For *linognathus spp.* the shoulder (64.8%), the neck (63.8%) and the sides (47.9%) were the main infestation sites. The ear/ head, tail, neck, the leg/ feet and the belly were the major attachment sites for ticks representing 83.2%, 12.0%, 7.2% 6.0% and 3.0% of the tick infestations respectively and all infestations on the neck were due to *B. decoloratus*.

4.2.1. Prevalence of Ectoparasites by Agro climate

The overall prevalence of ectoparasites in highland, midland and lowland were 71.8%, 41.2%, 38.4% in sheep and 39.6%, 70.1%, 59.4% in goats respectively (Annex 8). Agro climate specific prevalence's of ectoparasites identified on sheep were shown in Fig. 3. The prevalence of *M. ovinus* among the agro climates showed significant difference between midland and highland (OR=0.014, p<0.001) and lowland and highland (p<0.001) but there was no significant difference (p>0.05) between midland and lowland agro climates (Table 11). A similar logistic regression analysis performed on *D. ovis* prevalence among the three agro climates indicated significant difference between midland Vs highland (OR=0.588, p<0.01) and lowland Vs highland (OR=0.404, p<0.001) but no significant difference was observed in midland Vs lowland (p>0.05). A significant difference in prevalence of *linognathus* spp (OR=9.3, p<0.01) and ticks (OR=0.166, p<0.01) were found between midland and lowland but no significant difference (P>0.05) was observed between midland and highland and also between lowland and highland in both parasites. The prevalence of sarcoptic mange and *Ctenocephalides* spp. infestations in sheep was not significant (P>0.05) among the different agro climates.

The prevalence of different ectoparasites in goats by agro climate was shown in Fig. 4. In goats, logistic regression analysis of the effect of agro climate after adjusting for age and body condition (Table 12) indicated significant difference in prevalence of sarcoptic mange infestations between midland and highland (OR=5.01, p<0.01) and between lowland and highland (OR=4.6, p<0.01) while no significant difference (p>0.05) was noted in goats of lowland and midland agro climates. The prevalence difference of *Linognathus spp.* between midland and highland and between midland and lowland was not significant (P>0.05). However, the odds of *Linognathus spp.* infestation in lowland (OR=0.542, p<=0.01) was 0.542 times the highland odds (p<0.01). There was significant difference in prevalence of goat tick infestation between highland and lowland (OR=46.7, p<0.001) and highland and midland (OR=38.6, P<0.001), however, there was no significant difference (P>0.05) between midland and lowland. *Ctenocephalides spp.* infestation in goats also showed significant difference between midland and highland (OR=23.66, p<0.001) and between midland and lowland (OR=37.34, p<0.001) but no significant difference between lowland and highland.

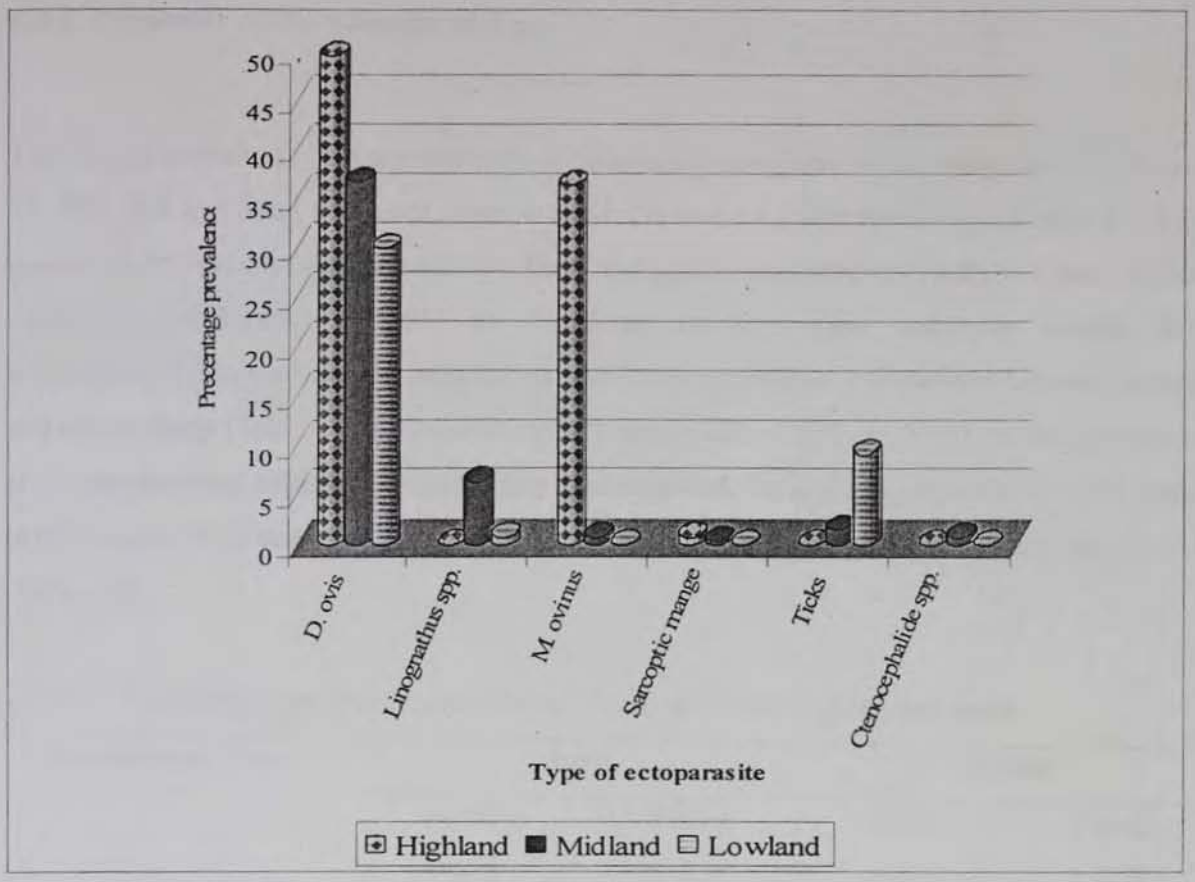

Fig. 3. Prevalence of ectoparasites in sheep by agro climate

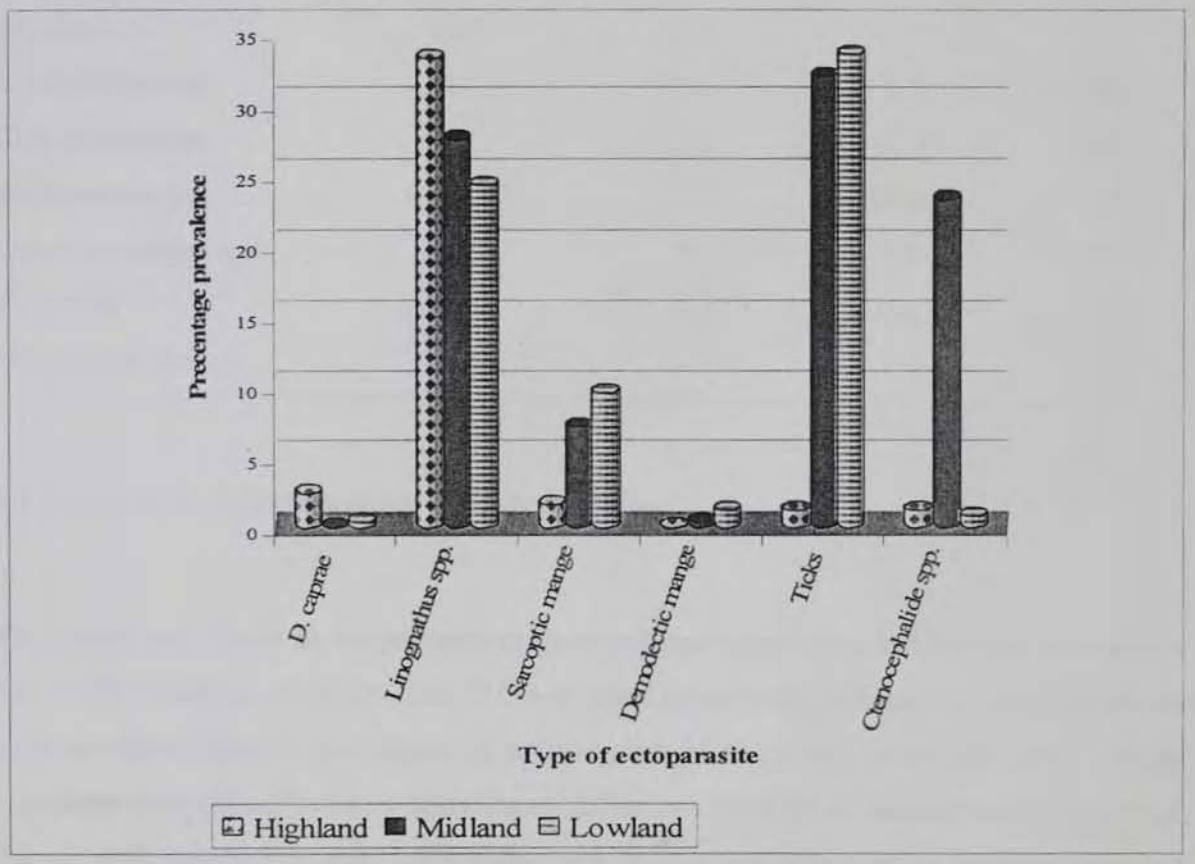

Fig. 4. Prevalence of ectoparasites in goats by agro climate

4.2.2. Prevalence of Ectoparasites by Age

The overall prevalence of ectoparasites in kids/lambs (young) and adult sheep was 42.0 % and 54. 2%, and in young and adult goats was 60.1% and 54.2% respectively (Annex 9). Age specific prevalence of ectoparasites in sheep and goats are shown in Table 9. There was no significance difference ($p>0.05$) in prevalence of *M. ovinus*, sarcoptic mange, tick infestations, *Linognathus spp.* infestations and *Ctenocephalides* infestations between young and adults sheep (Table 11) but significant difference (OR =0.591, $p< 0.01$) in the prevalence of *D. ovis* between adults and young sheep was recorded. In goats, no significance difference in prevalence of all ectoparasites ($p>0.05$) was observed between adults and young age groups (Table 12).

Table 9. Percentage age specific prevalence of ectoparasites on sheep and goats

Ectoparasite Type	**sheep**		**Goats**	
	Adult n=528	Young n=224	Adult n=474	Young n=278
D. ovis	42.2	29.9	-	-
M. ovinus	11.9	13.8	-	-
Sarcoptic mange	0.4	0.4	6.7	5.0
Tick infestations	4.2	2.2	21.9	22.7
Linognathus spp.	2.8	1.3	26.89	30.9
Ctenocephalides spp.	0.3	0	6.7	10.4
D. caprae	-	-	0.4	0.8
Demodectic mange	-	-	1.4	0

4.2.3. Prevalence of Ectoparasites by body condition

The overall prevalence of ectoparasites in good and poor body condition animals were 49.1% and 57.5% in sheep, and 52.0% and 73.7% in goats respectively (Annex 10). Table 10 shows body condition specific prevalence of ectoparasites in sheep and goats. In sheep, logistic regression analysis indicated no significance difference ($p>0.05$) in prevalence of *M. ovinus*, tick, *D. ovis*, Sarcoptic mange, *Linognathus spp.* and *Ctenocephalides spp.* between poor and good condition animals (Table 11). However, there was significant difference in prevalence of

sarcoptic mange (OR=4.3, p<0.001), ticks (OR= 1.6, p<0.05) and *Linognathus spp.* (OR= 2.1, p<0.001) between poor and good body condition goats. However, no significance variation (p>0.05) was observed in prevalence of *Ctenocephalides spp.*, *D. caprae* and demodectic mange infestation between different body conditions (Table 12).

Table 10. Percentage body condition specific prevalence of ectoparasites in sheep and goats

Ectoparasite Type	**sheep**		**Goats**	
	Good n=623	Poor n=129	Good n=562	Poor n=190
D. ovis	37.9	41.9	-	-
M. ovinus	13.6	6.9	-	-
Sarcoptic mange	0.3	0.8	3.0	15.3
Tick infestations	2.7	7.7	20	22.9
Linognathus spp.	1.9	4.6	25.1	37.9
Ctenocephalides spp.	0.2	0.8	8.5	6.8
D. caprae	-	-	1.1	0.5
Demodectic mange	-	-	0.2	1.6

4.2.4. Prevalence of Sheep Keds infestation by Hair type/ Size

The prevalence of *M. ovinus* on hairy, wooly and wooly sheared sheep was 0%, 41.2% and 7.6% respectively. Significance variation in prevalence of *M. ovinus* (x^2= 237.63, p= 0.000) was observed between wooly 92/223 (41.2%) and hairy 0/503 (0%) sheep. Similarly there was significant difference (x^2= 11.16, p=0.0008) in prevalence of *M. ovinus* in wooly 92/223 (41.2%) and wooly sheared 2/ 26 (7.6%) sheep.

Table 11. Adjusted multivariate logistic regression, odds ratio and p-values of agro climate, age and body condition for ectoparasites of sheep.

Risk Factor	*D. ovis*		*M. ovinus*		Sarcoptic mange		Ticks		*Linognathus*		*Ctenocephalides*	
	P-value	OR	P-value	OR	P-value	OR	P-value	OR	p-value	OR	P-value	OR
Agro climate												
Highland		1		1		1		1		1		1
Midland**	0.004	0.588	0.000	0.014	0.528	0.459	0.000	ND	0.994	1.0E+0	0.995	
Lowland**	0.000	0.404	0.000	0.007	0.995	0.000	0.000	ND	0.995	1.1E+0	1.000	0.829
Midland*	0.052	1.46	0.995	1.3E+07	0.995	1.6E+07	0.001	0.166	0.003	9.29	0.994	1.2E+07
Age												
Adult		1		1		1		1		1		1
Young	0.002	0.591	0.076	1.66	0.861	1.24	0.100	0.428	0.237	0.465	0.995	0.000
Condition												
Good		1		1		1		1		1		1
Poor	0.083	1.43	0.509	0.752	0.302	3.60	0.068	2.18	0.079	2.54	0.993	0.000

** Reference category Highland
* Reference category Lowland
OR= Odds ratio
ND=Not determined

Table 12. Adjusted multivariate logistic regression, odds ratio and p-values of agro climate, age and body condition for ectoparasites of goats.

Risk Factor	*Sarcoptes*		Ticks		*Linognathus*		*Ctenocephalides*		*B. caprae*		*Demodex*	
	P-value	OR	P-value	OR	P-value	OR	P-value	OR	p-value	OR	P-value	OR
Agro climate												
Highland		1		1		1		1		1		1
Midland**	0.004	5.01	0.000	38.645	0.165	0.760	0.000	23.665	0.994	0.000	0.995	5071180
Lowland**	0.006	4.60	0.000	46.70	0.003	0.542	0.629	0.634	0.130	0.192	0.995	8196002
Midland*	0.808	1.088	0.339	0.828	0.114	1.402	0.000	37..34	0.995	0.000	0.690	0.619
Age												
Adult		1		1		1		1		1		1
Young	0.970	1.013	0.822	1.046	0.183	1.253	0.192	1.461	0.079	4.412	0.994	0.000
Condition												
Good		1		1		1		1		1		1
Poor	0.000	4.32	0.030	2.1	0.000	2.124	0.384	1.370	0.594	0.558	0.171	5.196

** Reference category Highland
* Reference category Lowland
OR= Odds ratio

4.3. Effects of Ectoparasites on Skin Quality.

The prevalence of 'ekek' lesion on *D. ovis* and *M. ovinus* infested group of sheep pelts were 100 % and 95% respectively while all Sarcoptic mange infested goat skin and none of the *Linognatus* louse infested goats were having ekek lesions at pickled satge. All the apparently ectoparasite free control goat skins were free from ekek lesion while 15% of the control sheep pelts had 'ekek' at the pickled stage. Other defects such as scratches, scars and technical defects due to flaying were observed in each group of pelts (Table 13). There was a significant difference in prevalence of 'ekek' between *D. ovis* infested and control sheepskin group (x^2=29.57, p=0.000), *M. ovinus* infested and control sheepskin group (x^2=25.86, p=0.000) and sarcoptic mange infested goatskin and control goatskin group (x^2=40.00, p=0.000) indicating a strong association between these parasite and the pickled pelt defect, ekek.

Table 13. Defects observed at pickled stage in different groups of ectoparasite infested and apparently free sheep and goatskins

Defects Type	**Number of Defective sheep pelts by Group**			**Number of Defective Goat pelts by Group**		
	Damalina	Ked	Control	*Linognathus*	*Sarcoptes*	Control
'Ekek'	20	19	3	0	20	0
Scratch	10	8	3	9	11	6
Scars	12	11	6	13	8	7
Technical	2	2	3	4	2	5
Old age	-	-	1	-	1	-

There was a strong positive correlation between the severity of ectoparasite infestations (light, moderate and severe) on raw skins and the severity of "ekek' lesion (clear, light, moderate and severe) on pickled pelts (Table 14) for *D. ovis* infested sheepskin group (tau-b=0.745, rho=0.787, p=0.000), *M. ovinus* infested sheepskin group (tau-b=0.791, rho=0.828, p=0.0000) and sarcoptic mange infested goatskin group (tau-b=0.445, rho=0.473, p=0.0351).

Table 14. Correlation of 'ekek' status on pickled pelts with ectoparasite type and severity

Disease type on raw skin	**Severity**	**Total skins**	**Pickled pelt 'Ekek' status**			
			clear	light	Moderate	Severe
D. ovis infested sheep	Light	3	0	2	1	0
	Moderate	9	0	2	7	0
	Severe	8	0	0	2	6
M. ovinus infested sheep	Light	9	1	5	3	0
	Moderate	6	0	0	6	0
	Severe	5	0	0	1	4
Free/control/ sheep	NA	20	17	3	0	0
Sarcoptes infested goat	Light	7	0	2	1	4
	Moderate	5	0	0	1	4
	Severe	8	0	0	0	8
Linognathus infested goat	Light	11	11	0	0	0
	Moderate	5	5	0	0	0
	Severe	4	4	0	0	0
Free/control/goats	NA	20	20	0	0	0

NA = Not applicable

Grading pickled pelt from each ectoparasite affected and control groups according to QSAE (2001) indicated more number of pelts in higher grades (1–3) compared with ectoparasite infested sheep and goatskin groups (Fig. 5).

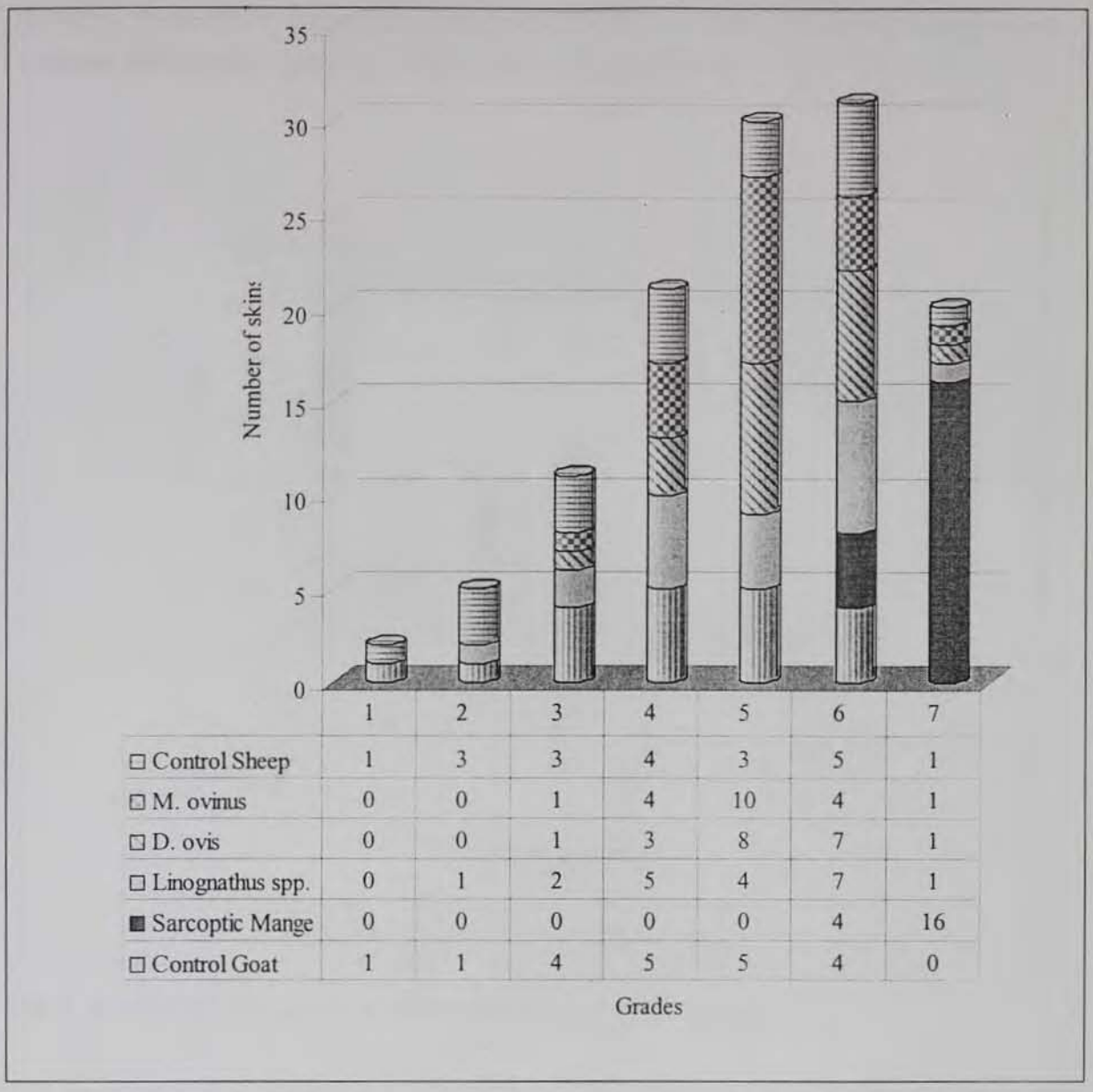

Fig. 5. Grade distribution of ectoparasite affected and control skin when processed to pickled stage

4.4. Results of Pickled Sheep and Wet Blue Goat Pelt Defects

Analysis of 1000 sheepskins processed in Dessie tannery to the pickled stage unveiled the presence of various skin defects of which 'ekek' (70.8%) was the dominant defect followed by scars (22%), scratch (14%), and knife damage (4.6%) (Annex 13 and Fig. 6). Similarly, out of 1000 goatskins processed to wet blue stage in Kombolcha tannery 'ekek' accounted for 42.3%, followed by scratch (29.5%), scars (24.1%) and knife damage (14.6%) (Annex 13 and Fig. 6). Defects such as knife damage, bad bleeding, beetle damage, putrefaction, crack and smoke are technical defects due to faulty flaying, preservation and handling of skin. Both in

pickled sheep pelts and wet blue goat pelts 'ekek' was the number one defect observed however, there was a significant difference (p=0.0000, X^2 =165.29) in proportion of 'ekek' between pickled sheep pelts (OR=3.31) and wet blue goat pelts.

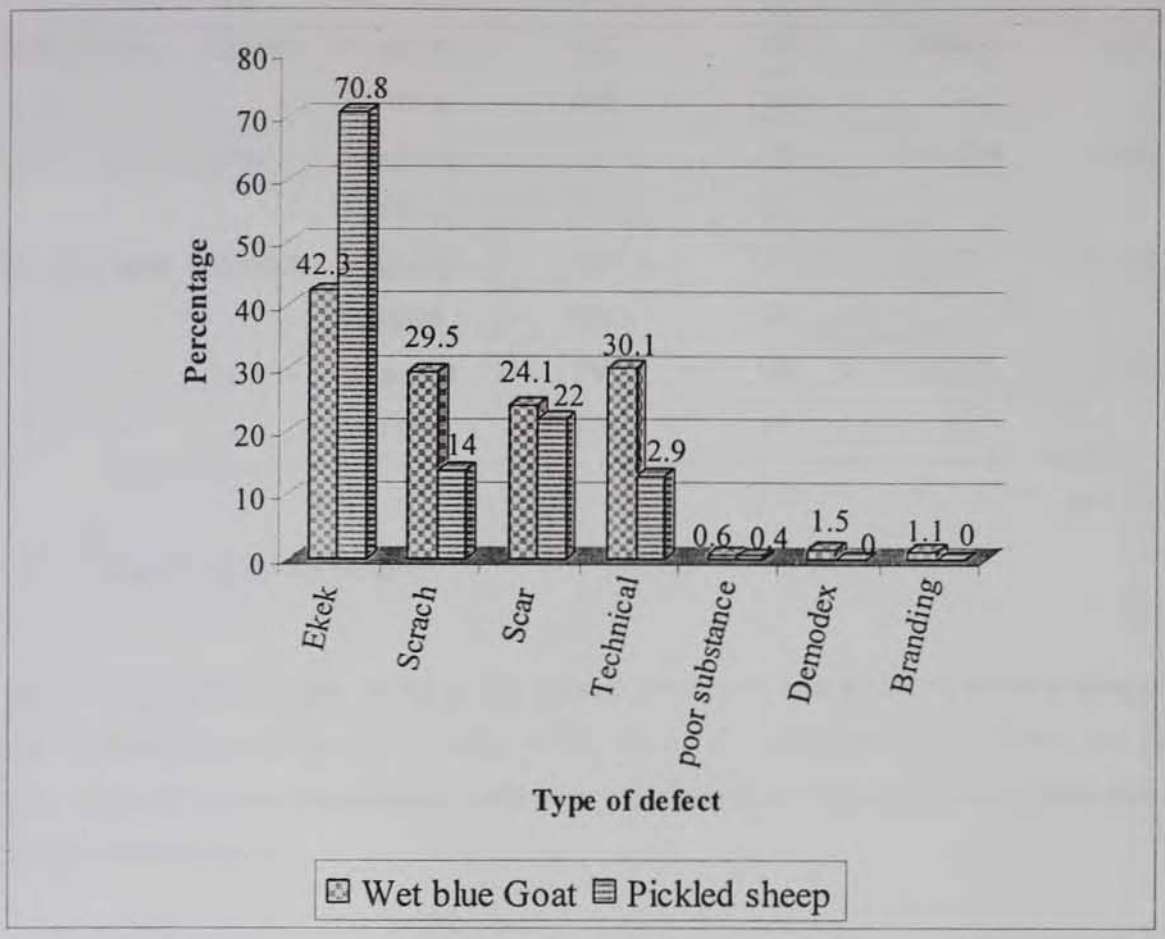

Fig. 6. Percentage defects on wet blue goat and pickled sheep pelts.

4.4.1. Association of 'Ekek' with Scratch and Scars

Significant association was observed between 'ekek' and scratch (p=0.000, x^2= 140.42), and 'ekek' and scars (p=0.000, x^2=114.594) on pickled sheep pelts and between 'ekek' and scratch (p=0.000, X^2 = 63.5243), and 'ekek' and scars (p= 0.000, x^2= 75. 2016) on wet blue pelts (Table 15).

Table 15. Association of scratch and scar with 'ekek' on pickled sheep and wet blue goat pelts

Type of pelt	Defect type	Defect Status	Ekek status		Chi-square	P- value
			Negative	Positive		
Pickled sheep	Scratch	Negative	192	100	140.419	0.000
		Positive	668	40		
	Scar	Negative	164	128	114.594	0.000
		Positive	616	92		
Wet blue goat	Scratch	Negative	350	227	63.524	0.000
		Positive	355	68		
	Scar	Negative	380	197	75.202	0.000
		Positive	379	44		

4.4.2. Effect of 'Ekek' on Grades:

'Ekek' was responsible for 70.8% of the pickled sheep pelt and 42.3% of the wet blue goat pelt downgrading and rejection. Grading of the 708 pickled sheep pelt and 423 wet blue goat pelts indicated that the proportion of pelts with 'ekek'was much higher in lower grades than in the top grades (Fig. 7).

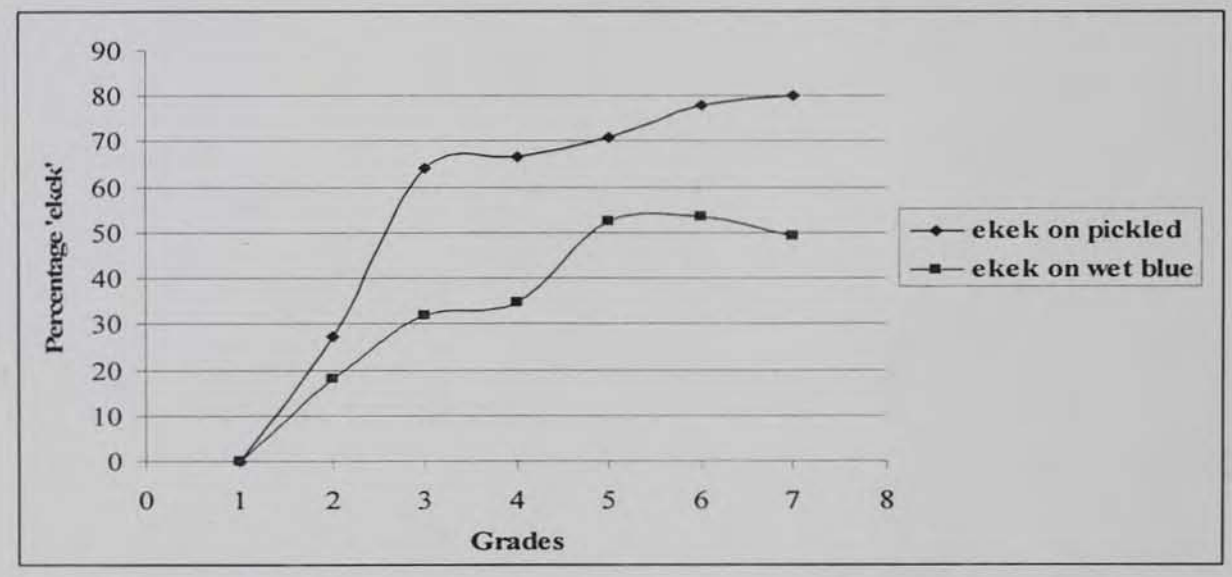

Fig. 7. Percentage of pelts with 'ekek' on pickled sheep and wet blue goat pelts by grades.

4.5. Economic Impact of Ectoparasites to the Tanning Industry

In the international market, the price of exported skin is determined both by size and quality grade of the skin (Annex 12). Tanneries record both the size and grade of the skin using a recording format (Annex 11). One year (2002/2003) record data analysis indicate that 20.1%, 42.4%, 26.0% and 11.5% of the 732,800 wet blue goat pelts and 7.5%, 37.7%, 37.1% and 17.4% of 653,680 pickled sheep pelts processed in the tanneries belongs to small, medium, large and extra large sizes respectively. Considering the proportion of skin in each size group, the amount of pickled sheep pelts and wet blue goat pelts presented for international market by size and grade and their value were given in Table 16 and Table 17. The Economic loses due to 'ekek' was calculated on the assumption that 70% of downgraded and reject on pickled sheep pelts and 42% of down grading and rejection on wet blue goat pelts (Annex 13) were due to 'ekek' and controlling 'ekek' will improve the proportion of downgraded and rejected skins to best skin grades (1-3) by 70% and 42% respectively. Accordingly based on the above points, the annual economic loses due to 'ekek' in Kombolcha and Dessie tanneries is calculated at about 1.6 million for pickled sheep skin and about 0.6 million for wet blue goat pelts. These calculated loses doesn't include processing and overhead costs in the tanneries.

Table 16. Economic loses due to 'ekek' on pickled sheep skin

		Grades					
Size	**Descrip**	**1 to 3**	**4**	**5**	**6**	**Reject**	**Total in USD**
Small	% grades	17.7	18.4	20.8	33.8	9.5	
	Quantity/Doz.	723.0	752.0	850.0	1,373.0	388.0	
	Value obtained	45,549.0	33,840.0	22,100.0	20,593.0	0.0	122,082.0
	value expected	45,549.0	43,315.2	44,115.0	74,965.8	17,118.8	225,063.8
	Difference		9,475.2	22,015.0	54,372.8	17,110.8	**102,973.8**
Medium	%grades	24.9	15.3	24.1	29.3	6.4	
	Quantity/Doz.	5,120.0	3,146.0	4,956.0	6,029.0	1,316.0	
	Value obtained	384,000.0	176,176.0	153,636.0	150,625.0	0.0	864,437.0
	Expected value	384,000.0	288,488.2	306,280.8	361,500.0	69,090.0	1,409,359.0
	Difference		112,312.2	152,644.8	210,875.0	69,090.0	**544,922.0**
Large	%grades	15.6	17.3	24.6	34.1	8.4	
	Quantity/Doz.	3,153.0	3,497.0	4,973.0	6,934.0	1,698.0	
	Value obtained	274,311.0	237,797.0	213,839.0	180,284.0	0.0	906,231.0
	Expected value	274,311.0	284,306.1	367,007.4	476,365.8	103,408.2	1,505,398.5
	Difference		46,509.1	153,168.4	296,081.8	103,408.2	**599,167.5**
Extra Large	%grades	13.6	16.1	28.3	34.1	7.9	
	Quantity/Doz.	1,314.0	1,556.0	2,735.0	3,295.0	763.0	
	Value obtained	123,518.0	116,700.0	123,075.0	102,145.0	0.0	465,438.0
	Expected value	123,518.0	137,394.8	241,500.5	320,603.5		873,222.2
	Difference		20,694.8	118,425.5	218,458.5	50,205.4	**407,784.2**
	Total Loses						**1,654,847.5**

Table 17. Economic loses due to 'ekek' on wet blue goat pelts

		Grades					
Size	**Descrip**	**1 to 3**	**4**	**5**	**6**	**Reject**	**Total in USD**
Small	% grades	17.2	21.3	23.8	27.3	10.4	
	Quantity/Doz.	2,116.4	2,620.9	2,928.6	3,359.2	1,279.7	
	Value Sold	78,306.8	62,901.6	43,929.0	33,592.0	0.0	218,729.4
	value expected	78,306.8	77,211.7	70,989.2	91,168.8	19,889.5	337,566.0
	Difference	0.0	14,310.1	27,060.2	57,576.8	19,889.5	118,836.6
Medium	%grades	20.5	25.2	24.3	26.4	3.6	
	Quantity/Doz.	5,309.1	6,526.4	6,293.3	6,837.2	932.3	
	Value Sold	254,839.6	169,686.4	119,572.6	82,046.9	0.0	626,145.5
	Expected value	254,839.6	229,990.3	196,225.0	185,424.8	18,795.2	885,274.9
	Difference	0.0	60,303.9	76,652.5	103,378.4	18,795.2	259,130.0
Large	%grades	14.2	18.3	26.4	29.8	11.3	
	Quantity/Doz.	2,252.8	2,903.3	4,188.4	4,727.8	1,792.7	
	Value Sold	117,147.7	104,519.2	92,144.4	94,555.9	0.0	408,367.2
	Expected value	117,147.7	124,029.0	144,918.6	158,097.6	39,152.6	583,345.5
	Difference	0.0	19,509.8	52,774.2	63,341.7	39,152.6	174,778.3
Extra Large	%grades	12.2	17.8	27.5	30.5	12.0	
	Quantity/Doz.	853.8	1,245.7	1,924.5	2,134.5	839.8	
	Value sold	46,958.2	43,599.1	57,735.6	46,958.2	0.0	195,251.1
	Expected value	46,958.2	54,063.4	77,942.3	76,543.3	19,399.1	274,906.3
	Difference	0.0	10,464.3	20,206.7	29,584.9	19,399.1	79,655.0
	Total Loses						**632,399.9**

5. DISCUSSION

The high prevalence of ectoparasites recorded in sheep (50.5%) and goats (56.7%) is suggestive of the importance of these health problems in small ruminants of the study area. Poor management and poor level of awareness of sheep and goat owners on the effect of ectoparasites are believed to have contributed to widespread occurrence of the diseases. This fact has been noted during the questionnaire study where only few respondents appreciate the effect of ectoparasites other than mange as either causing ill health problem or reducing the quality of skin.

Lice infestations were the most prevalent ectoparasites recorded both in sheep and goats with a prevalence of 39.8% and 29.2% respectively (Table 8). From the 299 sheep positive for lice, 37.4% were infested with *D. ovis*, 1.2% with *Linognathus spp* and 1.2% were having mixed infestation. Out of 220 goat cases, 28.3% were due to *Linognathes spp.* and 0.9% were due to *D. caprae*.

The overall lice prevalence obtained in this study is higher than observations made in central Ethiopia, 2.0% in sheep and 1.5% in goats (Mohammed, 2001), in southern rangeland 0% in sheep and 0.5% in goats (Nura, 2002) and around Kombolcha 14.2% (Abdulhamid, 2001). But lower than a higher prevalence of 89.5% report from examination of fresh sheepskin at Sebeta (Yesehak, 2000). Such differences in prevalence with the above observations may arise from differences in agro climate, management and health care of sheep and goats in the study sites and the sensitivity of the diagnostic method used to reveal ectoparasites. Besides this, examination of skin at collection center cannot give the true picture of the prevalence of louse infestation as there is easy contact transmission from skin to skin. The sensitivity and specificity of visual inspection by a skilled inspector on flock basis has been established to be 60% and 100% respectively but the test sensitivity on individual animal will be much lower than the aggregate sensitivity (Pearse and Gardner, 1994). Visual inspection for lice is known to have low sensitivity which varies with the number of lice per animal, skill of the inspector and the number of animal examined (Morcombe *et al.*, 1996).

Louse infestation may indicate some other underlying problem such as malnutrition and chronic diseases (Wall and Shearer, 1997). The possible reasons for such high prevalence of lice in the study area includes; poor sanitation, poor feeding and management, and inadequate

utilization of veterinary services. These conditions were observed during the study where sheep and goats were kept under dirty barns, allowed to graze on already devastated hilly areas with little vegetation cover. Besides this due to poor awareness of farmers on the pathogenic importance of the disease, only few owners reported to use modern veterinary service to treat louse infested animals. Lice infestations were associated with damage to the skin, loss in production, irritation and possibly vector in disease transmission (Radostitis *et al.*, 1994; Wall and Shearer, 1997). The irritation caused by even modest population of lice leads to scratching and rubbing, causing damage to the skin (Kettle, 1984) and severe infestation with *linognathus spp.* may cause anemia (Wall and Shearer, 1997). *D. ovis* is mobile and can spread over the entire body, causing considerable irritation, restlessness, interrupted feeding and loss of condition, and is responsible for development of nodular hypersensitivity reaction lesion (cockle) in pickled pelts (Heath *et al.*, 1995a; Wall and Shearer, 1997). A similar observation where *D. ovis* was strongly associated to 'ekek' was noted in both Kombolcha and Dessie tanneries. Considering the high prevalence of *D. ovis* in the study area and mobile nature of the parasite, the economic importance of lice both for farmer and for the tanning industry could be immensely very high.

According to Kettle (1984) *D. ovis* requires both suitable temperature, and fiber of appropriate diameter to which eggs can be attached for its oviposition. *D. ovis* eggs develop and hatch over the range of 33–39 °C and are virtually independent of humidity over the range of 7 – 75% RH. The temperature at skin surface of sheep is 37.5 °C, and this is the temperature at which maximum oviposition of *D. ovis* occurs. In this study, significant difference ($P<0.05$) in prevalence of *D. ovis* was recorded in adults (42.2%) than young (29.9%) sheep, and among highland (49.9%), midland (36.8%) and lowland (30%) agro climates (Fig. 3 and Table 11). The odds of *D. ovis* infestation in midlands and lowland were, respectively 0.588 times and 0.404 times higher than the highland. Young sheep were 0.6 times at risk for *D.ovis* infestation compared with adults. High prevalence of the parasite on adults and highland agro climate can be explained by requirements of *D. ovis* for its oviposition. Adult sheep have heavy fleece than young that provide a habitat which is readily colonized by lice and *Damalina* is susceptible to high temperature (Urquhart *et al.*, 1996).

The risk of *Linognathus* spp. in midland sheep was 9.3 times than lowlanders while in goats the prevalence in lowland was 0.542 times than in the highland. This may be attributed to the narrow temperature range required for lice breeding; when temperature is cooler than optimum, eggs do not develop while hotter temperature prevent egg laying and kill the lice

(Radostits *et al.*, 1994). *Linognathus spp.* infestation was more significantly prevalent in goats with poor body condition (37.9%) than those good (25.1%) body condition (Table 10 and Table 12). Poor body condition goats were 2.1 times more at risk for *Linognathus spp.* infestations than good body condition goats. Animals in poor condition and that are improperly feed and exposed to cold and debilitating diseases carry heaviest infestations of lice, since debilitated animals do not groom themselves and leave the lice undisturbed and *Linognathus spp.* were observed to cause anemia (Urquhart *et al.*, 1996).

M. ovinus was the second most important ectoparasite observed on sheep accounting for 12.5% overall prevalence. Infestation with *M. ovinus* does not produce any marked changes in health of sheep (Kettle, 1984). Presence of keds leads to irritation and staining of the wool by the feces of the ked. The irritation results in animal biting and rubbing with resultant damage to the fleece and development of a vertical ridging of the skin called 'cockle' (Kettle, 1984; Urquhart *et al.*, 1996; Wall and Shearer, 1997). The prevalence of *M. ovinus* was 36.5% in highland, 0.8% midland, however, no cases of *M. ovinus* was recorded in the lowlands. A similar result was obtained by questionnaire study where only respondents from highland considered keds as a problem in their area but no respondents from midland and lowland reported the existence of keds in their flock. The risk from *M. ovinus* infestation in midland was 0.014 times than the highland and much higher than the lowland since no cases were recorded (Table 11). According to Radostitis *et al.* (1994) and Kettle (1984) in the hot, humid tropics the parasite is restricted to cooler highlands and infestations may be lost when sheep are moved to hot dry areas. Kettle (1984) suggested as an account for this fact; temperature may play an important role in the dynamics of the keds. The finding of higher prevalence *M. ovinus* on wooly sheep (41.2%) and its total absence from hairy sheep is suggestive of the fact that wooly breeds are susceptible to ked infestation (Wall and Shearer, 1997). A significantly higher prevalence of the parasite on wooly sheep than wooly sheep which have been sheared (7.6%) is in line with the description that shearing may remove a high proportion (80–90%) ked population on sheep (Kettle, 1984).

Three genera of ticks (*Boophilus*, *Amblyomma* and *Rhipicephalus*) were identified both on sheep and goats. The species identified were *B. decoloratus*, *A. variegatum*, *A. gemma*, *R. pulchellus* and *R. evertsi evertsi*; with overall prevalence of 3.4% in sheep and 22.2% goats tick infestation. Infestation of *A. variegatum* and *A. gemma* were reported by Morel (1980) in sheep and Asrat (1987) and Dhuffera (1997) on sheep and goats. Mekuria (1987) reported *A. varigetum* both on sheep and goats in Nekemtie Awraja. *R. evertsi evertsi* (Morel, 1980; Asrat

1987; Mekuria, 1987; Dhuffera, 1997) and *R. pulchellus* (Morel, 1980; Asrat, 1987; Dhuffera, 1997) were also reported to exist on sheep and goats.

Both in sheep and goats, significantly higher prevalence of tick infestation was recorded in lowland and midland than highland (Fig. 3, Fig. 4, Table 11 and Table12). In goats, the risk of tick infestation in lowland and midland respectively was 46.7 and 38.6 times than that of highland. In sheep, the risk from tick infestation in midland was 0.166 times than the lowland. This may be attributed to higher temperature, humidity and prolonged sunlight that favor the survival and reproduction of ticks in lowland areas (Pangui, 1994). A similar observation by farmers was obtained during the questionnaire survey where only few respondents consider tick as a problem in their flock in the highland whereas about half of the respondents from midland and lowland recognize ticks as problem in their flocks. Sheep and goat owners also noted seasonality in occurrence of ticks which is related to the beginning of annual rain. Ticks were observed to affect poor condition (22.9%) goats than good condition (20%) goats ($P<0.05$). Young and undernourished animals are known to be susceptible to many diseases including ectoparasites (Noble and Noble 1982).

Tick infestations on sheep and goats have both cutaneous and systemic effects. The cutaneous effects of ticks feeding on sheep and goats includes development of papule, pustules, ulceration and alopecia while the systemic effects includes; introduction of surface bacteria into the skin, causing abscesses or systematically leading to bacteraemia and septicemia, tick paralysis due to neurotoxin or transmission of microorganism (Wall and Shearer, 1997). Despite such effects of tick on sheep and goats their effect as a cause of downgrading and rejection of skin in the tanneries was minimal. Because the major tick attachment site were ear/head, legs and belly region which are less valuable part of the skin for tanning and are usually trimmed off before tanning.

Clinical mange due to *Sarcoptes scabei var. caprae*, *Sarcoptes scabei var. ovis* and *Demodex caprae* were among the ectoparasitic diseases diagnosed on sheep and goats. The overall prevalence of clinical mange in sheep and goats were found to be 0.4% and 6.6% respectively. Tekle (1986) reported mange in 7.8% of sheep and 11.8% of goats in Hararghe, Tadesse (1994) 0.7% in sheep and 6.8% in goats in Dire Dawa, Nigussie (2001) nil in sheep and 6.9% in goats in Wolayta and Worku (2002) 2.1% in sheep and 4.3% in goats in Sidama zone. All this findings support the observation of farmers in the study area in which mange infestations are more prevalent in goats than sheep. According to the questionnaire finding

mange is more prevalent during the wetter and cooler months of the year. A similar seasonal observation was reported by Olubumni (1995) in Nigeria.

The present study revealed a prevalence of 0.4% sarcoptic mange in sheep and 6.1% in goats. This is in close agreement with previous observations made else where in the country: in Sidama zone 0.4% in sheep and 2.4% in goats (Worku, 2002) and around Wolayta 0% in sheep and 6.1% in goats (Nigussie, 2001). There was significant difference in prevalence of goat sarcoptic mange among highland (1.6%), midland (7.2%) and lowland (9.6%) agro climates. Goats in lowlands and midland were, respectively 4.6 and 5.0 times at risk for sarcoptic mange infestations than those in the highland. Interviewed farmers also noted that mange is more of a problem of lowland goats. According to Pangui (1994) high temperature, humidity and sunlight favor mange mite infestation. The higher temperature, humidity and sunlight which prevail in lowland and midland may have accounted for the differences in prevalence. The prevalence of the disease was also much higher in poor condition goats (15.3%) than good condition (3.0%). The susceptibility of poor condition animals to mange may be responsible for such difference (Radostitis *et al.*, 1994). The burrowing and feeding activities of *S. scabie* cause intense itching, inflammation, hair loss and formation of crusts of exudates, loss of condition and death (Olubunmi, 1995). Therefore the economic impact of mange must be certainly high judging from poor condition of affected animals, loss of affected skin, deaths due to the disease and cost of treatments.

Flea infestation with *Ctenocephalidus spp.* was one of the ectoparasite problem encountered in small ruminants of the study area. It is generally true that ruminants including sheep and goats, horses and pig do not have their own species of fleas (Urquhart *et al.*, 1996). However, most species of flea are not host specific and feed on any available animals, but in many cases full fertility is achieved after feeding on specific host. *Ctenocephalides spp.* occasionally infest sheep and goats and the clinical signs includes; papule, crusts, pruritus and excoriation (Wall and Shearer, 1997). In this study the prevalence of *Ctenocephalides spp.* was found to be 0.2% in sheep and 8.1% in goats. In goats, the prevalence of *Ctenocephalides spp.* in midlands (23.3%) was significantly higher than the lowland (0.8%) and the highlands (1.2%). This is probably associated with the high humidity, usually above 70% required for oviposition of their eggs (Wall and Shearer, 1997).

The study on association between different ectoparasites affected and control groups of skin and development of 'ekek' on pickled skin (Table 13) indicated that sheepskin infested with

D. ovis, *M. ovinus* and free control groups showed 'ekek' at pickled stage at prevalence of 100%, 95% and 15% respectively. The prevalence of 'ekek' at pickled stage on sarcoptic mange infested goatskin group was 100%. However, *Linognathus spp.* infested and free control groups of goatskins did not show any kind of 'ekek' lesion at pickled stage. Statistical analyses of these figures show a strong association between the presence of *D. ovis* and *M. ovinus* in sheep and sarcoptic mange in goats and occurrence of 'ekek' at pickled stages. In support of this finding, observation of Heath *et al.* (1995), Pfeffer *et al.* (1996) and Heath *et al.* (1996) indicate a positive relationship between *D. ovis* and pickled defect 'cockle' in New Zealand. Evertt *et al.* (1969) cited by Heath *et al.* (1995) was the first to demonstrate association between sheep ked, *M. ovinus* and rib cockle. Asp and Tauni (1988), Bayou *et al.* (1998) and Yesehak (2000) reported association of 'ekek' (a similar defect to cockle in Ethiopian sheep and goatskin) with existence of *D. ovis* and *M. ovinus* infestation on sheep. Bayou *et al.* (1998) and Abdulhamid (2001) also demonstrated the association of 'ekek' with sarcoptic mange in goats. In control groups of sheep skin in which no ectoparasite was found ekek' at pickled stage was detected on 3/20 (15%) of the pelts. Pfeffer *et al.* (1996) explained this fact as cockle ('ekek') can occur in response to a low number of lice and such light infestation may be missed during examination of the skin. In addition if the animals were treated before slaughter, it is possible that the lice could disappear before the cockle lesion had resolved which is expected to persist up to 20 weeks after removal of the lice (Heath *et al.*, 1996).

Failure of development of 'ekek' in one of the skin infested with *M. ovinus* may be attributed to the duration of infestation and number of *M. ovinus* required to initiate development of 'ekek' on the animal. A relationship between the severity and extent of cockle on a pelt and a number of ectoparasite present was suggested by Heath *et al.* (1995b). The study on severity of ectoparasite in each group (light, moderate and sever) and severity of 'ekek' lesion on pickled pelts (clear, light, moderate and sever) (Table 14) indicate a strong correlation in *D. ovis* infested ($p<0.001$), *M. ovinus* infested ($p<0.001$) sheepskin group and sarcoptic mange affected goat group ($p<0.05$). In support of these finding Heath *et al.* (1996) observed positive correlation of cockle severity with the size of terminal louse count.

The result from examination of pickled sheep and wet blue goat pelts showed that the major defects responsible for skin down grading and rejections (Annex 13 and Fig. 6) were 'ekek', scratches, scars and technical defects due to flaying, preservation and handling of the skins. In this study 'ekek' was found to be the most prevalent defect both on pickled sheep and wet

blue goat pelts. 'Ekek' as a single defect and together with other defects, was responsible for 70.8% of the pickled sheep and 42.3% of the wet blue goat pelts down grading and rejection. In the tanneries, selectors do not include larger round nodular lesions observed on goat pelts which on examination were due to demodectic mange as 'ekek' defect. After tanning demodectic mange lesions appear as round nodular cheesy mass which on further processing disappear leaving empty pockets that produce pit and scar on grain surface (FAO, 1995). The proportion of 'ekek' on pickled sheep pelts was found to be thrice more than that of wet blue goat pelts (Annex 13). This could be attributed to the different agents involved in development of 'ekek' lesion in sheep and goats. In 'ekek' affected skins, the most commonly affected parts of the pelts were the neck, shoulder, sides and belly altogether accounting for 67% and 64.5% of affected sites on pickled and wet blue skins respectively. The remaining proportion was infested by generalized 'ekek'. The present finding with regard to 'ekek' prevalence was much higher than observation of Asp and Tauni (1988) in which 30 % of pickled skin in Awash tannery were positive for 'ekek', but slightly lower than recent report (88.5%) by in pickled skin at Sebeta tannery (Yesek, 2000). All finding confirm the complaint of many tanneries regarding the growing increase in proportion of defects due to 'ekek' in recent 10 - 15 years. The high prevalence of 'ekek' is said to have increased from year to year and attained the maximum prevalence in 1999 (Pittards – Ethiopian partnership meeting, 1999).

Statistical analysis of 1000 sheep and 1000 goat pelts defects indicated that there was a significant association ($p<0.05$) between 'ekek' and scratch both on pickled sheep and wet blue goat pelts (Table 15). Asp and Tauni (1988) and Yesehak (2000) had also a similar observation on pickled sheep pelts processed in Awash and Sebeta tanneries respectively. This association could be attributed to the itching and rubbing of sheep and goats infested by lice, keds and mange mites against bushes, thorns posts and barbed wires (Asp and Tauni, 1988; Urquhart *et al.*, 1996; Wall and Shearer, 1997) causing scratches on their skin. A significant association ($P<0.05$) also found between 'ekek' and scar on pickled sheep and wet blue goat pelts (Table 15). This could be probably due to the development of secondary bacterial complication at sites where ectoparasites feed, causing lesions which up on healing leaves scars (Noble and Noble, 1982; Asp and Tauni, 1988).

This study revealed the proportion of pelts with 'ekek' were much higher in lower grades (grade 4, grade 5, grade 6 and rejects) compared with the first three best grades (Fig. 7). Infestation of sheep with *D. ovis* and *M. ovinus* and goats with sarcoptes mange leads to

development of 'ekek' and is responsible to cause higher proportion of pelts to fall into lower grades (Fig. 5). In agreement with this finding heath *et al.* (1996) has demonstrated association of *D. ovis* infestation of sheep with down grading of pelts, and Asp and Tauni (1988) and Yesehak (2000) also reported increase in intensity of 'ekek' at lower grades.

The impact of 'ekek' on the tanning industry is profound. This is mainly due to the fact that 'ekek' lesion can not be detectable at the raw skin and selection can not be made prior to processing. The defect appears only after processing the skin into pickled stage. Therefore the tanning industry loses three times with regard to each 'ekek' affected skin, first through the purchase of raw skin of undetectable inferior quality, secondly by the cost of processing of these skins and by the fact that such skins are down graded after processing and therefore are unsuitable for sale in the more profitable export markets (FAO, 1998). The different tanning costs in European tanneries are estimated to be 50 - 65% for raw materials, 20% for overhead, 12 – 15% for labor, 10% for chemical and 3% for energy costs (Hadly, 2001). In Ethiopia, since labor costs are cheaper than European industries; the proportion of raw material cost, overhead cost, energy and chemical costs are estimated to exceed the above figures. The economic impact of 'ekek' in Kombolcha and Dessie tanneries due to exported pickled and wet blue quality deterioration and rejection excluding the chemical, labor, overhead and energy cost was estimated to be between 1.6 million USD for sheep skin and around 0.6 million USD for wet blue goat skins. The economic loss due to 'ekek' would have been much higher than this, if clinically mange affected skins which are selected by skin and hide traders, had entered the tanneries. The Ethiopian tanning industries process 14.3 million skins annually (Mahmud, 2000). Out of which 706,166 dozen and 482,500 dozen is estimated to be sheep and goatskins, respectively. If a similar situation to this finding with regard to size and grades of the skins, and prevalence of 'ekek' exist all over the country; and all processed skins are exported, the annual lose due to 'ekek' taking the current export price is estimated to be 19.909, 170 USD and 5,988,218USD for sheep and goatskins ,respectively.

6. CONCLUSIONS AND RECOMMENDATIONS

Ethiopia has a huge small ruminant population characterized by different sheep and goat types that are adapted to different agro climate and environmental condition. However, their contribution to the national export income and food production is disproportionately small. Ectoparasites are among the major causes of sheep and goat production constraints and quality deteriorations of exported skin in Ethiopia. Even though difference in distribution of different ectoparasites was observed among agro climates, the overall prevalence is generally high resulting in high economic loses through decreased production and productivity, deaths and skin damages.

The major ectoparasites observed to infest sheep and goats were lice, keds mites and ticks. Lice (*D. ovis*) and sheep ked, *M. ovinus* in sheep and sarcoptic mange on goats were found to be strongly associated with sheep and goat pelt defect called 'ekek'. Ticks mainly infest sites which are trimmed before the tanning process; therefore their importance on deterioration of skin quality is minimal. Though *Linognathus* spp. was not observed to produce 'ekek' in pickled pelts; a strong association was observed between this parasites and scars and scratch. 'Ekek' along with scratch, scars and technical defects were the major causes of skin down grading and rejection in the tanneries. 'Ekek' was found responsible for down grading and rejection of 70.8% of the sheep and 42% of the goat pelts in the tanneries implicating a huge economic loss. Except in clinically mange affected skin lesions, 'ekek' is not observed in the raw skin. Because of this the economic loses due to 'ekek' are not only due to down grading and rejection but also due to costs of processing affected skins. Though there are different grading systems standards for raw, pickled and wet blue skins, only the pickled skin grading standards were observed to be used by the tanneries for both pickled and wet blue pelts. Moreover, the raw skin grading system was not implemented specially for salted skins.

Therefore based on the above points and others the following recommendations are forwarded.

- The effect of ectoparasite on production, productivity and skin quality other than the killer (mange) is not appreciated by farmers. Moreover technical defects on the skins due to faulty flaying, preservation and handling can be reduced through public awareness. Therefore; effective extension programs that raise public awareness on

effect of ectoparasites and method of flying, preservation and handling of skins should be implemented.

- Adaptation of standard grading system by all tanneries and training of selectors on the grading systems together with price by grade system should be implemented. This will reduce costs of processing of inferior materials a nd encourage farmers to keep the health of their animals and thereby produce quality product.
- Reducing the prevalence of ectoparasites mainly relies on treatment of affected animals with appropriate acaricides and improving the management system. Therefore all stakeholders: farmers, tanners and the government should participate and implement effective ectoparasite control programs.
- Further detailed study on economic loses associated with 'ekek' and investigation of other causes of skin downgrading and rejection should be conducted.

7. REFERENCES

Abdulhamid, N. (2001): Prevalence and Effects of Ectoparasites in Goats and Fresh Pelts & Assessment of Wet Blue Skin Defects at Kombolcha Tannery South Wollo, DVM thesis, Faculty of veterinary Medicine (FVM), Addis Ababa University, Debre Zeit.

ABoA. (1999): An overview of the Veterinary Services Delivery Activities.

Asfaw, A. (1998): The Tanning Industry. In: Ian, B.C. and Bayou, B. (eds.) Proceedings of Control of Sheep and Goat Skin Diseases for Improved Quality of Hides and Skin, 13-14 Feb.1998, FAO, Addis Ababa.

Asfaw, A. (2002): Challenges and Prospects of the Leather Industry in Relation to Export promotion. In: Parenti, A. (ed.) Proceedings of Challenges and Solutions for Ethiopian Leather Industry, 10 December 2002, UNIDO, Addis Ababa.

Asfaw, W. (1997): Country Report: Ethiopia. In: Proceedings of a Seminar on Livestock Development Policies in Eastern and Southern Africa, 28 July-1August, 1997, Mbabany, Organized By CTA, OAU/IBAR and The Ministry of Agriculture and Cooperative, Swaziland.

Ashine, S. (1987): Survey and Treatment Trail of Mange Mites in Sheep and Cattle of Robe Area, Bale Administrative Region, DVM thesis, FVM, Addis Ababa University, Debre Zeit.

Asp, J. and Tauni, M. (1988): Skin Diseases on Ethiopian Sheep and Their Effect on the Pickled Skin, A minor Field Study, Sweden University of Agricultural Sciences, Uppsala, pp. 27.

Asrat, G. (1987): Survey of Ticks on Domestic Animals in Harrarghe Administrative Region, DVM thesis, FVM, Addis Ababa University, Debre Zeit.

Bay, D. E. and Harris, R.L. (1988): Introduction to Veterinary Entomology (A Guide to Livestock Insects), Stonefly Publishing, Texas, pp. 111.

Bayou, K. (1998): Control of Sheep and Goat Skin Diseases. In: By Ian, B.C. and Bayou, B. (eds.) Proceedings of Control of Sheep and Goat Skin Diseases for Improved Quality of Hides and Skin, 13-14 Feb, 1998, FAO, Addis Ababa.

Bowman, D. D. and Lynn, R. C. (1999): Georgis' Parasitology for Veterinarians, Seventh Edition, W.B. Sounder Company, pp. 1-78.

Central Agricultural Census Commission (2003a): Ethiopian Agricultural Sample Enumeration, 2001/02, Statistical report on Livestock and Farm Implements, Addis Ababa, Ethiopia.

Central Agricultural Census Commission (2003b): Ethiopian Agricultural Sample Enumeration, 2001/02, Result for Amhara Region, Statistical report on Livestock and Farm Implements, Part 4, Addis Ababa, Ethiopia.

Chakole, K. (2001): Hides and Skin Defects, Nature and Effect on The Industry, Paper Presented at Technical Workshop on Good Practice For Ethiopian Hides and Skin Industry, 4-7 Dec. 2001, Addis Ababa.

Cole, H. E. (1986): Veterinary Clinical Pathology, 4th, ed., W.B. Saunders company, Philadelphia, pp. 391–403.

Degume, W. (2202): Production and Marketing Problem of AMALGMA. In: Parenti, A. (ed.) Proceedings of Challenges and Solutions for Ethiopian Leather Industry, 10 December 2002, UNIDO, Addis Ababa.

Demissie, A., Siraw, B., Teferi, K., Sertse, T., Mamo, G., Mekonnen, D. and Shimelis, S. (2000): Mange: A Disease of Growing Threat for the Production of Small Ruminants in Amhara Regional State. In: Proceedings of the Opportunities and Challenges of Goat Production in East Africa, a conference Held 10-12 Nov. 2000 at Debub University, Awassa, Ethiopia.

Dhuffrea, W. (1997): Survey of Ticks and Tick-borne Diseases in eight Domestic Animals in and Around Debre Zeit, DVM thesis, FVM, Addis Ababa University, Debre Zeit.

Gaime, H. (1994): The Prevalence of Mange Mite Infestations in Camel, Cattle and Sheep In and Around Makelle, DVM thesis, FVM, Addis Ababa University, Debre Zeit.

Gatenby, M. R (1991): Sheep. Coste, R. and Smith, J. A (eds.), The Tropical Agriculturalist, Macmillan (London) and CTA (Wageningen), PP, 6-11.

Getachew, T. (1995): Parasites of small Ruminants. In: Gray, G. D. And Uilenberg, G, (eds.) Parasitological Research in Africa.

Hadly, P. (2001): Improved Hide Quality through Ectoparasite Control. Paper Presented at Technical Workshop on Good Practice for Ethiopian Hides and Skin Industry, 4-7 Dec. 2001 Addis Ababa.

Health, A. C. G., Cole, D. J. W., Bishop, D. M., Pfeffer, A., Cooper, S. M., Risdon, P. (1995a): Preliminary Investigations into the Etiology and Treatment of Cockle, a Sheep Pelt Defect. *Veterinary Parasitology,* **56**, 239-254.

Health, A. C. G.; Bishop, D. M., Cole, D. J. W., Pfeffer, A. T. (1996): The Development of Cockle, a Sheep Pelts Defect, in Relation to *Bovicola ovis*, the Sheep Biting Louse. *Veterinary Parasitology*, **67**, 259-267.

Heath, A.C.G., Cooper, S.M., Cole, D. J. W. and Bishop, D. M. (1995b): Evidence for the Role of Sheep Biting Lice (*Bovicola ovis*) in producing Cockle, a Sheep pelt Defect. *Veterinary Parasitology*, **59**, 53 – 58.

Hopla, C. E., Dureden, L. A., .Keirans, J. K. (1994): Ectoparasites and Classification. *Rev.Sci.Tech.off. Int. Epiz.*, **13(4)**, 985 – 1012.

FAO (1998): Control of Sheep and goat Skin Diseases for Improved Hide and skins (phase II), Ian, B. C. and Bayou, K. (eds.), Proceedings on hide and skin Improvement, 13–14 Feb. 1998, FAO, Addis Ababa.

FAO (1995): Flaying and Curing of Hide and Skins as a Rural Industry; FAO Agricultural Development Paper No.49, Rome, Italy, pp.134.

FAO (1992): Production Yearbook, Vol. 46.

Jackson, P. (1991): Skin Diseases in Goats. In: Boden, E. (ed.) Sheep and Goats Practice, Bailliere, Tindal.

Kebede, N. (1992): Preliminary Survey of Mange of Sheep and Cattle In and Around Addis Ababa, DVM thesis, FVM, Addis Ababa University, Debre Zeit.

Gryseels, G. and Anderson, F. M. (1983): Studies on Traditional Agricultural systems, Initial result, 19977 -1980. In: Research on Farm and Livestock productivity in central Ethiopian Highlands, ILCA, Addis Ababa, Pp. 7 -22

Kimberling, C. V. (1988): Jenson and Swifts Disease of Sheep, 3rd Edition, Lea and Febiger, Philadelphia, pp. 285 – 315.

Kyomo, M. L. (1997): Global and African trends in Livestock sector: Opportunities and Challenges to its Development. In: Proceedings of a Seminar on Livestock Development Policies in Eastern and Southern Africa, 28 July-1August, 1997, Mbabany, Organized By CTA, OAU/IBAR and the Ministry of Agriculture and Cooperative, Swaziland.

Lehman, T. (1993): Ectoprasites: Direct Impact on Host Fitness. *Parasitology Today,* **9,** 8-13.

Mahmud, M. (2000): Raw Hides and Skin Improvement in Ethiopia Status and Challenges. In: Proceedings of the Opportunities and Challenges of Goat Production in East Africa, a conference Held 10-12 Nov. 2000 at Debub University, Awassa, Ethiopia.

Mekonnen, K. Gizaw, S. Desta, L. (1999): Yeku Integrated Water Shade Development Project Feasibility Study Report, Bureau of Agriculture, Amhara Region.

Mekuria, B. (1987): A preliminary Survey of Ticks of Domestic Animals in Nekemt Awraje, DVM thesis, FVM, Addis Ababa University.

Mohammed, H. (2001), Study on Skin Disease of Small Ruminants in Central Ethiopia, DVM thesis, FVM, Addis Ababa University, Debre Zeit.

Morcombe, P. W., Young, G. E., Ball, M. D. and Dunlop, R. H. (1996): The detection of Lice (*Bovicola ovis*) in Mobs of Sheep: a Comparison of Fleece Parting, the Lamp test and Table lock Tests. *Aust. Vet. J.*, **73**, 170 – 173.

Morel, P. C. (1980): Study on Ethiopian Ticks (Acarida, Ixodida) Republic of France, Ministry of Foreign Affairs, French Veterinary Mission, Addis Ababa, pp. 332.

Musema, K. (2002): Study on Mange Mites Infestations in Small Ruminants and Camel in Two Selected Agro Climatic Zone of Tigray, DVM thesis, FVM, Addis Ababa University, Debre Zeit.

Noble,R. E. and Noble, A. G. (1982): Parasitology; The Biology of Animal Parasites, 5th ed., Lea and Fabiger, USA, 323 – 370.

Nugussie, C. (2001): Study on Skin Disease of Cattle Sheep and Goats In and Around Wolayta Soddo, DVM thesis, FVM, Addis Ababa University, Debre Zeit.

Nura, M. (2001): Epidemiological Study on Skin Diseases of Small Ruminants in the Southern Rangeland of Oromia, DVM thesis, FVM, Addis Ababa University, Debre Zeit.

OIE (2002): Mange: In: Manual of standards Diagnostic Tests and Vaccines. Oie@oie.int

Okello-onen, J., Hassan, S. M. and Essuman, S. (1999): Taxonomy of African ticks; An Identification Manual, ICIPE Science Press, Nairobi, PP. 124.

Okoh, A. E. J and Gandame, J. N. (1992): Sarcoptic Mange of Sheep in Plateau State, Nigeria. *Bull. Anim. Hlth. Prod. Afri.* **30,** 61-63.

Olubunmi, P. A. (1995): The Prevalence of Mange Due to *Sarcoptes Scabiei var capri* in Ile-Ife Area of Nigeria, Its Control and Management. *Bull. Anim. Hlth. Prod. Afr.* **43,** 115-119.

Pangui, L. J. (1994): Mange in Domestic Animals and Methods of Control. *Rev. Sci. Tech. off. Int. Epiz.*, **13(4),** 1227 – 1243.

Pearse, H. G. B. and Gardner, J. A. (1994): Probability of Correctly Identifying a Lice-affected Flock of Sheep using Visual Inspection (Fleece Parting). *Wool Tech. Sheep Breed*, **(42)** 144 – 149.

Peter, G. (1995): Parasites and Skin Diseases. J. A. Allen &Company Limited, London.

Pfeffer, A., Cole, D. J. W., Bishop, D. M., Health, A. C. G., Phagan, M. D. (1996): Detection of *Dermatophilus* and Lice (*D. ovis*) On Flayed Pelts and Cockle on the Skin of Live Lambs. *New Zealand Veterinary Journal, (***44),** 121-125.

Pittards-Ethiopian Partnership review Meeting (1999): No 10, Addis Ababa, pp 9 – 21.

QSAE (2001): Leather: Wet blue Chrome Tanned Skin General Requirements (ES 206:2001).

QSAE (2001): Raw Hides and Skins: Grading of Sheep and Goatskins by Appearance and Mass (ES 39: 2001).

QSAE (2001): Raw Hides and Skins: terminology relating to Defects (ES 32: 2001).

Radostits, O. M., Blood, D. C., Gay, C. C. (1994): Veterinary Medicine, Textbook of Cattle, Sheep, Pigs, Goats and Horses, 8th Edition, Bailliere Tindall, UK, pp. 1280-1308.

Roberts, I. H., Blachut, K., Meleney, W. P. (1971): Over Summering Location of Scab Mite, *Psroptes ovis,* on Sheep in New Mexico. *Annals of Entomological Society of America,* **6,** 105-108

Sewell, M. M. H. and Brockesby, D. W. (1990): Hand Book on Animal Disease in the Tropics, 4th Edition, Bailliere Tindall, pp.2 -28.

Sherman, M. D. (1998): Diagnosis of Major Skin Diseases of Sheep and Goats. In: Proceedings of Control of Sheep and Goat Skin Diseases for Improved Quality of Hides and Skin, 13-14 Feb.1998 Addis Ababa, Edited By Ian, B. C. and Bayou, K. FAO, Addis Ababa.

Smith, M. C. and Sherman, D. M. (1994): Goat Medicine, Williams and Wilkins, Maryland, pp. 17 – 47.

Soulsby, E. J. C. (1982): Helminthes, Arthropods and Protozoa of Domestic Animals, 7th edition, Lea and Faebiger, Philadelphia, pp. 375 – 502.

Stata Corp. (2001): Stata Statistical Software. Release 7.0, College station, Texas.

SPSS for Windows (2002): SPSS for Windows, Release no. 11.5.0, LEAD Technologies Inc.

Steele, M. (1996): Goats. Coste, R. and Smith, J. A (eds.), The Tropical Agriculturalist, Macmillan (London) and CTA (Wageningen), PP. 79-80.

Tadesse, Z. (1994): Survey on Mange Mite and Ticks of Camel and Small Ruminants in Dire Dawa Region, DVM Thesis, FVM, Addis Ababa University, Debre Zeit.

Takele,G. (1986): Preliminary Survey of Mange Mites in Black Ogaden Sheep, Goats and Pigs in Harrarghe Administrative Region, DVM Thesis, FVM, Addis Ababa University, Debre Zeit.

Urquhart, G. M., Armour, J., Duncan, J. L., Dunn, A. M. and Jennings, F. W. (1996): Veterinary Parasitology, 2nd ed., Blackwell Science Ltd, UK pp 141 – 205.

Wall, R. and Shearer, D. (1997): Veterinary Entomology, 1st ed., Chapman and Hall, UK, pp 439.

Win Episcope 2. (2000): Version 5.1.2600, Microsoft Corp.

Worku, T. (2002): Study on Small Ruminants Skin Disease in Sidama Zone, DVM thesis, FVM, Addis Ababa University, Debre Zeit.

Yesehak, E. (2000): A Study on Ectoparasites of Fresh Sheep Pelts and Assessment of Pickled Skin Defects Processed at Sebeta Tannery, DVM thesis, FVM, Addis Ababa University, Debre Zeit.

Zelalem, A. and Fletcher, I. C. (1993): Small Ruminant Productivity in the Central Ethiopian Mixed Farming System. In: Proceedings of the Fourth National Livestock Improvement Conference, 13 – 15 Nov., IAR, Addis Ababa, Ethiopia.

8. ANNEXS

Annex 1. Questionnaire for sheep and goat owners

Date _____ Zone _____ Woreda_____ Kebele_____
Village_____ Owner Name_____

1. Family income source (Rank)

Crop sale ☐ Animal product sale ☐
Animal sales ☐ others ☐

2. Livestock ownership pattern (number of animals owned).

Sheep ☐ Camel ☐
Goats ☐ Equines ☐
Cattle ☐ Poultry ☐

3. Why do you keep sheep and goats? (Rank)

For income generation and insurance ☐ Wool production ☐
Meat for home consumption ☐ Skin production ☐
Milk for consumption ☐ others ☐

4. Management type
   - o Mixed farming ☐
   - o Pastoral ☐

5. Which species are more important for this area?
   - o Sheep ☐
   - o Goats ☐
   - o Equally ☐

6. How do you manage sheep and goats?
   - • Mixed with other species of animals ☐
   - • Separately ☐

Do you know any skin diseases that affect sheep and goats?
   - o Yes ☐
   - o No ☐

8. If yes, can you mention them?

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9. Which species are more commonly affected?

Disease	Sheep	Goats	Equally
Lice	☐	☐	☐
Ticks	☐	☐	☐
Keds	☐	☐	☐
Mange mite	☐	☐	☐
Dermatophilosis	☐	☐	☐
Others	☐	☐	☐

10 which age groups are more affected

Disease	Sheep			Goats		
	Lamb	young	Adult	Kid	young	Adult
o Lice	☐	☐	☐	☐	☐	☐
o Ticks	☐	☐	☐	☐	☐	☐
o Keds	☐	☐	☐	☐	☐	☐
o Mange mite	☐	☐	☐	☐	☐	☐
o Dermatophilosis	☐	☐	☐	☐	☐	☐
o Others	☐	☐	☐	☐	☐	☐

11. Is there seasonal variation in the occurrence of the diseases?

Diseases	Yes	No	I don't know
Lice	☐	☐	☐
Ticks	☐	☐	☐
Keds	☐	☐	☐
Mange mite	☐	☐	☐
Dermatophilosis	☐	☐	☐
Others	☐	☐	☐

12. If yes, in what season the disease is mostly encountered?

- o Lice
- o Keds
- o Ticks
- o Mange Mite
- o Dermatophilosis

13. Which skin diseases have effect on sell of sheep and goats?

	Yes	No
• Lice	☐	☐
• Keds	☐	☐
• Ticks		
• Mange Mite	☐	☐
• Dermatophilosis	☐	☐

14. Do they have effect on the sell of skin?

	Yes	No
• Lice	☐	☐
• Keds	☐	☐
• Ticks	☐	☐
• Mange Mite	☐	☐
• Dermatophilosis	☐	☐

15. How do you treat skin diseased animals?

- Modern treatment ☐
- Traditional treatment ☐

16. Which skin diseases are treated traditionally?

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17 What is the name of traditional remedy used? And its effect (recovery/ Partial recovery)

---

18. Are there other control methods other than treatment? If yes please mention it.

Annex 2. Definition and synonyms.

Papule: are a circumscribed solid mass less than 1 cm in diameter that is usually elevated and erythematous. Follicular papules suggest bacterial, fungal or parasitic infections, whereas papules without a hair follicle at the center are typical of allergy and ectoparasites.

Vesicles and pustules: A vesicle is a papule shaped fluctuant elevation containing serum. They are transient and suggest autoimmune irritant or viral etiologies. A pustule is pus filled vesicle and indicate infection, if follicular in orientation but may be autoimmune if non follicular. Demodicosis is a common follicular lesion in goats.

Hyperkeratosis: is an increased thickness of stratum corneum. During clinical examinations, hyperkeratosis is used to refer to accumulation of adherent keratinized material.

Scales and Crusts: Scales (Squames, flakes) are loose fragment of stratum corneum. Admixture with sebaceous and apocrine secretions makes the scales yellowish, greasy and adherent. Crusts are solid adherent combinations of materials such as serum, blood, pus, keratin, microorganisms and medications. They indicate the exudation has occurred and thus are nonspecific.

Alopecia: Spontaneous hair loss occurs more often in crossbreeds, mainly at the end of winter. Shearing at inappropriate time is thought to increases the risk of hair loss. Nutritional deficiencies or imbalances (such as high Calcium with low Zinc) have also been incriminated. Partial alopecia (hypotrichosis) is a nonspecific secondary lesion.

Pruritus (itching): frequently lead to excoriations and other secondary lesions. If pruritis is severe, special consideration is given to the possibility of sacrcoptic or chorioptic mange. Other conditions that may be pruritic include lice, zinc deficiency and photosensitization.
Erythema (reddening): it occurs in many acute disease conditions and is not diagnostic.

Absence of the skin: several congenital skin defects seen in sheep, including cutaneous asthenia, where the skin is abnormally fragile and easily torn, and epitheliogenesis imperfecta, where portion of epidermis is absent, apparently have not been reported in goats.
Brand marks: are man made ownership identification marks by hot iron on the animal skin.

'Ekek'/Cockle: is allergic dermatitis which causes itching, observable only after removal of the hair or wool and is characterized by multiple small circular lesions on the grain side of the skin.

Flaying: is removal of the skin from the animal.

Fly damages: are defects caused by faying knife.

Grain: is the surface of the skin on the hair or wool side.

Old age defect: is a grain defect which appears as dark discoloration along the back bone.

Putrefaction: is a fermentation of skin protein by bacteria producing foul smelling.

Scars: are circumscribed white spots, slightly thicker than the surrounding leather.

Scratches: are elongated scars of different size.

Bad bleeding: is a defect due to small cutaneous vessels that appear as slightly depressed line on the grain side of the skin because of improper bleeding.

Annex 3. Grading of raw skins in relation to defects

Skin origin	Grade	Characteristics
Lamb, sheep, goats.	Grade 1	No visible defect which are likely to depreciate the skin, appearing beyond 5 cm from the edges.
	Grade 2	Defects assessed to a total of 1– 3 defect units.
	Grade 3	Defects assessed to a total of 3–7 defect units.
	Grade 4	Defects assessed to a total of more than 8 defect units, the unusable area being at the most equal to 50 % of the area.
	Rejects	Skins of which more than 50% of the area is unusable

Source: QSAE (2001) ES 39:2001

Annex 4. Grading of pickled skin in relation to defects

Skin origin	Grade	characteristics
Lamb, sheep, goats	Grade 1	No visible defects which are likely to depreciate the skin.
	Grade 2	One defect assessed to a total of 1 – 2 defect units appearing within 5 cm from the edges.
	Grade 3	Defects assessed to a total of 3 - 6 defect units.
	Grade 4	Defects assessed at more than 7 defect units, appearing in not more than 20% of the total area of the skin.
	Grade 5	Defects assessed at more than 7 defect units, appearing in not more than 50% of the total area of the skin.
	Grade 6	Culls of which more than 50% of the area is usable
	Rejects	Culls of which more than 50% of the area is unusable.

Source: QSAE (2001) ES 39:2001

Annex 5. Grading of pickled skin by size

Skin origin	Size	Size in dm^2	Code
lamb		Up to 20	00
		20 to 40	01
Sheep, Goats	Small	20 to 40	00
	Medium	40 to 65	01
	Large	65 to 90	02

Source: QSAE (2001) ES 39:2001

Annex 6. Grading of wet blue chrome tanned leather

Grades	Characteristics
Grade1	Skins with good grain appearance and full of substances with two or three minor defects outside the butt and shoulder area which do not depreciate the quality of the skin.
Grade 2	Skins with good grain appearance with closed minor defects possibly along belly and back and two or three similar defects randomly spread on the butt and shoulder area, this skin have a cutting value of about 90%.
Grade 3	Skins with good grain appearance with closed minor defects possibly along belly and back and two or three similar defects randomly spread on butt and shoulder areas, this skin will have a cutting value of about 80%.
Grade 4	Skins with a cutting value of at least 70%, major defects visible on neck portion with minor defects on butt and shoulder.
Grade 5	Skins having at least 60% cutting value with random, minor skin blemishes all over the skin.
Grade 6	Skins having similar defects as grade 5, but having a cutting vale of about 50%.
Grade 7	Skins having the same grain characteristics as grade 6, but slightly poorer in substances and having cutting value of not less than 25%.
Grade 8	Skins with empty substances with major deformation in shape and highly irregular in grain character with 10 – 25% cutting value.
Rejects	Skins with less than 10% cutting value.

Source: QSAE (2001) ES 206: 2001

Annex 7. Detailed crude summary of questionnaire study

Description	Number of respondents by agro climate		
	Highland	Midland	Lowland
1. Rank of income			
Crop			
o 1	17	14	11
o 2	8	9	15
o 3	0	0	0
Animal			
o 1	6	9	15
o 2	19	16	11
o 3	0	0	0
Animal product			
o 1	0	0	0
o 2	0	0	0
o 3	24	23	26
Others			
o 1	2	2	0
o 2	0	0	0
o 3	0	0	0
o 4	0	1	0
2. Livestock ownership pattern			
Small ruminant			
• No	0	0	0
• 1 – 5	1	13	10
• 5 – 10	9	8	8
• >10	15	4	8
Cattle			
• No	1	0	4
• 1 – 5	19	14	15
• 5 – 10	3	11	4
• >10	2	0	2
Equine			
• No	11	22	11
• 1 – 5	12	3	15
• 5 – 10	2	0	0
• >10	0	0	0
Poultry			
• No	2	7	16
• 1 – 5	7	12	5
• 5 – 10	5	4	5
• >10	11	2	0
Camel			
• No	25	25	22
• 1 – 5	0	0	3
• 5 – 10	0	0	1
3. Reason for small ruminants keeping			
Income and Insurance			
▪ no	0	0	0

▪ 1	25	21	24
▪ 2	0	4	2
▪ 3	0	0	0
Home meat			
▪ No	1	1	0
▪ 1	0	4	1
▪ 2	24	20	16
▪ 3	0	0	9
Home milk			
▪ No consumption	24	20	8
▪ 1	0	0	1
▪ 2	0	0	8
▪ 3	1	3	9
▪ 4	0	2	0
Wool production			
▪ No	19	25	26
▪ 1	0	0	0
▪ 2	0	0	0
▪ 3	4	0	0
▪ 4	2	0	0
Skin production			
• No	0	0	0
• 1	0	0	0
• 2	1	0	0
• 3	20	20	9
• 4	4	5	17
4. The more important species in the area.			
• Sheep	25	16	9
• Goat	0	9	11
• Equal	0	0	6
5. Sheep and goat management system			
• Mixed with other species	12	24	2
• Separately	8	1	24
6. Knowledge f skin diseases on sheep and goats			
• Yes	23	22	24
• No	2	5	2
7. Type of skin disease known			
• Mange	1	20	24
• Keds	23	0	0
• Lice	8	2	1
• Ticks	1	6	5
• Others	2	4	1
8. More commonly affected species			
Mange			
• Sheep	0	0	2
• Goat	1	18	19
• Equally	0	2	3
Keds			

• Sheep	23	0	0
• Goat	0	0	0
• Equally	0	0	0
Lice			
• Sheep	8	0	0
• Goat	0	2	1
• Equally	0	0	0
Ticks			
• Sheep	1	3	3
• Goat	0	2	1
• Equally	0	1	1
9. More commonly affected age group			
▪ Mange			
▪ Lamb/kid	0	7	0
▪ Young	0	0	0
▪ Adult	1	7	2
▪ All	0	6	22
keds			
▪ Lamb/kid	0	0	0
▪ Young	8	0	0
▪ Adult	15	0	0
▪ All	8	0	0
Lice			
▪ Lamb/kid	0	2	0
▪ Young	0	0	0
▪ Adult	5	1	1
▪ All	3	0	0
Ticks			
▪ Lamb/kid	0	0	0
▪ Young	0	0	1
▪ Adult	1	3	1
▪ All	0	3	3
10. Seasonality of the disease			
Mange			
o Yes	1	11	14
o No	0	9	10
Keds			
o Yes	15	0	0
o No	8	0	0
Lice			
o Yes	5	1	0
o No	3	1	1
Ticks			
o Yes	1	4	5
o No	0	2	0
11. Season of occurrence			
Mange			
• Dry	0	0	0
• Rainy	0	1	0
• Cold	1	10	14

Keds			
• Dry	15	0	0
• Rainy	0	0	0
• Cold	0	0	0
Lice			
• Dry	5	1	0
• Rainy	0	0	0
• Cold	0	0	0
Ticks			
• Dry	1	4	5
• Rainy	0	0	0
• Cold	0	0	0
12. Skin disease that affect sell of sheep and goats.			
Mange			
o Yes	1	20	24
o No	0	0	0
Keds			
o Yes	7	0	0
o No	16	0	0
Lice			
o Yes	3	1	0
o No	5	1	1
Ticks			
o Yes	0	1	0
o No	1	5	5
13. skin diseases that affect sell of skin			
Mange			
o Yes	1	20	24
o No	0	0	0
Keds			
o Yes	2	0	0
o No	21	0	0
Lice			
o Yes	2	0	0
o No	6	2	1
Ticks			
o Yes	0	0	0
o No	1	6	5
14. Ectoparasite treatment method used			
▪ Modern	2	16	23
▪ Traditional	0	8	4
▪ None	21	0	0
15. Control method other than treatments.			
▪ Culling	0	2	0
▪ Flock segregation	0	0	1
▪ Shearing	20	0	0
▪ None	3	18	23

Annex 8. Frequency distribution of ectoparasites on sheep and goats by agro climates

Ectoparasite identified	Highland		Midland		Lowland	
	Sheep n=252	Goats n=250	Sheep n=250	Goats n=251	Sheep n=250	Goats n=251
D. ovis	125	0	92	0	73	0
D. caprae	0	6	0	0	0	1
M. ovinus	92	0	2	0	0	0
Sarcoptic mange	2	4	1	18	3	24
Demodectic mange	0	0	0	1	0	3
Linognathus species	0	84	16	69	2	61
Ctenocephalides	0	3	2	56	0	2
B. decoloratus	0	2	0	13	1	11
A. variegatum	0	1	3	51	10	23
A. gemma	0	0	1	13	2	8
R. pulchalis	0	0	0	9	12	45
R. evertsi evertsi	0	0	0	0	5	11
overall	**181**	**99**	**103**	**176**	**86**	**149**

Annex 9. Frequency distribution of ectoparasites on sheep and goats by age

Ectoparasite Type	Young (Kid/Lamb)		Adult	
	Sheep (n= 224)	Goats (n= 278)	Sheep (n=528)	Goats (n=474)
D. ovis	67	0	253	0
D. caprae	0	4	0	2
M. ovinus	31	0	63	0
Sarcoptic mange	1	14	2	32
Demodectic mange	0	0	0	4
Linognathus species	3	76	15	128
Flea infestations	0	29	2	32
B. decoloratus	0	8	1	20
A. variegatum	4	31	9	44
A. gemma	0	7	3	14
R .pulchalis	1	27	11	33
R. evertsi evertsi	3	3	2	8
Overall	**94 (54.16)**	**167(41.96)**	**286(54.22)**	**257(60.07)**

Annex 10. Frequency distribution of ectoparasites on sheep and goats by body condition

Ectoparasite type	**Good**		**Poor**	
	Sheep(n=623)	Goats(n=562)	Sheep (n=129)	Goats (n=190)
D. ovis	236	0	54	0
D. caprae	0	6	0	1
M. ovinus	85	0	9	0
Sarcoptic mange	2	17	1	27
Demodectic mange	0	1	0	3
Linognathus species	12	142	6	72
Flea infestations	1	48	1	13
B. decoloratus	0	3	1	23
A. variegatum	8	17	5	58
A. gemma	1	2	2	19
R. pulchalis	10	17	2	37
R. evertsi evertsi	1	4	4	7
Overall	**306 (49.12%)**	**292 (51.96%)**	**74 (57.36%)**	**140 (73.68%)**

Annex 11. Tannery skin selection by size and grade recording format

Lot No._____ Origin of the skin_____

Grade	**Size**					**Total**
	Extra Small	Small	Medium	Large	Extra large	
1						
2						
3						
4						
5						
6						
Rejects						
Total						

Annex 12. Average export price of pickled sheep and wet blue goat pelts by size and grade

Item	Size	Price in USD by Grade							
		Grade 1 - 3		Grade 4		Grade 5		Grade 6	
		Min	Max	Min	Max	Min	Max	Min	Max
Pickled	30/40	38	42	26	30	15	18	8	9
sheep	40/50	60	63	41	45		26		15
skin	50/60		75	53	56	29	31	23	25
	60/70	84	87	63	68	36	43	25	31
	70+	93	94	67	75	44	45	22	26
Wet	30/40	24	28		16		10		8
blue	40/50	34	37	20	24		15		10
goat	50/55	40	48	21	26	18	19		12
skin	60/70	49	52	30	36		22	16	20
	70+	53	55		35	24	30	18	22

Source: National Bank of Ethiopia (2004) Personal Communication

Annex 13. Percentage defects on pickled sheep and wet blue goat pelts

Defects type	% Wet blue Goat pelt	% Pickled sheep pelt
Ekek	42.3	70.8
Scratch	29.5	14
Scar	24.1	22
Knife	14.6	4.6
Putrefaction	2.6	8.2
Beetle Damage	3.3	0.1
Old Age	0.4	0.8
Poor Substance	0.6	0.4
Smoke	2.3	0
Bad Bleeding	1.5	0
Demodectic mange	1.5	0
Branding	1.1	0
Crack	5.8	0

Annex 14. Export quantity and value earned from sheep and goatskin trade by year.

Item	Year	Exported Quantity (Kg)	Value (Birr)
Sheep and goatskin	1994	5,664,350	242,253,988
	1995	5,359,216	298,784,752
	1996	4,872,865	252,657,877
	1997	7,043,375	351,953,765
	1998	5,103,078	259,715,879
	1999	4,509,087	205,986,695
	2000	7,700,481	314,387,884
	2001	8,416,287	487,016,934
	2002	7,179,993	461,867,319

Source: Ethiopian Custom Authority (2004, personal communication)

Annex 15. Percentage share of skin from total value (Birr) obtained through hide and skins export from 1994 - 2002

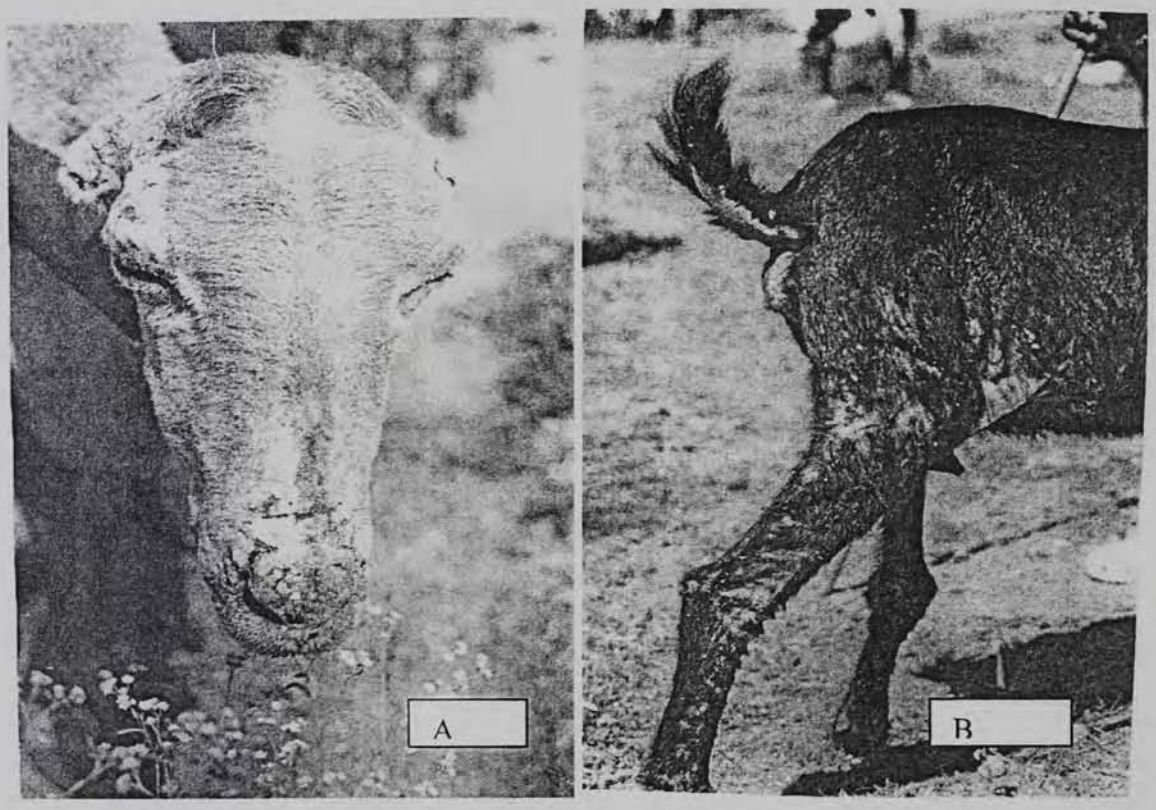
Year	Total	Hide	Skin	Leather	% Skin Share
1994	297,445,329.0	53,657,684.0	242,253,988.0	1,533,657.0	81.4
1995	356,004,019.0	55,321,447.0	298,784,752.0	1,897,820.0	83.9
1996	318,929,098.0	28,950,803.0	252,657,877.0	38,320,418.0	79.2
1997	397,653,901.0	17,411,021.0	351,953,765.0	28,289,115.0	88.5
1998	290,347,349.0	11,039,990.0	259,715,879.0	19,591,480.0	89.5
1999	241,228,661.0	10,296,246.0	205,986,695.0	24,945,752.0	85.4
2000	390,624,391.0	32,535,481.0	314,387,884.0	43,701,025.0	80.5
2001	632,187,840.0	143,769,474.0	487,016,934.0	1,401,432.0	77.0
2002	531,762,684.0	69,697,879.0	461,867,319.0	197,486.0	86.9

Source: Ethiopian custom Authority (2004) personal communication

Annex 16. Severity classification for the study of effect of ectoparasites on quality of skins

Group	Mean Count / Lesion Distribution	Severity Score
D. ovis, Linognathus	0	Free
	1-50	Light
	50-150	Moderate
	>150	Severe
M. ovinus	0	Free
	1-10	Light
	10-25	Moderate
	>25	Severe
Sarcoptic mange	No lesion	Free
	Lesions localized at one site	light
	Lesions localized at two sites	Moderate
	Lesions distributed in more than two sites	Severe

Annex 17. Pictures of sheep and goats infested with mange



Picture 1. Sheep (A) and Goat (B) infested with sarcoptic mange

Picture 2. A goat flock infested with mange.

9. CURRICULUM VITAE

Personal Information

Name: Tefera Sertse

Date of Birth: Jan. 20, 1970

Place of Birth: Zuula (Robe) Bale Zone, Oromia Region

Marital Status: Married

Language Skill: Amharic, Oromic and English

Nationality: Ethiopian

Contact Address: teferasertse@yahoo.com

Educational Background

Period	Institution	Award
1978 – 1982	Sanbitu Elementary School	
1982 – 1988	Robe Junior and senior High School	Certificate
!988 – 1994	Faculty of Veterinary Medicine, AAU	DVM Degree
2002 – 2004	Faculty of Veterinary Medicine, AAU	MSc degree

Trainings:

- Continuing professional development course on equine health and welfare
- Computer: Word processor, spreadsheet and database management

Work Experience:

May, 1995 to October, 1995:	Amhara bureau of agriculture, Cheffa Gulla Woreda veterinarian.
Nov, 1995 to May, 2000:	Amhara bureau of agriculture, Bati woreda veterinarian.
June, 2000 - to date:	Amhara bureau of agriculture, Regional veterinary officer.

Major additional responsibilities:

- Coordinator of Sida and UNDP supported animal health activities at bureau of agriculture.
- Member, Editorial board of 'Gibrinachen' Magazine prepared by bureau of agriculture.
- Member, team of animal health technician training manual preparation, at bureau of agriculture.

Research output:

Tefera Sertse (1993): Prevalence of Bovine Trypanosomiasis in Arba Minch District, DVM thesis, FVM, Addis Ababa University.

Demissie, A., Siraw, B., Teferi, K., **Sertse, T.**, Mamo, G., Mekonnen, D. and Shimelis, S. (2000): Mange: A Disease of Growing threat for the Production of Small Ruminants in Amhara Regional State. In: Proceedings of the Opportunities and Challenges of Goat Production in East Africa, a conference Held 10-12 Nov. 2000 at Debub University, Awassa, Ethiopia.

Tefera Sertse (2004): Investigation on Ectoparasites of Small Ruminants in Selected sites of Amhara Regional State and their Impact on the Tanning Industry.

Technical paper presented:

- Poultry production under backyard system and its constraints, seminar on current topics, June, 1993, Faculty of veterinary medicine, Addis Ababa university, Debre Zeit.
- Survey on mange of sheep and goats in the Amhara regional state. In: proceedings of workshop on the control of mange, lice and keds in the Amhara regional state, Feb., 14-16/2000, Bahir Dar.
- Review on causes of small ruminant skin diseases and their impact on the tanning industry, March, 2003, Faculty of veterinary medicine, Debre Zeit.

Member of Scientific Society:

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World Society for Protection of Animal (WSPA)

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Dr. Bewket Siraw, Head Animal Production and Health Department, Bureau of agriculture, Bahir Dar.

10. THE SIGNED DECLARATION SHEET

I, the under signed, declare that this thesis is my original work and has not been presented for a degree in any university.

Name Tafere Sertse

Signature

Date of submission 15th June, 2004

This thesis has been submitted for examination with my approval as an academic advisor.

Dr. Abebe Wossene

2004
TEF/494

Investigation on ectoparasites of small ruminants in selected sites of Amara Regional state & their impact on the Tannig industry

Tefera Sertse

C-1