

Review

Ectoparasitism: Threat to Ethiopian small ruminant population and tanning industry

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Sheep and goats are important contributors to food production in Ethiopia providing meat, milk and income generation for the country. Skins are the most important items to generate foreign currency for developing countries like Ethiopia. However, the huge resource potential of sheep and goats populations of the country are constrained and threatened by compound effect of diseases, poor management and malnutrition. Parasitic skin diseases caused by ectoparasites such as mange mites, lice, keds and ticks are among these threats resulting in serious economic loss to the tanning industry and the country as a whole. The economic impact of ectoparasitism in Ethiopia is not well documented. 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 to 90% defects were believed to be due to external parasites. The estimated economic loss due to drop in quality of sheep and goat skin is around USD 25.8 million per year. It also takes time before disease affected animals after treatment could return to their normal body condition. Currently, ectoparasites are among major causes in decreased production, reproduction of these animals as well as leather quality deterioration, down grading and rejection of skins. As many as one-quarter to one third of all skins processed at tanneries in Ethiopia have various defects and are unsuitable for export purposes where most of these defects occur in the pre-slaughter stage of production while the animals are alive and are directly related to parasitic skin diseases. Information available so far in Ethiopia indicate that parasitic skin diseases of small ruminants are widely distributed in different agro-climatic areas, causing serious economic loss to the farming community, tanning and leather industry at large, seriously hampering the income generation and foreign currency flow to the country. The extent of the problem has increased continuously during the past few years, threatening the small ruminant population, health, production and reproduction that warrants cost effective control measures.

Key words: Control, Ethiopia, ectoparasites, small ruminants, tanning industry.

INTRODUCTION

The small ruminant population of Ethiopia is about 18.1 million sheep and 14.8 million goats (Community-supported agriculture (CSA), 2009). Owing to their high

fertility, short generation interval and adaptation even in harsh environments, sheep and goats are considered as an investment and insurance to provide income for the

purchase of food during seasons of crop failure. Furthermore, wool and manure are also important by-products of small ruminant productions (Ministry of Agriculture and Rural Development (MoARD), 2005).

Self-sufficiency in food production, increase in rural income and foreign currency earning of the country through improving the quality and quantity of export items which are among the main objectives of the current agricultural development policies of Ethiopia. Sheep and goats are important source of income for agricultural community and are also one of Ethiopia's major sources of foreign currency through exportation of live animals, meat and skin (Shiferaw et al., 2010).

Ectoparasites such as mange mites, lice, keds and ticks are widely distributed in all agro-ecological zones in Ethiopia, causing serious economic loss in small holder farms (Kumsa et al., 2012). They are also one of the most important causes of loss in production and mortality of animals in various part of the country through decrease in production and reproduction (Figure 2a, b), down grading and rejection of skins (Ayele et al., 2003; Yacob et al., 2008a). It was reported that 35% of sheep and 56% of goat skin rejections in Ethiopia are attributed to ectoparasites (Kassa, 2006). All these established facts imply that ectoparasites pose serious economic losses to the farmer, the tanning industry and the country as a whole (Berhanu et al., 2011). Skins from goats and sheep are important economic products contributing for the largest share to the total and agricultural export commodities (Food and Agriculture Organization (FAO), 2005) followed by live animals (Ayele et al., 2003). The current utilization of hides and skins in Ethiopia is estimated to be 45% for cattle hide, 75% goat skin and 97% sheep skin with expected off take of 33, 35 and 7% for sheep, goats and cattle, respectively (Mohammed, 2000). However in recent years, this rank has been relegated to fifth level mainly because of rejection and down grading inflicted on hides and skin defects mainly due to infestation by external parasites (Kassa, 2006).

The control program against ectoparasites and skin diseases have been designed by the Ministry of Agriculture and Rural Development of Ethiopia (MoARD) in 2005 and launched in Tigray, Amhara and Afar regions. In Oromia regional state, this activity started in 2010 and is still ongoing.

Despite such national and regional emphasis given to the control programs against ectoparasites, the problem seems to be still alarming, questioning on the efficiency of this control program in the area. Reports from North-west Amhara region by Sisay et al. (2013) indicate the current overall prevalence of ectoparasites in the area is 44.9% in sheep and 43.5% in goats. As more recent report point out that ectoparasitic skin disease of small ruminants are still active and serious in northern part of the country. For instance, in Tigray Regional state, after

realization of the control program, an overall ectoparasite prevalence of 55.5% in sheep and 58% in goats were reported by Mulugeta et al. (2010). Surprisingly, the overall prevalence of ectoparasites reported by Serste and Wossene (2007) was 50.5% in sheep and 56.4% in goats before control program was launched in eastern Amhara region. It is clear that re-infestation of flocks is very frequent and the control activity is not well internalized and properly realized.

in other regions, this control program is still going on in selected zones of Oromiya and Afar regions but no study was so far conducted on the impact of this control program on the current status of ectoparasites and related skin diseases. This paper addresses the current effect of ectoparasitism on health and production of sheep and goat in Ethiopia with particular emphasis to their distribution and impact to tanning industries as well as economy of the country.

STATUS OF ECTOPARASITES OF SMALL RUMINANTS IN ETHIOPIA

Ectoparasites are the major causes of skin diseases that hamper small ruminant production in many areas of Ethiopia. Studies conducted in different parts of the country in the past three decades have revealed that the occurrence and spread of skin diseases have been shown to correlate with feed scarcity host, poor husbandry, climatic factors and inadequate veterinary services including absence of national control strategies (Kassa, 1998; Teshome, 2002; Yacob et al., 2008a). According to report by Serste and Wossene (2007), ectoparasites, particularly sarcoptic mites along with other affects on the body is blamed to cause losses due to death of sheep and goats in north Amhara region in Ethiopia. Ectoparasites also have transmission ability for many infections due to blood sucking habit. Skin damage is the most important cause of losses in livestock industry (Tadesse et al., 2011).

Mange mites

Mange mites are common in Ethiopia and therefore are reported from many regions and different agroclimates. Based on the reports so far, mange mites are most prevalent in four national regional states of Ethiopia namely, the Amhara Oromia Tigray and Southern Nation and Nationalities regional states (Yacob et al., 2008a; Mulugeta et al., 2010; Asnake et al., 2013). In all reports, three genera of mites namely, *Sarcoptes*, *Psoroptes* and *Demodex* were reported to affect small ruminants in Ethiopia.

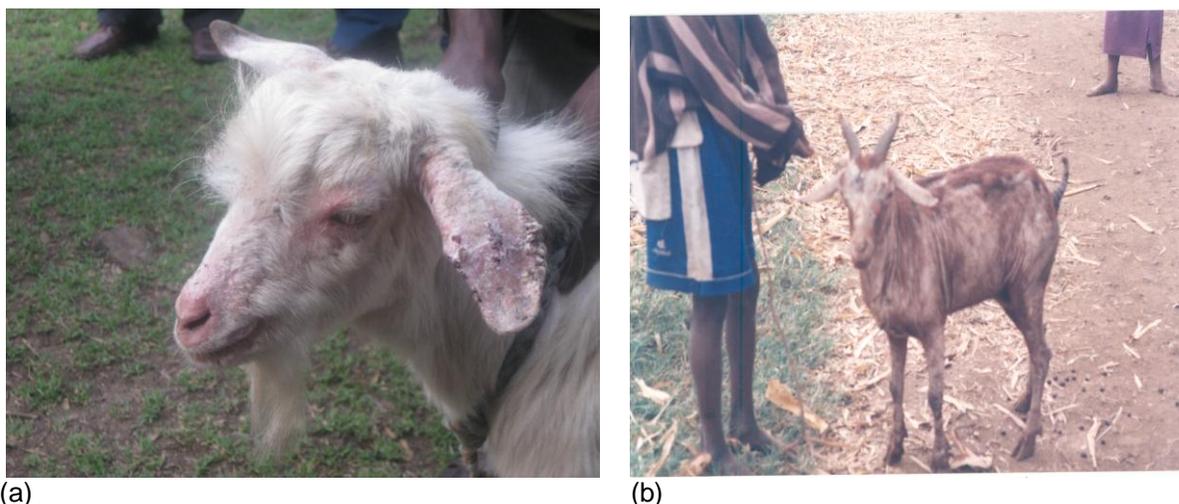


Figure 1. Goat infested by generalized Sarcoptic mange (a) in Chiffra, Afar region (b) in Benatsemaye district of south Omo zone, Ethiopia. Source: Pictured by Yacob Hailu (2011).



Figure 2. Alopecia (a) and Death due to sarcoptic mange (b) in Kamisse (Wollo). **Source:** Yacob HT (2012).

Sarcoptic mange

Sarcoptic scabiei var. *caprae* and *Sarcoptic scabiei* var. *ovis* have a wide geographic distribution in many goat (Figure 5) and sheep rearing in arid and semi-arid areas of Ethiopia, and it is more commonly seen in goats than sheep (Figures 1a, b, 3a, b and 4).. In Ethiopia, they are widely distributed in lowland mainly (Yacob et al., 2008a; Mulugeta et al., 2010; Asnake et al., 2013), low and midlands (Kumsa et al., 2012) as well as central midland part of the country (Yacob et al., 2008b). The highest prevalence of sarcoptic mites observed in sheep and goats were 30.32% in Tigray (Kedir, 2000) and 57.6% in Southern Ethiopia (Asnake et al., 2013), respectively.

Psoroptic mange

Psoroptic mange (sheep Scab), caused by *Psoroptes ovis*, which is common in Ethiopia, is reported from different regions. Mites of the genus *Psoroptes* cause psoroptic mange in sheep and goats (Figures 5, 6 and 7).. In sheep, its prevalence is found greater than in goats therefore, it causes greater damage in sheep than in goats. Etagegnehu (1992) and Nigatu (1992) have reported that *Psoroptes* has a prevalence of 42.9 and 32.87% from Cheffe State farm (Wollo). Recent studies indicate that in Ethiopia, Psoroptic mange is most common among small ruminants in lowland areas of north (Kassa, 2006; Mulugeta et al., 2010) and South



Figure 3. Goats affected with generalized Sarcoptoid mange (sever itching, alopecia and visible depression) in Kamisse (Wollo). Source: Yacob Hailu (2012)



Figure 4. Sheep affected with generalized sarcoptoid mange (alopecia) in Kamisse (Wollo). Source: Yacob Hailu (2012).

(Dessie et al., 2010) as well as central lowland areas (Yacob et al., 2008b). Its prevalence is highly decreasing compared to previous studies as reported recently, 2.63% in sheep and 5.13% in goats by Shibeshi et al. (2013) in Guto-Gida district of Eastern Wollega zone.

Demodectic mange

Demodectic mange has been reported in sheep (*Demodex ovis*) and goats (*Demodex caprae*). It is one of the major skin diseases of sheep and goats (Figure 8a, b). Demodectic mange is distributed in different agro-

ecological zones in Ethiopia as reported by Yacob et al. (2008a) in central lowland of Oromiya; by Serste and Wossene (2007) in midland and highlands of Amhara region, and Asnake et al. (2013) in lowland and midland areas in southern part of the country. The highest prevalence was 6.8% in goats by Mulugeta et al. (2010) in and around Mekele, followed by 2.83% by Asnake et al. (2013) in southern Ethiopia.

Pediculosis

Lice infestation in Ethiopia is the most frequently reported and the most important skin disease of small ruminants this is because lice are found to be the cause of cockle. According to Tefera and Abebe (2007), *Bovicola ovis* and *Linognathus* spp. are the two species with prevalences in sheep of 38.5 and 2.4%, respectively while in goats *Linognathus* species has prevalence of 28.3%. Nowadays, pediculosis is a serious health problem of small ruminants in Ethiopia (Figure 9). The highest prevalence was recently reported in sheep from Assela by Hailu (2010), who identified *Linognathus* spp (75.5%), *B. ovis* (67.1%), *Linognathus ovillus* (14.6%) and *B. ovis* (36.1%), this last one was reported by Asnake et al. (2013). Other reports were *B. ovis* in sheep 15.3 and 27.9% in goats, *L. ovillus* (27.9%) from Tigray by Mulugeta et al. (2010) and *B. ovis* (26.64%) in sheep from Wolayta Sodo (Yacob et al., 2008a). The louse species identified in many studies conducted so far in Ethiopia were *B. ovis* and *L. stenopsis*. Results obtained by Ermias (2000) from examination of fresh sheep pelts also showed a much higher infestation rate of 89.55%. In Ethiopia, most lice populations on animals vary seasonally, depending on the condition of the host. Lice populations on animals are greater during the rainy months (Hailu, 2010).

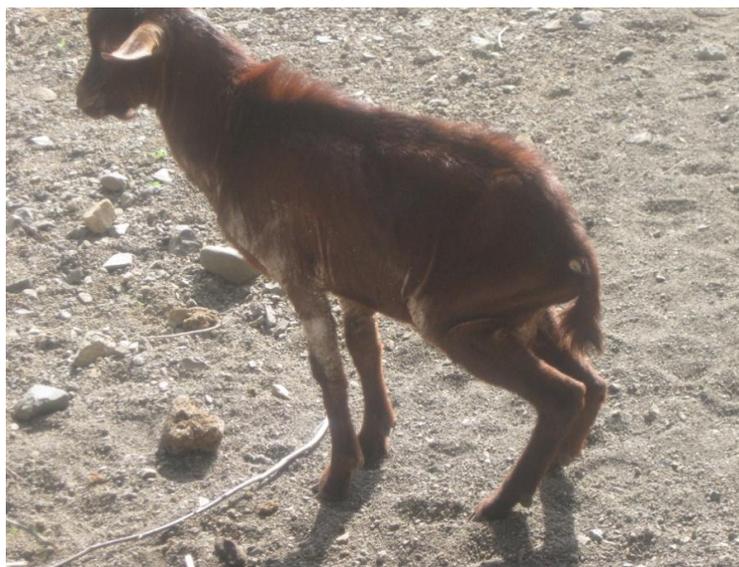


Figure 5. Goat affected with generalized sarcoptic mange (lameness and unthriftiness) in Kamsisse (Wollo). Source: Yacob Hailu (2012).



Figure 6. Psoroptic mange in sheep. Thick crusts on bridge of nose. Source: Ethiopian Sheep and Goat Productivity Program ESGPIP (2010).

Sheep keds (*Melophagus ovinus*)

In Ethiopia, few works are available on ecological distribution of sheep ked. Recent reports on sheep ked of small ruminants indicated that the parasite is most common in sheep mainly in cooler high altitudes (Figure 10). According to Enquebahe and Etsay (2010), the prevalence varies from 1.84 to 19.48% in Tigray regional



Figure 7. Severe itching due to *Psoroptes communis* var *canciculi* affecting the external ear canal. Source: Ethiopian Sheep and Goat Productivity Program ESGPIP (2010).

state. Other reports were in sheep. 65% from Assela highlands (Hailu, 2010) (Oromyia region); 19.1% from Mekele midlands (Mulugeta et al., 2010); 14.2% from central highlands of Oromyia regional state (Kumsa et al., 2012) and 20.14% from Gondar highlands (Tewodros et al., 2012). In all cases, the identified species was *Melophagus ovinus*. Infestation of sheep with *M. ovinus* leads to the development of cockle and those results in downgrading and rejection of skins. The prevalence of cockle lesion in *M. ovinus* infested groups of sheep skin



Figure 8. (a) Demodectic Mange in goats with thickened epidermis in Chiffra, Afar region Source: Yacob Hailu (2011) (b) Papules and nodules on face. Source: ESGPIP (2010).



Figure 9. Partition for collection of lice from heavily infected sheep (a) and spraying highly emaciated sheep due to heavy lice infestation in Assela. Source: Yacob Hailu and Hailu Wondimu (2012).

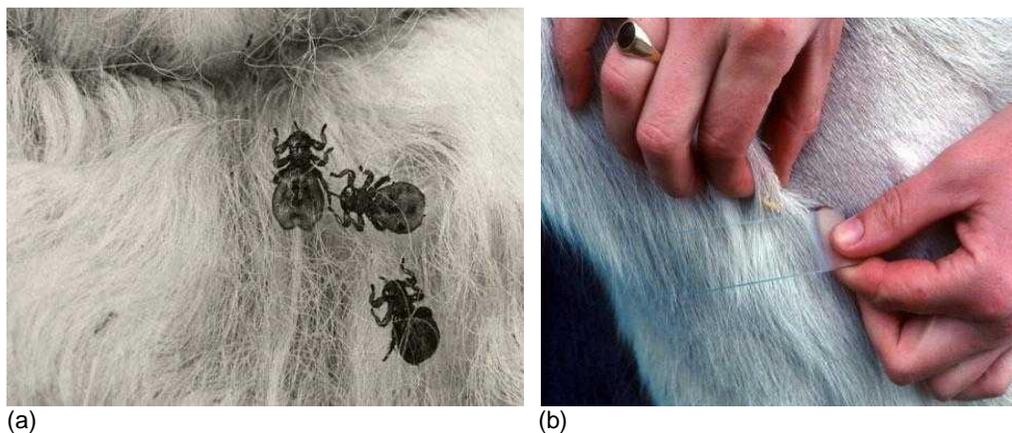


Figure 10. Adult keds on the sheep wool (a) and collection of keds (b) Source: ESGPIP (2010).

was found to be 100 and 95%, respectively (Tefera and Abebe, 2007). Examination of fresh sheep pelts also indicated the prevalence rate of 32.7% infection rates (Ermias, 2000). Both lice and keds are considered as cause of cockle in Ethiopian sheep pelts (Kassa, 1998). According to Serste and Wossene (2007), about 70.8% of the pickled sheep pelt and 42.3% of the wet blue goat pelt were downgraded and rejected due to cockle caused by both lice and sheep ked.

Ticks

Ticks are one of the most serious ectoparasites in Ethiopia. They cause the greatest economic losses in livestock production. Their effects are various including reduced growth, milk and meat production, damaged hides and skins, transmission of tick-borne diseases of various types and predispose animals to secondary attacks from other parasites such as screw worm flies and infection by pathogens such as *Dermatophilus congolensis*, the causative agent of streptothricosis (Ethiopia Sheep and Goat Productivity Improvement Program (ESGPIP), 2010). Reports from different areas of Ethiopia indicated that highest overall prevalence of ticks infestation are, 23.8% in sheep and 10% in goats (Teshome, 2002) from Sidama zone; 31.78% in sheep and 18.63% in goats from Wolayta Sodo (Yacob et al., 2008b); 16% in sheep and 29.7% in goats from Tigray region (Mulugeta et al., 2010) and 57.6% in goats from three agro-ecological zones of southern rangeland of Ethiopia (Asnake et al., 2013). In all these studies, it was observed that about four genera namely, *Amblyomma*, *Hyalomma*, *Boophilus* and *Rhipicephalus* were known to affect sheep and goats in different agro-ecological zones in the country. The high prevalence of ticks in different areas seems to be related to absence of national campaign for strategic control of these ectoparasites.

Ectoparasitism

Ethiopian small ruminant skins especially sheep skins traditionally have good reputation for quality in the world leather market due to their fine grain and compact structure. The leather industry sector is one of the fast growing economic sectors in Ethiopia (ESGPIP, 2009). Until recently, Ethiopia's second largest source of foreign income was the hides and skins sector. However, the percentage of skins having defects that downgrade quality has increased tremendously. Tanneries state that currently only 10 to 15% of harvested skins qualify for top grades, with the rest downgraded and rejected mainly due to deterioration of skin quality due to ectoparasitic skin diseases and various defects (ESGPIP, 2009).

Hides and skins products were supplied to domestic

and export markets and contributed significantly to the country's economy by providing 14 to 18% of the foreign exchange earnings (FAO, 2005). According to data from ESGPIP (2009), the leather and leather product exports increased from 67 million USD to 104 million USD between 2010/11. As reported by Berhanu et al. (2007), on average, the leather and leather products industry contributed 5.9% to the total export earnings for the years 2010/11. But this is much lower than would be expected, given the huge size of the livestock population in the country.

In Ethiopia, large numbers of sheep and goats are slaughtered throughout the year. However, the numbers of skins that reach the tanneries for processing is much lower than expected (Ermias, 2000; Asfaw, 2002; Numery, 2001). The Ethiopian tanning industry has long complained about the grades of small ruminant skins, which resulted in poor quality of processed skins. As many as one-quarter to one third of all skins processed at tanneries have various defects and are unsuitable for export purposes (Kassa, 1998; Degume, 2002). Up to 65% of these defects occur in the pre-slaughter stage of production while the animals are alive while considerably large portions of these pre-slaughter defects are directly related to parasitic and/or to secondary self-inflicted damages (Haffize, 2001). Post-slaughter defects related to poor management and treatments of skins after slaughter are also among important problems (Hagos et al., 2013). This, therefore, creates a serious problem for competition in international markets through the export of processed skin. Almost all commercial tanneries have indicated rejections of 20 to 24% of purchased skins from sheep and goat, which has resulted in a loss of \$6.9 million (Belachew, 2004).

Skin problems caused by lice, keds, mange and ticks are among the major pre-slaughter defects that reduce skin qualities and results in rejections (Kassa, 2006; Tefera and Abebe, 2007). The predominant causes of downgrading and rejection of skin from sheep and goat were said to be cockle in the early processing stage (Heath et al., 1995a, b). Tick bites leave small but distinct blemish lesion on the skin, which appears as a small hole in the leather. Such skins give "ticked" leather, which is of inferior quality (Henderson, 1991). Lice infestations are hazardous particularly that of great damage to the grain of skin (Mullen and O'Connor, 2002). The lesion cockle would not heal quickly. It will take about three months to heal after treatment (Kassa, 1998).

In Ethiopia, keds and lice are considered a major cause of cockle and are visible on the skin surface of affected animals (Kassa, 1998; Ermias, 2000). It is an allergic skin hypersensitivity reaction due to lice infestation and this defect appears on the grain side of semi-processed and crust leather after pickling that cannot be detected when the skin is examined raw or unprocessed. It results in

huge economic loss to tanneries and the country at large since the damage is recognized after a lot of cost is incurred on the processing after which the damaged skins have to be rejected or downgraded (Kassa, 2006). According to Yisehak (2000) and Abdulhamid (2001), studies conducted at Sebeta tannery on sheep skin and Kombolcha tannery on goat skins on routine production system indicate 89% of cockle in pickled sheep pelts and 71.16% in goat pelts, respectively. According to Demissie et al. (2000), the estimated economic loss due to drop in quality of sheep and goat skin is around USD 14 million per year.

Many studies in Ethiopia underlined that the effect of ectoparasites on small ruminant health and production as well as skin quality is multifaceted. Each parasite has adopted its own way of feeding and consequently affecting these animals. Ticks affect sheep and goat health and skin quality in three ways. The penetration of the skin by the piercing mouth parts by ticks makes holes which are defects in processed skins. When feeding, ticks can allow bacteria to pass through the skin leading to the development of local abscesses which damage skin quality more extensively than the holes caused by feeding (ESGPIP, 2010). The economic impact of tick infestations is enormous in Ethiopia with a conservative estimate of 1 million Ethiopian Birr (over 55 thousand USD) loss annually was made through rejection and downgrading of hides and skins due to effect of ticks (Kassa, 2006).

Lice are easily overlooked because of their small size. They can multiply very fast before being discovered. By this time, the animal might be too anaemic and emaciated and difficult to recover. An allergic skin hypersensitivity reaction due to lice is another cause for "Cockle" in processed sheep skins (Kassa, 2006). Skin puncture by blood sucking keds causes an inflammatory response of the skin to the presence of keds and their saliva known as cockles. This is recognized after the wool or hair has been removed from the skin. Cockle causes down grading of the skin because it weakens and discolours it (Kassa, 1998). In some parts of Southern Ethiopia, Amhara and Afar region mite infestation, mainly sarcoptic mites were blamed to cause heavy mortality (Demissie et al., 2000, Asnake et al., 2013). Death might 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 causes such as pneumonia or bacterial septicemia introduced through self inflicted bite and scratch wounds.

CONCLUSION AND RECOMMENDATIONS

The contribution of these animals to the Ethiopian export

income and food production is far below the existing potential being hampered by ectoparasites that play a very destructive role by depressing the productivity of sheep and goats. These parasites also seriously damage sheep and goat skins, resulting in the rejection or downgrading of the skins. Export earnings from this important commodity are therefore drastically reduced. Even though, control programs started in few regions such as Amhara, Tigray and Oromiya, still, reports indicate that these programs are far from recorded expected control and reduction of impact exerted by ectoparasites. The problem is still very serious and there are still animals suffering from ectoparasitism in ectoparasites control campaign regions, threatening the national economy, sheep and goat population and tanning industries. Lack of awareness creation and absence of control on animal movement and poor quarantine policy might have resulted in ineffectiveness of the control campaigns. This threat of ectoparasites on overall sheep productivity and tanning industry in Ethiopia warrants urgent strategic control intervention based on peculiar characteristic of each agro-ecology.

REFERENCES

- Abdulhamid N (2001). Prevalence and Effects of Ectoparasites in Goats and Fresh Pelts and Assessment of Wet Blue Skin Defects at Kombolcha Tannery South Wollo, DVM thesis, Faculty of veterinary Medicine (FVM), Addis Ababa University, Debre Zeit.
- Asfaw A (2002). Challenges and prospects of the leather industry in relation to the export promotion. In: Paranti A (ed) Proceedings of challenges and solutions for Ethiopian leather industry, 10 December 2002, UNIDO, Addis Ababa, Ethiopia.
- Asnake F, Yacob Hailu Tolossa, Hagos A (2013). Ectoparasites of Small Ruminants in Three Agro-Ecological Districts of Southern Ethiopia. *Afr. J. Basic Appl. Sci.* 5(1):47-54.
- Ayele SW, Assegid MA, Jabbar MM, Belachew H (2003). Livestock marketing in Ethiopia, A review of structure, performance and developing initiatives, working paper No. 52, Addis Ababa, Ethiopia, pp:1-4.
- Belachew H (2004). Livestock marketing and animal health in Ethiopia. Paper presented at the 18 annual conference of the Ethiopian Veterinary Association. 9-10 June (2004). Addis Ababa, Ethiopia.
- Berhanu G, Hoekstra D, Samson J (2007). Heading towards commercialization. Blackwell scientific publication, Oxford, pp:1-3.
- Berhanu W, Negussie H, Alemu S and Mazengia H (2011). Assessment on major factors that cause skin rejection at Modjo export tannery, Ethiopia, *Tropical Animal Health and Production* 43 (5), 989-993.
- CSA (2009). Central Statistics Authority, Agricultural sample survey (2008/09). Statistical bulletin 302, Addis Ababa.
- Demissie A, Siraw B, Teferi K, Tsertse T, Mammo G, Mekonnen D, et al. Mange: a disease of growing threat for the production of small ruminants in the Amhara National Regional State. In: Merkel RC, Abebe G, Goetsch AL editor. The Opportunities and Challenges of Enhancing Goat Production in East Africa. Awassa, Ethiopia: Dehub University; 2000; p. 80-91 10-12 November 2000.
- Degume W (2002). 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.
- Dessie S, Hailu D, Dereje B (2010). Epidemiological study of small ruminant mange mites in three agro-ecological zones of Wolaita,

- Southern Ethiopia. *Ethiop. Vet. J.*, 14 (1), 31-38.
- Enquebaher K, Etsay K (2010). Epidemiological study on mange mite, lice and sheep keds of small ruminants in tigray region, northern Ethiopia. *Ethiop. Vet. J.*, 2010, 14 (2), 51-65.
- Ermias Y (2000): A study on ectoparasites of fresh pelts and assessment of pickled skin defects processed at Sebeta tannery. DVM Thesis, AAU, FVM, Debre Zeit, Ethiopia pp.11-21.
- ESGPIP [The Ethiopia Sheep and Goat Productivity Improvement Program] (2009). Common defects of Sheep and goat skins in Ethiopia and their causes Technical bulletin, 19.pp. 12-16. Available on [<http://www.esgipp.org/PDF/Technical%20no.41.pdf>]. [Accessed on September 23, 2013].
- ESGPIP [The Ethiopia Sheep and Goat Productivity Improvement Program] (2010). Control of external parasite of sheep and goat. Ethiopian Society of Animal Production (ESAP). Technical bulletin, 41: 2-11. Available on [<http://www.esgipp.org/PDF/Technical%20no.41.pdf>]. [Accessed on September 23, 2013].
- Etagegnehu D (1992). Constraints to sheep production: A case control study of the Cheffey State farm, South Wollo, northeastern Ethiopia. DVM Thesis, Addis Ababa University, FVM. Debre Zeit, Ethiopia.
- FAO (2005). Ethiopia FAO's Information system on water and agriculture. <http://www.Fao.org>. Rome. Italy.
- Haffize M (2001). Study on Skin Diseases of Small Ruminants in Central Ethiopia. DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine. Debre Zeit, Ethiopia, pp:17-27.
- Hagos A, Yacob Hailu, Tolossa and Mulugeta Y (2013). Impact of sheep and goats ectoparasites on the tanning industry in Tigray region. *Ethiop. Vet. J.* 17 (2):63-76.
- Hailu W (2010). Study on the prevalence of major ectoparasites of sheep and assess the major risk factors in Arsi zone of Oromia regional state and evaluate the in vitro and in vivo acaricidal efficacy of seven medicinal plants against lice in naturally infested sheep. MSc thesis, Addis ababa University, FVM.
- Heath ACG, Cole DJW, Bishop DM, Pfeffer AT, Cooper SM, Risdon P (1995a). Preliminary investigation in to the etiology and treatment of cockle, a sheep pelt defect. *Vet. Parasitol.* Elsevier Sci. Ltd., 56:239-254.
- Heath ACG, Cooper SM, Cole DJW, Bishop DM (1995b). Evidence for the role of sheep biting lice (*Bovicola ovis*) in producing cockle, a sheep pelt defect. *Vet. Parasitol.* Elsevier Sci. Ltd., 59: 53-58.
- Henderson DC (1991). The Veterinary book for Sheep Farmers. Farming press books, UK.
- Kassa B (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.
- Kassa B (2006). 'Cockle, mange and pox: Major threats to the leather industry in Ethiopia. Ethiopian leather industry: Perseverance towards value addition', Proceedings of the National Workshop, Addis Ababa, Ethiopia, December 14–15, 2006, pp. 71–92.
- Kedir M (2000). Study on mange mite infestations in small ruminants and camel in to selected Agro climatic zones in Tigray, Northern Ethiopia. DVM Thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.
- Kumsa B, Beyecha K, Geloye M (2012). Ectoparasites of sheep in three agro-ecological zones in central Oromia, Ethiopia. *Onderstepoort J. Vet. Res.* 79(1); 1-7.
- MoARD (2005). Mange, Lice and Sheep Ked control project in Amhara, Tigray and Afar regions, MoARD Animal Health Department, Addis Ababa.
- Mohammed 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.
- Mullen GR, O'Connor BM (2002). Mites (Acari), In: Medical and Veterinary Entomology, (Mullen GR, Durden LA, Eds.), pp. 449-517.
- Mulugeta Y, Yacob HT and Hagos A (2010). Ectoparasites of small ruminants in three agro-ecological sites of Tigray Region, Ethiopia. *Tro. Anim. Health. Prod.* 42:1219-1224.
- Nigatu K (1992). Preliminary survey of mange mites of sheep and cattle in and around Addis Ababa. DVM Thesis, Addis Ababa University, FVM. Debre Zeit, Ethiopia.
- Numery A (2001). Prevalence and effect of ectoparasites in goats and fresh goat pelts and assessment of wet-blue skin defects at Kombolcha tannery. South Wollo Northeastern Ethiopia, DVM Thesis, AAU, FVM, Debre Zeit.
- Serste T, Wossene A (2007). 'A study on ectoparasites of sheep and goats in eastern part of Amhara region, northeast Ethiopia'. *Small Ruminant Research* 69 (1) 62–67.
- Shibeshi B, Bogale B, Chanie M (2013). Ectoparasite of Small Ruminants in Guto-Gidda District, East Wollega, Western Ethiopia. *Acta Parasitologica Globalis* 4 (3):86-91.
- Sisay Amare, Yilkal Asfaw, Yacob Hailu Tolossa (2013). Ectoparasites of Sheep and Goats in North-West Amhara Regional State, Ethiopia, *Ethiop. Vet. J.* 17 (1):55-67.
- Tadesse A, Fentaw E, Mekbib B, Abebe R, Mekuria S, Zewdu E (2011). Study on the prevalence of ectoparasite infestation of ruminants in and around Kombolcha and dam age to fresh goat pelts and wet blue (pickled) skin at Kombolcha Tannery, Northeastern Ethiopia. *Ethiop Vet J.* 15, 87-101.
- Tefera S, Abebe W (2007). Effect of ectoparasites on quality of pickled skins and their impact on the tanning industries in Amhara regional state, Ethiopia. *Small Ruminant Research*, 69 (1-3), 55-61.
- Teshome W (2002). Study on skin diseases of small ruminants in Sidama zone, Southern Ethiopia, DVM Thesis, AAU, FVM, Debre Zeit, Ethiopia pp.8-18.
- Tewodros F, Fasil W, Mersha C, Malede B (2012). Prevalence of Ectoparasites on Small Ruminants in and Around Gondar Town. *American-Eurasian J. Sci. Res.* 7 (3): 106-111, 2012.
- Yacob HT, Nesanet B, Dinka A (2008a). Prevalence of major skin diseases in cattle, sheep and goats at Adama Veterinary Clinic, Oromia regional state, Ethiopia. *Rev. Med. Vet.* 159, 455-461.
- Yacob HT, Yalaw TA, Dinka AA (2008b). Ectoparasite prevalence's in sheep and goats in and around Wolita Soddo, Southern Ethiopia. *Rev. Med. Vet.* 159, 450-454.
- Yisehak E (2000). A Study on Ectoparasites of Fresh Sheep Pelts and Assessment of pickled Skin Defects Processed at Sebeta Tannery. DVM thesis, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia. pp. 24.