STUDY ON PREVALENCE OF MAJOR GI NEMATODIOSIS OF SMALL RUMINANTS IN THREE SELECTED SITES OF AFAR REGION, ETHIOPIA

BY

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1. INTRODUCTION

Helminths infections in small ruminants are among serious problems in the developing countries, particularly where nutrition and sanitation standards are generally poor through reduction of productivity infected animals and mortality. Most parasitic helminths infect their host via the oral route, and live either at the mucosal surface of the gastrointestinal tract or cross this mucosal barrier on their way to predilection sites The problem is greatest in tropical countries with good rainfall (Mulcahy *et al*., 2004).

Small ruminants are widely distributed through out the world and are of major importance as a source of economic security and income for smallholder farmers. In Africa, sheep and goats are estimated to be 17% and 18% respectively of the world's small ruminant's population (Fakae, 1990). Highly adaptive nature to range environment, ability to utilize wide variety of plant species, short generation cycle, and high reproductive rates made sheep and goats complementary to the livestock production (Ndamukong *et al*., 1994).

Sheep and goats are a major source of food protein, income, savings, skin, fiber and manure. Despite their physiological adaptation and ability to thrive under harsh environmental conditions, the full exploitation of these resources is hindered in the tropical environment and particularly in Africa due to a combination of factors such as drought, poor genetic potential of the animals, traditional system of husbandry and the presence of numerous diseases (Waruiru *et al*., 2005). Among prevalent diseases, GI helminths, particularly nematodes have been recognized as one of the major factors that limit production. Gastro-intestinal nematodes reduce productivity, by causing production losses which is manifested by reduced weight gain; lowered meat and milk production and moralities especially in lambs and kids (Kaufmann, 1996).

Domestic ruminants are frequently exposed to multiple parasitic infections throughout their life. In most cases of natural infections animals are known to harbour single or mixed parasites with various species or several different types of parasites is a common phenomenon (Cox, 2001). In the field while sharing common pasture, animals are exposed to a variety of parasites among which are gastrointestinal nematodes that cause considerable animal health problems in many parts of the world (Waller *et al*., 2004).

The epidemiology of nematodosis is influenced by several factors and governed by interactions of the parasite-host relations as well as environmental factors. The major risk factors can therefore be broadly classified as parasite factors (parasite species, population dynamics and their epidemiology), host factors (genetic resistance, age and physiological status of the animal) and environmental factors (climate, nutrition and management). The importance of helminthosis may vary greatly from one year to the next and between geographical locations depending on the prevailing climatic conditions. Moreover, stress, poor nutrition and concurrent disease may be associated with the release of hypobiotic larvae from the dormant state leading to clinical helminthosis. There is also a great variation in resistance between species. While some studies have reported that goats are more susceptible than sheep to a similar challenge (Fakae, 1990).

Studies on the epidemiology of nematode parasites of small ruminants conducted so far in Ethiopia revealed the existence of *Haemoncus contortus*, *Oesophagostumum columbianum, S. papillosus, Oesophagostumum venulosum, Chabertia ovina, Skrjabinema ovis, Bunostomum trigonocephalum, Trichostrongylus spp., Teladorsagia spp.* and *Trichuris spp* (Bayou, 1992; Dereje, 1992; Esayas, 1999; Kasambara, 1999, Amenu, 2005).

Even though Afar region is known to have a large population of small ruminants managed under traditional system; studies are lacking so far on the epidemiology and prevalence of nematode parasites of these animals.

The main objectives of the present study were therefore to:

- Determine the prevalence of GIT nematodes in three selected site of Afar region
- Identify major nematode species parasitizing small ruminants in the area
- Observe the seasonal variation in the prevalence of these nematode species and assess the major predisposing risk factors

2. LITERATURE REVIEW

2.1. Major GIT nematodes of small ruminants

Parasitic gastroenteritis is among important causes of production losses in sheep and goat. The most important and widely prevalent nematodes are: Trichostrongyle group *(Haemonchus, Ostertagia, Trichostrongylus, Mecistocirus, Cooperia and Nematodirus), Oesophagostomum and Bunostomum* (Eysker and Ploeger, 2000).

Nematodes parasites are major causes of production loss, impaired GIT function via competition for the hosts essential nutrients and damages during their feeding. These effects could be manifested by sever clinical signs such as anemia, edema, diarrhea and anorexia resulting in poor general performance, even mortality particularly in the young, aged and immune suppressed individuals (Fox, 1997; Eysker and Ploeger, 2000).

2.1.1 GIT nematodes that cause decreased feed ingestion and utilization by the host

This group includes mainly *Teladorsagia spp.*, *Trichostrongylus spp*., *Cooperia spp*., *Strongyloides papillosis*, *Oesophagostomum spp* and *Nematodirus spp*. The pathological changes observed due to these parasites include: tunnel under mucosal epithelium of abomasum (*Teladorsagia spp* ., *Trichostrongylus axei*) and small intestine, erosion of mucosal epithelium of abomasum and intestine, catarrhal enteritis, villous atrophy in anterior small intestine, hyperemia and edema. In extreme cases, diphtheritic enteritis and exudates hinder absorption (Dunn, 1978; Soulsby, 1986; Urquhart *et al.*, 1996; Radostits *et al*., 2000).

The manifestation of these lesions is marked alteration in the influx and efflux of water and electrolytes (chlorine and sodium ions) in the bowel and morphological and biochemical changes in the epithelial cells and their microvilli (Soulsby, 1986) leading to protein losing enteropathy, accompanied by excessive mucus production, diarrhea, weight loss, hypo proteinaemia (Smith and Sherman, 1994; Urquhart *et al.*, 1996), some times pica (Troncy, 1989) and in chronic cases this form is almost indistinguishable from malnutrition (Dunn, 1978).

2.1.2 GIT Nematodes that remove the host's tissue and blood

This group of parasite includes *Haemonchus spp*., *Chabertia ovina*, *Gaigeria pachyscelis*, *Bunostomum trigonocephalum* and *Trichuris spp.* In most cases, the predominating syndrome is said to be progressive debilitating anemia (Smith and Sherman, 1994), but hyper acute and acute infection of *Haemonchus contortus* and acute infection of *Gaigeria pachyscelis* could lead to death without any more clinical manifestation than acute anemia (Dunn, 1978; Soulsby, 1986; Troncy 1989; Smith and Sherman, 1994; Bowman, 1999; Radostits *et al*., 2000).

The losses caused by *Haemonchus contortus* are more severe and important due to its extreme pathogenicity, wide geographical distribution in tropics and its high prevalence in small ruminants (Dunn, 1978; Troncy, 1989). *Gaigeria pachyscelis* is a highly virulent nematode that sucks blood and can cause death of a host even in small burden as few as 24 parasites (Soulsby, 1986). *Chabertia ovina* is a plug feeding parasite of large intestine which causes loss of blood when it draws plugs of mucosa by its wide mouth, and its blood sucking is said to be accidental, and loss due to hemorrhage at the biting site is voluminous (Soulsby, 1986; Troncy, 1989). *Bunostomum trigonocephalum* is a blood sucker causing progressive anemia (Dunn, 1978; Soulsby, 1986) and blood sucking habit of *Trichuris ovis* was indicated by Troncy (1989).

The clinical manifestations due to these nematodes vary from sub-clinical to bleeding to death (Dunn, 1978; Soulsby, 1986; Troncy, 1989; Urquhart *et al.*, 1996) and could be generally summarized as pale mucus membrane, edema on the ventral aspect of the body, bottle jaw, weakness, wool falls out in patches, prostration and death.

2.1.3 Nematodes that cause marked nodular reaction

Marked tissue reaction manifested by formation of nodules in the intestine of infected small ruminants is commonly observed in infestation by the 3rd stage larvae of *Oesophagostomum columbianum* (Soulsby, 1986; Troncy, 1989; Urquhart *et al.*, 1996). In previously exposed sheep and goats due to sensitization, 3rd stage larvae of *Oesophagostomum columbianum* pass into sub mucosa of small intestine and some times under heavy infection to sub mucosa of large intestine and marked inflammatory reaction around each larvae takes place. These nodules (inflammatory reaction) could be as big as 2.0 cm in diameter and containing greenish eosinophilic pus and fourth stage larvae (Urquhart *et al*., 1996).

According to Soulsby (1986), these nodules are due to leucocytes, especially eosinophils and foreign body giant cells collected around the parasites and the focus becomes encapsulated by fibroblasts. Whenever there is massive infestation, the number of nodules will be numerous while the colon contains few adult worms. Extensive nodules on the intestinal walls and mucosa interfere with absorption, bowel movement, digestion and when these supurative nodules rapture to peritoneal surface causing supurative peritonitis and multiple adhesions (Soulsby, 1986; Smith and Sherman, 1994).

2.2. Morphology and Biology

Nematodes are multicellular organisms with unsegmented with elongated body and externally covered by cuticle. The sexes are separate, with females generally larger than males. The cuticle may be modified to form inflation, expansion and papillae. The mouth opening in its simplest form is only a pore, whereas in highly specialized forms it leads to a bucal capsule of variable size (Hendrix, 1998).

The esophagus is filariform type. In the male nematodes, the caudal end may terminate on a cuticular expansion, the copulatory bursa, with bursal lobes and rays which are useful in identification. In the case of *Haemonchus* species asymmetrical dorsal lobe is a characteristic. Accessory male organs are sometimes important in identification, especially of the trichostrongyloids, the two most important being the spicules and gubernaculums. The spicules are chitinous organs, usually paired, which are inserted in the female genitalia opening during copulation. The gubernaculums, also chitinous, is a small structure which acts a guide for the spicules (Dunn, 1998; Urquhart *et al.*, 1996).

The life cycle of most of GIT nematode is similar, the cycles are direct, that is these nematodes do not require other animals to complete their life cycles (Urquhart, *et al.*, 1996).
The life cycle is direct with a single host. Females are oviparous. The eggs passed in the external environment, under favourable conditions (temperature and humidity) hatch to first stage larvae

(L_1). The L_1 develop and moult to second stage larvae (L_2), and then the L_2 in turn moult to third stage larvae (L_3), which is the infective stage. The first three larval stages are free-living constituting the pre-parasitic phases. Within GI tract of the host the L_3 moult to fourth stage larvae (L_4), which transform to a young adult stage (L_5) which eventually becomes mature and start to lay eggs (Soulsby, 1986; Urquhart *et al*., 1996).

Adult nematodes inhabit the gastro-intestinal tract. Eggs produced by the female gastro intestinal nematodes are almost similar. They are elliptical with oval shell. Depending on the species, the dimension of these eggs varies (55-100µm x 25-35µm). The only exception is the case of *Nematodirus* egg, which is much larger measuring 150 -230µm (Troncy, 1989). The eggs embryonate and hatch into first-stage larvae (L_1), which in turn moult into second-stage larvae (L_2) shedding their protective cuticle in the process. The L_2 larvae moult into third-stage larvae (L_3), but retain the cuticle from the previous moult during this stage, the larvae leave feacal pellet and available on nearby pasture waiting for a host (Soulsby, 1986).

These double-cuticles L_3 is the infective stage. The time required for the eggs to develop into infective larvae depends on temperature. Under optimal conditions (high humidity and warm temperature), the developmental process requires about 7 to 10 days. In cooler temperature the process may be prolonged. Ingesting of the L3 infects ruminants. Most larvae are picked up during grazing and pass to the abomasum, or intestine, ex-sheathing the extra cuticle in the process. The L_3 of the *Trichostrongyle* group penetrates the mucous membrane (in the case of *Haemonchus* and *Trichostrongylus)* or enters the gastric glands (*Ostertagia*). During the next few days the L_3 moults to the fourth stage (L_4) and remains in the mucous membrane (or in the gastric glands) for about 10 to 14 days. They then emerge and moult into a young adult stage (L_5). Most *Trichostrongyles* mature and start egg production about 3 weeks after infection (Urquhart *et al*., 1996). The parasitic part of the life cycle of *Oesophagostomum* requires about 6 weeks to complete the life cycle. The infective L_3 penetrate the lamina propria of the intestinal wall and the host response to the infection, which surrounds the L_3 results in the formation of fibrous nodules.

The larvae emerge into the lumen of the intestine after about 2 weeks and mature in the following 4 weeks. If animals previously infected, the larvae may spend a prolonged period of time (3-5 months) in the nodules. Eventually many of the larvae will die and the nodules may become calcified .The L_3 larvae of *Bunostomum* infect ruminants when they are ingested or penetrate the hosts skin. Following skin penetration, the larvae are carried in the venous blood through the heart to the lungs, where they penetrate the alveoli, are coughed up and then swallowed, and so pass to the small intestine. Here they moult and mature in 8-9 weeks after infection (Reinecke, 1989). The infective larval stage of *Trichuris* is contained within the egg. The larva is released after the egg is ingested by the host (Charles, 1998). According to Anene, (1993) adult female nematodes produce eggs. The period between the infection of an animal by ingestion of infective L_3 larvae and the first egg production by the adult female parasite is called the prepatent period. This period is different for different species of nematodes which varies from one to three weeks. For some other gastro-intestinal parasites, the prepatent period is about 3-4 weeks (Egwang and Slocombe, 1981).

Different species of nematodes have different egg-producing capacities. The individual female *Cooperia*, for example, produces many eggs but is not very pathogenic. Females of *Trichostrongylus* are quite pathogenic but produce few eggs. This means that the number of nematode eggs in a feacal sample is not an accurate indication of the amount of damage being done by gastro-intestinal parasites (Urquhart *et al*., 1996).

Table 1: Daily egg production per female of some gastro-intestinal nematodes

No	Species	Daily egg production/female
1	*Haemonchus*	5000-15000
2	*Ostertagia*, *Trichostrongylus*	100-200
3	*Cooperia*	1000-3000
4	*Nematodirus*	50-100
5	*Oesophagostomum*, *Chabertia*	5000 - 10000

Source: O' grady and Slocombe (1980).

2.3. Epidemiology

The study of Epidemiology is based on an intimate knowledge of the life cycle as well as the complex host parasite relationship in the parasitic stage. In nematode parasite the emphasis is on the seasonal incidence, which has been mentioned previously. Many factors are known to influence the transmission and prevalence of nematode infection in grazing ruminants (Urquhart, *et al*, 1996). Broadly, three influencing factors that can determine the occurrence of small ruminant of GIT nematodiosis could be mentioned (Smith and Sherman, 1994; Stromberg, 1997).

2.3.1 Environment-Parasite interaction

Nematode eggs are deposited on the pasture in faecal pellets and pass through developmental stages in that faecal matter.L_3 move out of the faeces and onto herbage. The development from egg to L_3, the survival of all stages to that point, the translation of L_3 onto herbage and the duration of survival of L_3 determine the infectivity of pastures. All of the factors are themselves dependent on climatic conditions (Urquhart *et al.*, 1996).

The rate of mortality of eggs and pre-infective larvae broadly parallel the rate of loss of moisture from faecal pellets. In hot, dry summer weather the moisture content of faecal pellets can fall from 60% to 9% in 2 days. Despite this, some L_3 are able to survive over summer, particularly those that remain in faecal pellets. The contribution of eggs deposited in spring to infectivity in the following winter is generally much less than that of autumn contamination and the relative importance of spring contamination vary between years. Cool temperatures favour over-summer survival, probably by allowing retention of moisture in faecal pellets. There is a significant difference between years in the proportion of spring deposited eggs which survive and translate to L_3 on pasture. Summer rainfall rehydrates faecal pellets and encourages the migration of L_3 onto soil and herbage. It also may lead to large daily fluctuations of temperature and rapid changes in relative humidity - events likely to increase the mortality of L_3. Following such summer conditions spring deposited eggs are likely to make less of a contribution to pasture infectivity in the following winter. In summer conditions which are consistently hot and dry it seems likely that more larvae remain in faecal pellets where they are protected from desiccation and are relatively inactive (Stromberg, 1997).

Generally, larvae derived from eggs deposited early in summer are available on pasture in greatest numbers during autumn months, whereas larvae on pasture in winter are mainly derived from eggs deposited in late summer and early autumn (Anderson, 1983).

Having conductive temperature and moisture, nematode eggs deposited by carrier animals are able to develop to the third stage larva (L3) in the external environment. Depending upon the prepatent periods of the nematode, three to five week are generally enough for an infected host to begin shedding egg. Larvae derived from autumn deposition have much more favorable conditions for survival during their free-living stages and generally show prolonged survival through winter (Troncy, 1989). Factors to be included in environment-parasite interaction and thus affecting the epidemiology of GIT nematodes are mentioned as follows:

2.3.2 Hypobiosis

Ostertagia spp, *H. contortus* and *T. axei* can arrest their development at the early L_4 stage. This phenomenon is probably not primarily a host immune response but a survival technique developed by the parasite. Inhibition is not a characteristic of intestinal trichostrongylosis (Troncy, 1989).

Ingested larvae are more likely to be inhibited at some particular times of the year. For instance in case of *H. contortus*, some ingested larvae are immediately rejected, depending on the immune status of the host. In such case, the proportion which becomes inhibited instead of developing directly to adults increases from near zero in January to an overwhelming majority in winter in summer rainfall zones. This seasonal inhibition occurs independently of the immune response of the animal and appears to be a result of an environmental effect on the larvae during the free-living stage. Infective larvae ingested in spring and summer has the ability to develop directly to adults, if not rejected by the host. The inhibition of larvae ingested in autumn and winter appears to be an evolutionary adaptation which favors the parasite by delaying the egg laying phase of the life cycle until after winter when a higher proportion of eggs will be able to develop and complete their life cycles. (Barger, 1987)

Maximum inhibition of *Ostertagia* spp and *T. axei* occurs for larvae ingested in late winter and early spring. Without treatment effective against inhibited larvae, it is assumed that development of these parasites resumes in autumn, leading to contamination of pastures in autumn and winter, when eggs have a higher biotic potential than in spring. Firm proof of the normal fate of inhibited *Ostertagia* spp and *T. axei* is lacking. Inhibited larvae of any genus do not cause any pathogenic effects while they remain inhibited (Stromberg, 1997).

2.3.3. Climate and Season

In the cool tropical environment of Ethiopia, Tembley *et al*., (1997) recovered a large number of nematode parasites from small ruminants during wet season. Similarly peak infection rate of GIT nematodes were reported during the rainy season and lower infection rate during dry season of the year in southern Nigeria (Fritsche *et al.*, 1993).

This seasonal fluctuation may be due to a number of factors which are responsible for the numbers and availability of infective stage, and these may be conveniently be grouped as factors affecting contamination of the environment, and those controlling the development and survival of the free living stage of parasite, the number of parasite eggs found in the faces is influenced by, number of adult parasites established in the gastro-intestinal tract, level of host immunity, age of the host, species of parasite, stage of infection, parturition, consistency of the faces (Urquhart, *et al*., 1996; Stromberg, 1997).

2.3.4 Grazing Behavior of Hosts

Grazing behavior of the host is one of the influencing factors affecting the epidemiology of GIT nematodes. Sheep grazing close to ground are more exposed to massive numbers of infective larva compared to free ranging goats that are less exposed to the infective larva since their feeding behavior includes a large component of browsing at levels well above the ground (Smith and Sherman, 1994).

2.3.5. Flock Management

Overstocking and prolonged grazing on the same pasture lead to over grazing (loss of available herbage per animal) and hence lower plane nutrition. It also encourages large amount of fecal deposit on the grazing field and potentially to higher level of infectivity per unit area. Due to this overstocking and prolonged grazing on a plot of land, besides affecting the growth rate of animals, it may exacerbate the pathogenic effect of acquired infections by lowering the protective immunity (Troncy, 1989; Ndamukong *et al*., 1994; Thamsborg *et al*., 1996).

2.3.6. Feed availability and quality

Nutrition plays a great role in worm burden control. Poorly fed animals are more susceptible and carry more worm burden due to their failure to over come of infection. In tropical Africa where small Ruminants are kept under grazing management, the feed availability and quality mainly depends on the season of the year. Wet season being good both for feed availability and the quality is also conducive for parasite-larvae survival and development on pasture, while dry season is bad both to the host and parasite larva. But during dry season, accumulation of flock along water courses for the search of water and green grass favors disease transmission and spread between flocks (Troncy, 1989; Teklay, 1991).

2.3.7. Development and survival of infective larvae in the environment

The development of larvae in the environment depends upon the warm temperature and adequate moisture. In most tropical and sub-tropical countries, temperatures are permanently favorable for larval development in the environment. Exceptions to this are the highland and mountainous regions throughout the world, and the winters of southern Africa and Latin America where temperatures may fall below those favorable for the development of *Haemonchus* larvae (Anene, 1993). The ideal temperature for larval development of many species in the microclimate of the tuft of grass or vegetation is between 22^{o}C and 26 °C. Some parasite species will continue to develop at temperatures as low as 5 °C or at much slower rate. Development can also occur at higher temperatures, even over 30 °C, but larval mortality is high at these temperatures. The ideal humidity for larval development in this microclimate is 100%; the minimum humidity required for development is about 85%. The survival of larvae in the environment depends upon adequate moisture and shade. Desiccation from lack of rainfall kills eggs and larvae rapidly and is the most lethal of all climatic factors (Troncy, 1989; Urquhart *et al.*, 1996).

Larvae may be protected from desiccation for a time by the crust of the feacal pat in which they lay or by migrating into the soil. Infective larvae may survive for up to 6 weeks or even longer in the manure pats, which act as a reservoir of infections during dry periods. The development of infective larvae ingested by an animal during adverse environmental conditions may be temporarily arrested in the abomasal or intestinal mucosa. This suspension of development helps some nematode parasites to survive in the dry seasons. Among the three larval stages in the environment (L_1, L_2 and L_3), it is the L_3, which has a protective sheath that is the most resistant to moisture, temperature and sunlight to make themselves accessible to ingestion by ruminants, the larvae have to migrate or be transported from the faeces in which they were deposited on the ground to any nearby herbage. Such movement occurs in two ways: horizontal migration/transport and vertical migration/transport (Urquhart *et al.*, 1996; Stromberg, 1997).

2.4. Pathogenic impacts of GIT nematodes on the infected host

2.4.1. Effect of larval stages on the host

Considerable damage is caused by fourth-stage larvae (L_4) of abomasal parasites (*Haemonchus, Mecistocirrus, Ostertagia* and *T. axei*). The L_3 enter the mucous membrane or the glands in the wall of the abomasum within six hours of entering the host, and will usually stay in the mucous membrane or the glands for about two to three weeks. If large numbers of *Haemonchus*, *Ostertagia* and *T. axei* larvae enter the abomasum, the host will be affected by: reduced appetite and reduced digestive capability of the abomasums (Soulsby, 1986).

The larvae of *Trichostrongylus* in the small intestine may cause severe damage to the intestinal mucous membrane with similar effects. Under certain circumstances, larvae ingested at the end of a rainy season (in savannah-type climates) may remain inhibited in the abomasal wall during the dry season until the next rainy season or until the animal experiences stress, such as that produced when the animal is calving/lambing or sick. The inhibition will then cease, and the (L_4) will develop into an adult worm. This development may be accompanied by destruction of the mucous membrane, the extent of which depends on the numbers of inhibited larvae emerging (Morley and Donald, 1980).

The L_4 of *Haemonchus* is a bloodsucker in the abomasum. Animals infected with large numbers of larvae therefore may suffer from anemia before the parasite eggs can be detected in the animal's faces (Soulsby, 1986; Fox, 1997).

2.4.2. Effect of adult worms on the host

According to Armour (1982), infections with gastro-intestinal nematodes usually involve several different species of parasites, which may have an additive pathogenic effect on the host. Mixed infections comprising any of the species *Haemonchus, Mecistocirrus, Ostertagia*, *Trichostrongylus*, *Bunostomum*, *Cooperia*, *Nematodirus*, *Oesophagostomum* and *Trichuris* are common. The pathogenic effect of gastro-intestinal parasites may be sub-clinical or clinical. Young animals are most susceptible. The effect of these parasites is strongly dependent on the number of parasites and the nutritional status of the animals they are infecting. The following clinical signs may be seen: weight loss, reduced feed intake, diarrhea, mortality, reduced carcass quality and reduced wool production/quality.

Severe blood and protein loss into the abomasum and intestine due to damage caused by the parasites often results in edema in the submandibular region (a condition called bottle jaw). Some nematodes that suck blood, such as *Haemonchus, Bunostomum* and *Oesophagostomum*, are responsible for specific clinical signs. *Haemonchus* is the most pathogenic of the blood suckers and infections with large numbers of this parasite often result in severe anemia in the host. Diarrhea may not be a feature of *Haemonchus* infections. Blood losses from *Bunostomum* and *Oesophagostomum* infections may add to the severity of the anemia (Troncy, 1989).

Table 2: Major GI nematodes of small ruminants, their localization and pathogenic effects

Site	Parasite species	Action
Abomasum	*Haemonchus contortus*	Blood sucking
	Ostertagia trifurcata	Mucosal damage
	O. circumcineta	Mucosal damage
	Trichostrongylus axei	Mucosal damage
Small Intestine	*Cooperia oncophora*	Mucosal damage
	C. curticei	" "
	C. mcmasteri	" "
	Nematodirus filicollis	" "
	N. battus	" "
	N. spathiger	" "
	T. colubriformis	" "
	T. vitrinus	" "
	Bunostomum trigonocephalum	" "
Caecum	*Trichuris ovis*	Blood sucking
	Oesophagostomum venulosum	Mucosal damage
Colon	*Oesophagostomum columbianum*	Nodule formation
	Chabertia ovina	Mucosal damage

Source: Reinecke (1989)

2.5. Identification and diagnostic procedure of GI nematodes

2.5.1. Quantitative technique for parasite eggs identification

McMaster egg counting technique

According to Egwang and Slocommbe (1981), the simplest and most effective method for determining the number of eggs or oocysts per gram of faces is the McMaster counting technique described below. The McMaster counting technique is a quantitative technique to determine the number of eggs present per gram of faces (EPG). A flotation fluid is used to separate eggs from feacal material in a counting chamber (McMaster) with two compartments. The technique described below will detect 50 or more EPG of faces. This technique can be used to provide a quantitative estimate of egg output for nematodes, cestodes and coccidia. Its use to quantify levels of infection is limited by the factors governing egg excretion (Reinecke, 1989).

In case of a time delay between processing the sample and reading the count, egg numbers may decline dramatically. Also, eggs may change their appearance, becoming crenated and "ghost-like". It is therefore advisable to prepare only a few samples at a time. Keeping prepared samples in the refrigerator after mixing can prevent these changes. Using the salt-sugar solution as flotation fluid also reduces the morphological changes (Egwang and Slocommbe, 1981)

Stoll egg counting technique

For counting nematode egg 3g of feaces weighed in to a test tube graduated to 45 ml. The tube is then filled to the 45ml, mark with decinormal caustic soda solution and IO or 12 glass beads are added. The tube is then closed with a rubber stopper and is shaken to give a homogenous suspension of the feacal material. If much froth appears in the tube can be left till it disappears. As soon as possible after shaking, 0.15ml of the well mixed suspension this amount, and placed on a slide. The total number of egg in the 0.15ml, sample is then counted and this number, multiplied by 100, gives the number of egg in 1 gram of feaces. Coarse material, such as horse feaces, can be sieved to remove fibers, which may block the pipette. For field work a heavy flask graduated at 56 and 60ml may be used. The flask is filled to the 56ml, mark with decinormal caustic soda solution and feaces are added till the fluid reaches to 60ml mark. The 0.15ml is with drawn and the number of eggs in it is multiplied by 100 to give the number of egg per gram of feaces. This method gives reliable counts of trematode as well as nematode eggs (Soulsby, 1986).

Interpretation of feacal egg counts

According to Armour (1982) a number of factors can influence the occurrence, recognition or numbers of helminthes eggs found in a feacal sample. In particular, the number of eggs is not necessarily indicative of the number of worms present. Reasons include:

- Eggs are produced only by fertile adult female worms and will, therefore, be absent in immature or single sex infections.
- The daily output of eggs by fertile females is influenced by host-physiological factors such as stress or lactation (increased) or immunity (decreased)
- Chemotherapy can also affect egg-production e.g. corticosteroids (increased) or sub-lethal anthelmintic doses (decreased)
- Some food-stuffs may have a similar effect e.g. tannin-rich forages (decreased)
- The concentration of eggs (per gram of feaces) is influenced by the daily volume of feaces being produced by the host, the rate of passage by the ingest through the intestine, and the distribution of eggs throughout the feacal mass
- Some eggs from different species are indistinguishable (particularly trichostrongylides and strongylids). This complicates clinical interpretation as some species (e.g. *Haemonchus*) produce many more eggs per day than others (e.g. *Ostertagia*).

The number of eggs per gram can be calculated as follows:
Count the number of eggs within the grid of each chamber, ignoring those outside the squares. Multiply the total by 50 – this gives the eggs per gram of feaces (EPG).

2.6. Preparation of faecal culture, isolation and identification of GI Nematode larvae

2.6.1. Isolating and identification of inhibited/immature larvae and adult worms

These may be required for the estimation of the effects of anthelmintics, or to estimate, for other reasons, the number of helminthes present in the alimentary tract. In general the procedure is to ligature of the various parts of the alimentary canal and to pass their contents through various graded screens to remove solid debris. The worms can the picked out of the clarified fluid remaining and can be identified and counted. If necessary the contents of portions of the alimentary canal can be preserved in formal and dealt with when time is available. The mucosa of the alimentary tract may be digested with acid pepsin (10g pepsin, 30ml HCl and 1000ml of water) at 37^0c for several hours. The material is then sieved through a mesh of 200 apertures to the linear inch, which retains the immature worms. These are preserved in 5 per cent formol-saline (Soulsby, 1986).

According to Armour and Duncan, (1987) the isolation of inhabited from immature larvae from the GIT is carried out in conjunction with isolation of adult GI parasite. This method is quantitative technique for counting and identifying infective larvae. The isolation of inhibited/immature larvae is used to establish the number and seasonal occurrence of inhibited larvae. To prevent immature larvae from being counted as inhibited larvae, the number of inhibited larvae should be determined only in animals kept isolated from re-infection for at least 21 days. This allows non-inhibited larvae to complete development (Agneessens *et al*., 2000).

2.7. Supplementary Diagnostic and Identification Techniques for Nematodes

2.7.1. Packed cell volume determination (PCV)

Infections with some parasite species, particularly *Haemonchus, Bunostomum, Trichuris* and *Fasciola* can cause anemia. In acute haemonchosis and fascioliosis, the pathogenic effect of the parasite is often present before eggs appear in the feaces. The PCV technique allows an estimation of the degree of anemia present by measuring the volume occupied by the RBCs in a sample of circulating blood (Levine, 1978).

The PCV determination is a useful procedure to carry out on both individual animal and herd/flock to assess the possible role of *Haemonchus* and other blood-sucking parasites. It is useful as an early aid to the diagnosis of haemonchosis and fasciolosis. However, anemia can occur as a result of other causes, in particular trypanosomosis and some tick-borne diseases, so this test must be done in conjunction with both parasite egg counts and assays for circulating haemoparasites (Armour, 1982).

2.7.2. Mucosal membranes and red blood cells value

For infections with blood sucking nematodes like *Haemonchus* the characteristics of mucous membrane and the red blood cell values (haematocrit, packed cell volume) provide useful tool for diagnosis. Recently in South Africa "FAMACHA" a color chart, is evaluated as a tool, to decide which individuals in a flock should be selectively treated for *Haemonchosis*. The color of the mucous membranes of all sheep in a flock is regularly cheesed against: "FAMACHA" chart and sheep with pale membranes will be treated with anthelmintic (Kaplan *et al*., 2004).

2.7.3. Serological methods as a diagnostic tool for nematode infections

An ELISA using crude antigens has been used for diagnosis of gastrointestinal nematode infections). Using the mean value of ELISA as with crude *O. ostertagi* antigen has been available during the last 20 years (Klevs *et al.*, 1981). Proteins as antigens were able to demonstrate differences in infection level between the different commercial dairy farms (Pleoger *et al*., 1994). The obvious disadvantage of a crude worm ELISA is that antigenic epitomes are shared by many worms and cross reactions with other nematodes and even with *Fasciola hepatica* do occur (Eysker and Pleoger, 2000). Moreover, ELISA is not very appropriate for diagnosis of parasitic gastro-enteritis on individual animals. Other indirect measures of parasite infection include serum antibodies level against *O. ostertagi* (Gasbarre *et al*., 1990), serum pepsinogen or gastrin for abomasal nematodes (Fox, 1997).

Measuring serum level of pepsinogen

Identifying the threshold for treatment and the animal could have a positive treatment response; depend on the possibility of having reliable diagnostic technique for gastrointestinal parasitism. Two of the most promising diagnostic method to be used for this purpose is pepsinogen level and an immunological assessment (ELISA) of antibody titers (Eysker and Ploeger, 2000). Blood pepsinogen values have been used for 35 years as a diagnostic tool for Ostertagiosis in cattle ((Jennings *et al*., 1996). In the first grazing season high pepsinogen values in cattle correlate with the occurrence of parasitic gastro-enteritis. According to Hilderson, *et al.*, (1989) values above 3000 μm tyrosine are diagnostic for ostertagiosis. A problem in interpretation of these differences is that no standardize method is used and between laboratory comparisons are lacking. It has been demonstrated repeatedly that blood pepsinogen values correlate with infection levels of abomasal nematodes. This renders blood pepsinogen values as a good candidate for held health monitoring. A major disadvantage of these methods is that they are very laboring intensive and thus too expensive (Berghen, *et al*., 1993).

Measuring serum level of gastrin

Hypergastrinaemia occurs around patency of a nematode infection such as *O. ostertagi* and seems to be associated with the presence of adult worms (Hilderson *et al*., 1989; Fox, 1997) Demonstrated a correlation between exposure levels and gastrin values in the second half of a first grazing season. However, it was also clear that gastrin is far less sensitive than feacal egg counts, pepsinogen values and serology to detect infections (Pleoger *et al*., 1994).

However, these methods are non-specific do not reflect any parasite species in particular and impractical for use in the field (Stear, *et al*., 1995). To assess the level of exposure of any age class of dairy or beef cows at a certain time, in particular the beginning and the end of the grazing season. It is important to perform differential pasture larval counts, using the same keys for larval differentiation as for feacal larvae cultures, because, there are significant differences between species in their bionomics (Bryan and Kerr, 1988).

2.8. Isolation and identification of infective larvae from pasture

2.8.1. Tracer worm counts

This method is an alternative method to study pasture infectivity level is used to relate nematode infection acquired by ruminants during summer to prevailing weather conditions (Niven, *et al*., 2002). Group of worm free 'tracer' ruminants were put onto pastures, previously contaminated with specific nematode egg, for successive periods of 2-4 week, subsequently they will be housed to prevent further infection and necropsied used to estimate the numbers of worms acquired (Hendrix, 1998). As of pasture larval count tracer worm count will not only reflect ingestion of larvae by grazing (recent exposure) but also subsequent establishment (Vercruysse and Claerebout, 2001).

According to Koosterman *et al.*, (1996) tracer worm counts will better reflect what happens within a herd or flock than pasture larval counts and it is possible to differentiate the nematode present to species level.

2.8.2. Sentinel worm counts

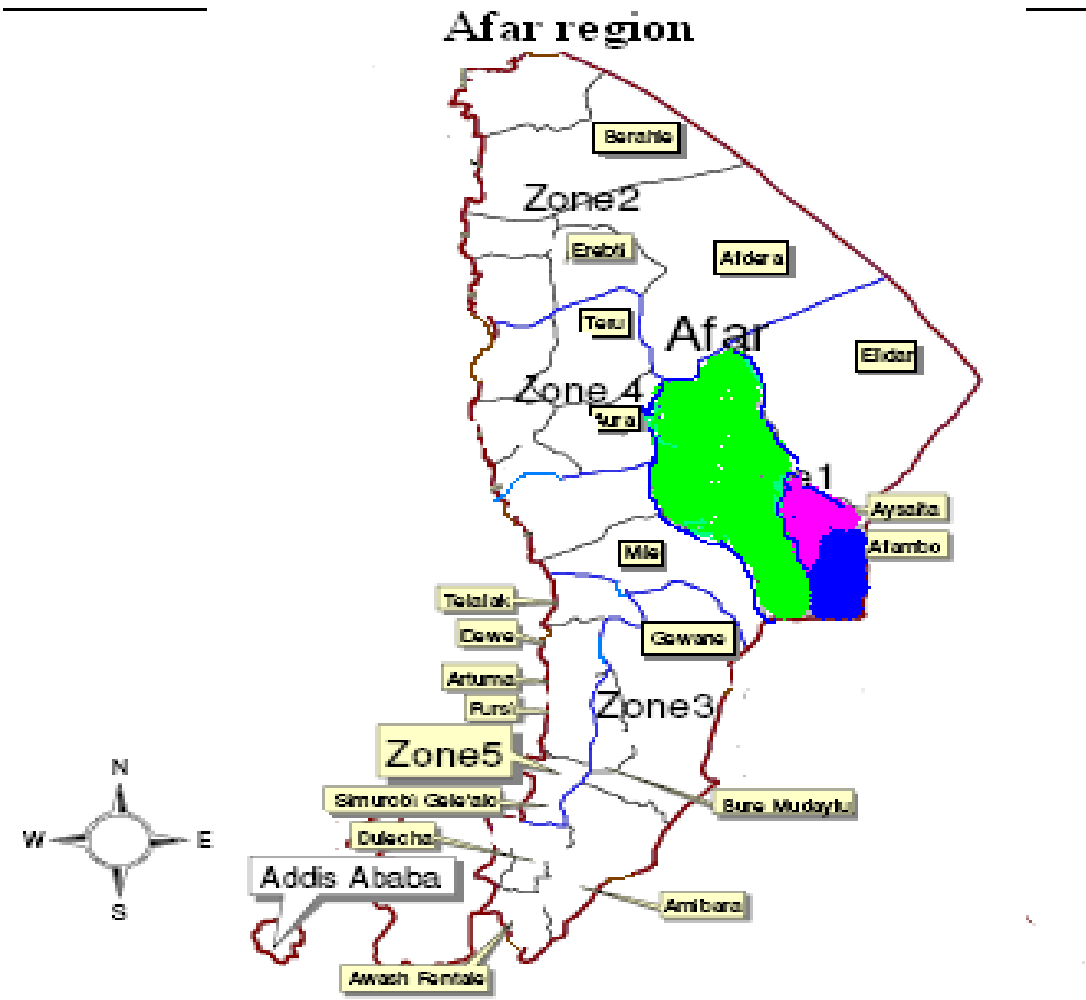
Animals' representative for the herd/flock should be taken all age, sex and is taken randomly animals from grazing and kill the animal to count the parasite while tracer counts reflect pasture infectivity and recent exposure of herd / flock (Armour and Duncan, 1987).

The sample size should be large enough to cope with the wide within group variation of nematode burdens. Necropsy of the sentinel animals will allow finding and enumeration of species with long prepatent periods that cannot be found easily using tracer animals (Gibbs, 1984). Sentinel work counts reflect overall dynamic of nematode population, including development of resistance (Soulsby, 1986).

3. MATERIALS AND METHODS

3.1. Study area

The study was conducted in three different selected districts of Afar Regional state. The selected sites were, Ayssaita, Dubti and Afambo.



Source: (FAO – MOARD, 2003).

Ayssaita is one of the 29 districts of the Afar region and is located at a distance of 680 km from Addis Ababa, capital city of Ethiopia. It is bordered to the south by Afambo, to the north by Elidar, to the west by Dubti and to the east by Djibouti republic. The mean average temperature of the area is 28-48$^{0}{}_{C}$ with the annual rainfall of 300mm/annumm (CSA, 2003).

Dubti is also part of the administrative zone 1, bordered to the south by the Somale region, to the north by the Administrative Zone 2, to the west by Chifra and to the east by Ayssaita. Its mean average temperature is 17-45^{0}c with the annual rainfall of 350mm/annumm (CSA, 2003).

Afambo is named after Lake Afambo, located at the border of this woreda with Asayita, near the international border with Djibouti in the part of the administrative zone 1. Afambo is bordered to the south by the Somale region, to the north by Ayssaita, to the west by Dubti and on the east by Djibouti. The highest peak in this woreda is Mount Dama Ali. The only perennial river in Afambo is the Awash, which passes through Lake Afambo, and a chain of lakes south and east of it: Laitali, Gummare, Bario, and Lake Abbe. The mean average temperature is the 30-480c with annual rainfall of 300mm /annumm (CSA, 2003).

3.2 Study animals

The study animals were sheep and goat population raised under traditional management system in the three purposely selected districts.

3.3. Study methodology

3.3.1. Study type

Cross sectional study for prevalence determination using post mortem and fecal examination and longitudinal prospective study for characterization of the seasonal dynamics of nematodes according to Toma *et al.*, (1996) were employed.

3.3.2. Study procedures

A) Post mortem examination method

Nematode species identification and worm burden determination were carried out using post mortem examination beginning from October 2007 up to April 2008. Samples were obtained by systematic random sampling method. 60 sheep and goats were purchased from each study sites and subjected to post mortem examination.

A day before slaughter, ante mortem examination was performed and the origin, age, sex, and general health condition of the animals were properly recorded. The age of the animals was determined by the protocol developed by Gatenby, (1991) and Mike, (1996) (Annex 6 and 7).

Following slaughter, the gastrointestinal tracts were removed, and the abomasums, small intestines and large intestines were immediately isolated by three ligatures (between omasum and abomasum, abomasum and small intestine, ileum and cecum) to avoid mixing of the contents.

Collection of the contents of abomasum and intestines, identification and counting procedures were conducted according to Soulsby, 1986; Jorgen, and Brian, 1994, Kaufmann, 1996 and Urquhart *et al*., 1996 (Annex 1, 2 ,3).

In a mixed infection of nematode species, the intensity of nematode infection was classified as low (< 2000 nematode), moderate (2000-10,000) and high (>10,000) as described in Radostits *et al*., (2000).

B) Fecal sampling for prevalence study and quantification

For each district and both species of animals the sample size was determined using the formula described in Thrusfield, (1995):

$$\mathbf{n = \frac{1.96^2 \times Pex\ (1 - Pexp)}{d^2}}$$

Where **n** is the required sample size, **Pexp** is expected prevalence based on previous preliminary survey; **d** is the level of precision (5%), 1.96 to indicate 95% confidence level.

Based on the above formula, our sample size for each district was therefore, 384 (83 sheep and 301 goats) by considering 50% expected prevalence of GIT nematodiosis in the study area. Hence, the over all sample size was 384 *3 sites* 2 seasons = 2304 fecal samples; but due to little sheep population in the Region, only 520 sheep were sampled.

The study period was divided in to two based on the seasonal condition of the area as late wet season (October and December) and early dry season(January to April).

Fecal samples and worms recovered from GIT were preserved in 70% ethanol and 10% formalin, respectively for later examination in the laboratory. The fecal samples were examined by both qualitative (flotation) and quantitative (modified McMaster) techniques (Annex 4). Fecal egg count was determined using modified McMaster technique, each nematode egg counted represents 50 eggs per gram of feces, when the fecal samples became negative for nematode egg in modified McMaster technique, and it was subjected to flotation technique.

The intensity of infection was classified as light (50-800 EPG), moderate (801-1200 EPG) and heavy infections (>1200 EPG) as described in Jorgen and Brian (1994) for the mixed infections in grazing small ruminants.

3.3.3. Questionnaire survey

The questionnaire survey was conducted to assess risk factors like management practices, nutrition and helminthes control measures. A total of 6 peasant associations from randomly selected 60 house holds were interviewed.

3.4. Data analysis

Microsoft Excel was used to store all the data and Stata 2003 version and SPSS 11.5 soft wares were used to analyze the data. Statistical tests like the, percentages; means and ANOVA were employed for data analysis. An association was considered as significant when the P value was less than 0.05.

4. RESULTS

4.1. Post mortem results

4.1.1. Nematode species identification and their prevalence

A total of 5 different species of nematodes were recovered from the gastrointestinal tracts of 180 sheep and 300 goats during the study period.

The identified parasites and their respective prevalence in decreasing order were as follows: *Haemonchus contortus,* 89.1 %; *Oesophagostomum columbianum* 91.6%, *Trichostrongylus axei* 92.6%, *Tricuris ovis* 83%, *Bunostomum trigonocephalum,* 82% respectivley.

All the animals examined (81%) were found to be infected with gastro-intestinal nematodes. The prevalence is given in the Table 3.

Table 3: The prevalence rates of GIT nematode species in the three study districts by species animal.

Nematode species	Specie animal	Ayssita n=160 %	Afambo n=160 %	Dubti n=160 %	P- value	F
	sheep	90.6	94.3	81.25		
H. contortus	goats	86	95.3	87.1	0.029*	3.58
	sheep	94.3	93.1	98.7		
O. columbianum	goats	89.3	95	79.3	0.034*	3.41
	sheep	90	92.5	98.1		
T. axei	goats	93	87	95	0.02*	6.37
	sheep	87.5	93.1	81.9		
T. ovis	goats	78.5	78.9	76.7	0.005**	5.32
	sheep	83.1	83.7	83.1		
B. trigonoceph	goats	81.4	84.7	75.2	0.989	0.011
Overall		87.4	89.7	85.6		

* Significant difference; ** Highly significant difference

4.1.2. Influence of season, study site, age, animal host & sex on parasitic infestation

The seasonal point prevalence of *H.contortus* varied significantly (p<0.001) between the two seasons of the year with higher prevalence in 98% in LW season and lower in 80.4% in ED season., and again significant difference in the prevalence of *T. axei, H.contortus, T. ovis* and *O. columbianum* was observed between the study sites. The seasonal point prevalences of five nematode species are indicated in the figure 1.

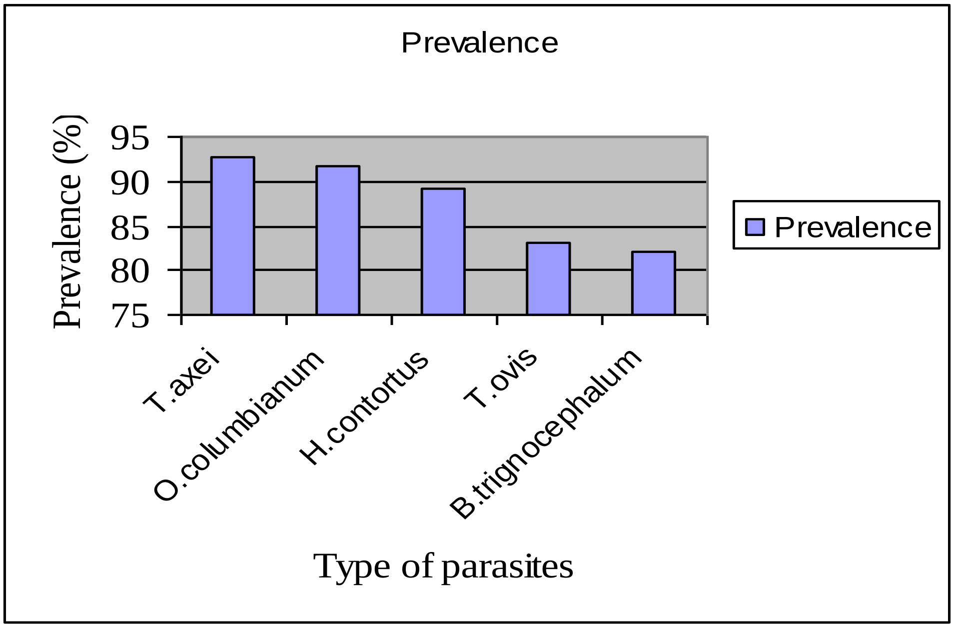


Figure 1: Prevalence of nematode in late wet and early dry seasons

LW= Late wet season; ED= Early dry season

4.1.3. Intensity of adult nematode species

Significant difference ($p<0.001$) in the mean nematode burden of different nematode parasites was observed between the two seasons and between the two animal species (Table 4).

Table 4. Seasonal mean nematode burden in sheep and goats

Variables	Study site			Season		Animal host		Sex	
	Ayssaita	Afambo	Dubti	LW	ED	Goats	Sheep	Male	Female
Total animals	160	160	160	240	240	330	150	240	240
Prevalence									
PM	100	100	100	100	100	100	100	100	100
MNB± SE	921.24	842.66	759.38	1085.31	596.88	712.24	1124.57	801.23	880.95
	(629.86)	(479.87)	(458.89)	600.53	292.51	393.43	669.64	509.29	550.83
CI at 95 %	815-989	767-917	687-831	1002-1143	559-634	1007-1201	669-754	736-865	805-931
Significance	P=0.24			P=0.000***		P=0.000***		P=0.100	

*** Highly significant difference

The prevalence of GIT nematodiosis was not significantly different between Districts, seasons of the year, species of animals and between the two sexes.

The results of post mortem indicated that out of 100% of infected animals in the study area, 99.9% were infected by more than one nematode species. On district bases; 100%, 99.9%, and 99.9% of infected sheep and goats in Afambo, Ayssaita and Dubti of the study sites respectively had mixed nematode infections and only 0.1% in Ayssaita and Dubti, of infected animals in respective study areas harbored one nematode parasite species. Poly parasitism of more than three nematode species in a single host predominates in all study areas and varies from 71% in Ayssaita district to 44.4% in Afambo and 68.1% in Dubti. A total of 58.3% of poly-parasitized animals in all study area were infected by 4 or more nematode species (Figure 2).

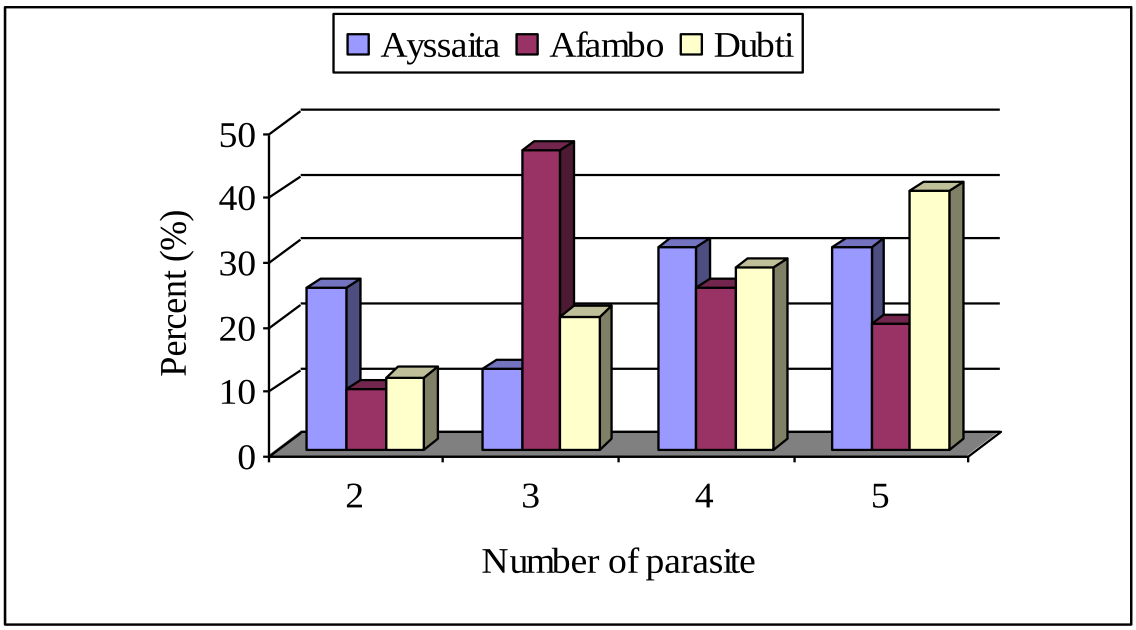


Figure 2: Percentage of animals infected by a given number of parasites

The results of post mortem examination have shown that 79.1 % of the infected animals harbored light infection, 20.8 % moderateTable 5.

Table 5. The intensity of nematode count observed from small ruminants in the study area

Intensity (Level of infection)	Animal species				Total	
	Sheep		Goats			
	No.	%	No.	%	No.	%
Light(<2000 nematodes)	130	72.2	250	83.3	380	79.1
Moderate(2000-10000)	50	27.7	50	16.6	100	20.8
Severe(>10000)	0	0	0	0	0	0

4.1.4 Correlation of nematode count to EPG counts from slaughtered small ruminants

The mean total nematode burden and mean total EPG count both from slaughtered animals in this study was positively correlated, and their correlation was significant r=0.131, p=0.01.

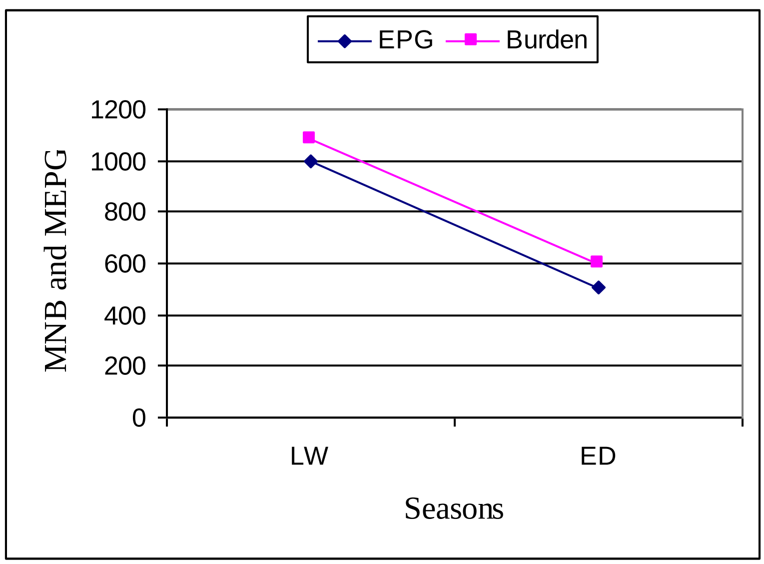


Figure 3: Correlation of nematode burden with EPG

4.2 Coprological results

4.2.1 Results of fecal egg count

The only few of infected animals had a fecal egg count in the range of 50-1000 EPG and majority proportions of animals had fecal egg count over 1200.

Fecal examination results in all study sites from population of sheep and goats during two sampling periods; late wet (October- December), early dry (January- March), indicated significant seasonal variation ($p<0.05$) for all study sites.

The highest prevalence was observed in Afambo district and the lowest prevalence was recorded in Ayssaita wereda is indicated in the table 6.

4.3. Influence of season, age, species and sex differences in fecal egg counts

Faecal samples collected from 504 sheep and 1806 goats and examined by the modified McMaster technique using flotation fluid zinc sulphat as the floating medium revealed that 75.3%, 79.4 % and 77.4% of the samples in Ayssaita, Afambo and Dubti district respectively. Mean EPG count in three study area have showed highly significant variation in two season of the year ($p< 0.001$) for late wet and early dry seasons, but in districts mean EPG counts was not significantly different ($p>0.05$).

Age differences of the animals had shown significant difference in EPG count in all seasons of the year ($p<0.05$). A species difference has revealed highly significant differences in two seasons late wet and early dry seasons of the year ($p< 0.001$).The findings are presented in the table 6.

Table 6. Nematode prevalence by coprological examination

District	No of animals	Prevalence %
Ayssaita	770	75.3
Afambo	770	79.4
Dubti	770	77.4
Overall	2310	77.4
P=0.097		
Species	2310	
Sheep	520	55
Goats	1267	22.5
P=0.000***		
Sex		
Male	892	38.6
Female	895	38.7
P=0.54		
Age		
1	482	26.5
2	637	35.3
3	395	22.6
4	373	15.6
P=0.041		
Season		
LW	1155(894)	77.4
ED	1155 (527)	45.6
P=0.000***		

*** Highly significant difference

Table.7. Mean EPG count by season, species, age and sex of animals.

Variable	EPG			
	N=2310	Mean ± SD	CI at 95%	P-value
Sex				
Male	690	652.46 ± 516.7	613.84 - 691.09	
Female	1620	792.16 ± 758.2	755.21 - 829.11	P=0.000
Age				
1	612	814.05 ± 710.8	757.62 – 870.49	
2	816	775.74 ± 772.7	722.63 – 828.84	
3	522	721.84 ± 667.1	664.47 – 779.20	P=0.021
4	360	697.22 ± 610.8	633.91 – 760.53	
Species				
Sheep	520	1162.30 ± 1070.2	1016.48-1173.03	P=0.000
Goats	1267	635.49 ± 493.0	624.58 - 673.08	
Seasons				
LW	1155	997.66 ± 815.3	950.59 - 1044.74	
ED	1155	503.20 ± 432.4	478.24 - 528.17	P=0.000

4.4 Questioner survey

4.4.1 Management

Result of 60 livestock owners interviewed revealed in this three district, 100% of livestock owners use a communal grazing and they use a free grazing system. Different age group and specie graze together. Availability of livestock pasture was better during the rainy season (July to September) than the dry season (October to April). Grazing area in most cases was very close to livestock grazing points.

4.4.2 Livestock diseases

External parasite, bacterial diseases (Blackleg and Anthrax), CCPP, and gastrointestinal helminthiasis were the most important livestock diseases in the area. During the survey 45% of the interviewed farmers ranked gastrointestinal helminthiasis as major, 35% as moderate and 20% as “least important”. Gastrointestinal helminthiasis was found to affect cattle and small ruminant both during the rainy and dry seasons.

4.4.3. Drug purchase and usage

The 80% of farmers bought antihelmentic drugs from unauthorized persons in black market, (15%) from veterinary clinic and health post and 5% from CAHWs. Furthermore, all pastoralist administer the drug in their house.

5. DISCUSSION

5.1. Identification of nematode species

5.1.1. Nematode prevalence

The most common species of nematodes associated with parasitic gastro-enteritis in small ruminants in most sub-Saharan countries are *Haemonchus contortus, Oesophagostomum columbianum* and *Trichostrongylus colubriformis. Trichostrongylus axei, Bunostomum trigonocephalum, Cooperia curticei, Trichuris ovis, Strongyloides papillosus,* and *Chabertia ovina* also contribute to the syndrome. In winter rainfall and cool highland areas, *Ostertagia circumcincta* and *Nematodirus filicollis* are also involved in the pathogenesis of parasitic gastro-enteritis in goats and sheep (Grabber, 1973). The prevalence and seasonal activity, life cycle and pathogenicity of each species vary with animal species, country and/or climatic region (Urquhart *et al*., 1996).

The postmortem examination of 480 sheep and goats during the study period enabled the identification of five (5) nematode species parasitizing the small ruminants in the study area. The prevalence of GIT nematodiosis of small ruminants from necropsied animals indicated 97.5% in sheep and 100.0% in goats. This result coincides with Menkir *et al*., (2006).

The existence of commonly reported species such as*, H. contortus Oe. columbianum, Trichuris ovis, T. axei, and Bunostumum* in higher percentage through out the study period in all Districts of the study sites agrees to the findings of other workers in other parts of the country (Bayou, 1992; Dereje, 1992; Esayas, 1999; Kasambara, 1999; Abebe and Essay, 2001 and Amenu, 2005).

The proportions of the genera of nematodes identified in the current study in which *Haemonchus, Oesophagostomum, Trichuris, Trichostrongylus and Bunostumum* was the most prevalent and is similar to findings of another study carried out in a semi-arid area of Kenya
(Ng'ang'a *et al*., 2004a). However, the order of prevalence reported by a study in Ghana was *Haemonchus*, *Oesophagostomum*, *Trichostrongylus,* and *Cooperia* (Agyei,1997); while that of a

study in South Africa was *Haemonchus*, *Trichostrongylus*, *Ostertagia*, *Cooperia*, and *Oesophagostomum* (Horak, 1981) and that of a Zimbabwean study was *Haemonchus*, *Oesophagostomum, Trichostrongylus*, *Ostertagia*, *Cooperia*, and *Trichuris* (Grant,1981) and *Oesophagostomum columbianum*, *Trichostrongylus colubriformis, Haemonchus contortus*, *Trichostrongylus axei*, *Tricuris ovis*, *Bunostomum trigonocephalum*, in Southern, Nations, Nationalities and People's Regional State Ethiopia (Amenu, 2005). It therefore seems obvious that differences in prevalent worm genera are dependent on geographical and climatic factors.

5.1.2. Seasonal dynamics in prevalence of nematode species

The seasonal dynamics in prevalence of identified nematode species indicated highly significant variation ($p<0.005$) between two seasons of the year and between species of animals. Figure 1 this present finding coincides from the findings of Nwosu *et al*. (1996) in Nigeria; Tembely *et al*. (1997) at Debre-Berhan of Ethiopia, Magona & Musisi (1999) in Uganda; Debela, (2002) in Adami Tulu; Ng'ang'a *et a*l., (2004a) and Ng'ang'a *et a*l., (2004b) in Kenya Amenu, (2005) in Southern, Nations, Nationalities and People's Regional State who indicated clear seasonal differences and Menkir *et al*., (2006) in a semi-arid region of eastern Ethiopia.

The observed parasite burden approximately 2–3 months after onset of rains is due to the presence of suitable climatic conditions for the development of free-living stages of the nematodes during this time. Although this finding can not be generalized to all the year, since only 8 months of a single year were included in this study, it is similar to findings from other studies that are highest the parasite burden during the wet months of the year and start to fall at the onset of the dry season, Nwosu *et al*. (1996) in Nigeria; Tembely *et al*. (1997) at Debre-Berhan of Ethiopia, Magona & Musisi (1999) in Uganda; Amenu, (2005) and Menkir *et al*., (2006).

5.2. Intensity and type of infection

The increased mean nematode burden obtained during the let wet season (1085.31± 600.53) compared with early dry season (596.88 ± 292.51) is in agreement with other findings in different parts of the world Yadav and Tandon (1989), Charles (1989), Debela, (2002), Ng'ang'a *et a*l.,(2004a) and Umur (2005), and is probably attributed to the highest number of infective larvae present in the pasture at let wet season and exposure to a high larval challenge in good pasture and favorable condition to the infective stage of the parasite (Troncy, 1989 , Urquhart *et al*., 1996).

The nematode egg out put (EPG) variation obtained during the different seasons of the year was highly variable particularly between late wet and early dry ($p<0.05$). This finding agrees with the results of Charles, 1989; Jacquiet *et al*.,1995; Fritsche *et al*., 1993; Agyei, 1997; Assefa & Sissay, 1998; Silva and Bevilaqua, 1998; Etana, 2002 and Menkir *et al*., (2006) who indicated the highest fecal egg count during the rainy season and the lowest during the dry season.

The highly EPG count obtained during the let wet season of this work could be explained by the fact that, those larva which get access to the host after rain might have been reached to egg laying adults during the time of sampling, therefore their existence in high number was not indicated by the presence of proportionally high number of eggs in the faeces (Troncy, 1989; Jorgen and Brian, 1994).

The relatively low fecal egg count obtained in the Dubti study site during in the study period could be explained by the better opportunity sheep and goats have for browsing during two season, after harvesting the cotton plant they reirrigate the plant and they regenerate they life therefore less challenge by the infective larvae and less nematode burden during previous wet season (Smith and Sherman, 1994). Contrary to this, the highest EPG was found during the study period in Afambo and Ayssaita, and this could be due to their free grazing and feeding on contaminated short grasses emerging just after first rain, faster development rate of larvae to $L_{3,}$ due to the presence of favorable humidity and temperature as the result of irrigated land in the areas.

The significance ($p<0.001$) mean nematode egg count observed in sheep than goats in late wet season (1407.29 ± 1162.01 versus 635.49.8 ± 493) in early dry season the highly significant EPG out put ($p<0.005$) of ovine than caprine this result coincide with Diallo, (1998); Mbae *et al.*, (2004) he find heavier infection in sheep than goat and the highly significant EPG out put, might probably be due to the variations in feeding habit of the two species and partly also due to the seasonal influence. Goats are browsers and they prefer browsing than grazing in late wet season when the plant leaves are plenty, so that the challenge to the infective stage of larvae is less than that of sheep, which prefer to graze than browse at any season (Urquhart *et al*., 1996; Craig, 1998; Radostits *et al*., 2000).

The significant variation ($p<0.05$) obtained in mean fecal egg out put of female animals (792.16 ± 758.2) than male (652.46 ± 516.7) coincide with the results of Assefa and Sissay (1998) and Debela, (2002) who reported female animals to have higher fecal egg out put than male animal. The present finding is not in agreement with the result of Amenu (2005) who reported higher EPG output in male animals than females. Other authors (Esayas, 1988; Achenef, 1997; Getachew, 1998) reported the absence of difference in fecal egg out put between the tow sexes. In the study areas small ruminants are used for milk and butter production to family consumption and to the market with good market price as they have greater demand. In this animals whose sexual cycle is seasonal when have a good pasture in rainy seasons, parasites tend to synchronize their reproductive cycle with that of their hosts. For instance, ewes and goats show a spring rise in fecal nematode ova that coincides with lambing and on the on set of lactation. Similarly, the development of helminth larvae ingested by the host in early winter tends to be inhibited until spring in a phenomenon called hypobiosis (Urquhart *et al.*, 1996).

Only few male animals were allowed to remain in the flocks mainly for the purpose of breeding service. The reproductive performance of female animals increases after rainy season because of adequate availability of good pasture, so this increases the EPG. This phenomenon seems to result from a temporary immune response associated with changes in the circulating levels of the lactogenic hormone, prolactin. Whenever, serum prolactin levels increases parasite specific immune response decreases. Whenever, prolactin levels decrease due to end of lactation or if lambs weaned early and the suckling stimulus removed, increase parasite specific immune response, (Urquhart *et al*., 1996; Craig, 1998; Radostits *et al*., 2000).

The present finding in the intensity of nematode infection, 79.1% light; 20.8% moderate and 0% heavy in necropsied animals differs from other findings in different regions of the country (Melkamu, 1991; Dereje, 1992; Yoseph, 1993; Achenef, 1997; Haile-leul, 2002). This is because the categorization of intensity of infection as light, medium and heavy used was that of Graber, 1973 who categorized 1-50 worms as light; 51-100 worms as medium and >100 worms as severe however we preferred to use the categorization which we found in Blood *et al*., 2000, that categorizes <2,000 nematodes as light; 2,000- 10,000 nematodes as medium and >10,000 nematodes as heavy infection in mixed infections of sheep.

The prevalence of poly parasitism from necropsied animals in this study (99.9%) agrees with the work of Yoseph, (1993) but higher than most of the findings (Gebre-yesus, 1986; Solomon, 1987; Ahmed, 1988; Esayas, 1988; Tesfa-alem, 1989; Melkamu, 1991; Bayou, 1992; Dereje, 1992; Getachew, 1998). The existence of more than two nematode species in a single host has an additive pathogenic effect on the host. The pathogenicity is usually high when *Hemonchus*, *Trichostrongylus* and *Oesophagostomum* occur together (Jorgen and Brian, 1994).

5.3. Coprology

The significant difference in the prevalence of nematodes in late wet season (77.4%) and early dry season (45.6%) is in agreement with the results of other studies like that of Agyei, (1997) but it disagrees with the finding of Yoseph (1993),Achenef (1997) and Amenu (2005). The observed rise in FEC approximately 2–3 months after onset of rains is due to the presence of suitable climatic conditions for the development of free-living stages of the nematodes during this time (Troncy, 1989 and Agyei, 1996). Significant difference ($p<0.05$) in the EPG between the study seasons was observed. This finding is in agreement with the findings of other authors (Achenef, 1997); (Vlassoff *et al*, 1999 and Good *et al*, 2006). Age differences of the animals had shown significant difference in EPG count in two seasons of the year ($p<0.05$) This result coincide with to the findings of a study that found other authors Achenef, (1997); Vlassoff *et al*, (1999), Ng'ang'a *et al*., (2004a), Ng'ang'a *et al*., (2004b), Mbae, (2004), Magona and Musisi, (2002), Debela, (2002) and Good *et al*, (2006) where the result indicated that the prevalence of strongyle infection is highest for Lambs. Contrary to (Amenu, 2005) where he find no difference in age.

5.3.1 Correlation of EPG to nematode burden

The mean total nematode burden and mean total EPG count both from slaughtered animals in this study was positively correlated, and their correlation was significant (spearman's rho=0.131, $p<0.01$). A similar positive correlation was found in sheep of Debre Brehan with a correlation coefficient of r= 0.52. Silvestre *et al*., 2000 also found positive correlation (r=0.47; p= 0.02) in sheep and a higher positive correlation of r=0.74 was found in young sheep (McKenna, 1981).

5.4. Questionnaire survey

5.4.1. Management

The result indicated that most of the farmers used free grazing system for their animals. Due to the scarcity of feed particularly during the dry season, all animals were concentrated in the same area and this situation might have increased the chance of infection by gastrointestinal helminthes.

5.4.2. Livestock diseases

45% of the interviewed farmers ranked gastrointestinal helminthiasis as major, 35% as moderate and 20% as "least important". Gastrointestinal helminthiasis was found to affect cattle and small ruminants both during the rainy and dry seasons. This could emanate from the fact that the areas are irrigated and are hence favorable for development of GIT parasite.

The observed positive association between free-range grazing and FEC compared to zero-grazing is due to the increased risk of infection and re-infection in free-range grazed animals compared to their zero-grazed counter-parts. This is in agreement with reports from other authors that under traditional free-range grazing systems there is continuous infection and re-infection from heavily contaminated pastures rendering anthelmintic treatment of limited value compared to the situation under zero-grazing (Waller, 2004).

Moreover, anthelmintic treatment under free-range system is also expensive due to the need for more treatments per year because of the constant re-infection of treated animals, not to mention the increased chances of development of anthelmintic resistance with the necessary increased use of anthelmintics under the free-range grazing system.

5.4.3. Drug purchase and administration

To improve helminth control and productivity in this area, farmers need to integrate management practices aimed at minimizing animal exposure to parasites with reduced reliance on anthelmintics. Therefore, a sustainable integrated helminth control strategy for this area should include adoption of supplementary feeding, and effective anthelmintic treatment regimes. An example of an effective anthelmintic treatment strategy that could be adopted in this resource-poor farming system is the FAMACHA procedure that was developed for resource-poor farming systems in South Africa (Van Wyk and Bath, 2002) and has been validated in other countries (Kaplan *et al*., 2004 and Ejlertsen *et al*., 2006). This system is based on assessment of anemic status of parasitized animals and treating only anemic animals that are succumbing to the effects of helminthoses. Although the drawback of this method is that it assumes that the anemia is solely a result of helminthoses, it has great potential in helminth control in resource-poor farming systems. Compared to conventional strategic anthelmintic treatments where all animals are treated, the FAMACHA system results in a large proportion of the animals not being treated.

From the results of this study it is quite clear that GIT nematodiosis of sheep and goats in the study areas was one of the major problems that hampered efficient utilization of the available small ruminant resources at hand. Favorite climatic conditions, backward level of management, poor level of consciousness and awareness of farmers about livestock diseases absence of veterinary services are believed to have contributed for widespread distribution and occurrences of these. This growing threat of GI nematodes to small ruminant production and resources at these pastoral areas needs well coordinated and urgent intervention.

6. CONCLUSION AND RECOMMENDATIONS

Gastro intestinal nematode parasites of sheep and goats in the study areas were one of the major problems that hampered efficient utilization of the available small ruminant resources by imposing exerting deleterious effect on infected hosts, which may be manifested by lowered vitality, reduced rate of reproduction as well as severe economic impact due to slower growth rate or death of infected individuals.

The present study revealed the wide spread existence of five nematode species *(O. columbianum, H. contortus, T. axei, T. ovis, B. trigonocephalum)* at the three selected site suggest the importance of GI nematodiosis hampering the productivity and health of small ruminants of the study area.

As various epidemiological factors are known to affect the prevalence and distribution nematode, the assessment of seasonal dynamics in prevalence of different nematode species has shown significant changes in the two seasons. A high prevalence of the GIT nematodiosis was observed in late wet season than early dry season. However, some of economically important nematode species such as *H. contortus, T. axei* and *O. columbianum* and *T. ovis* have indicated significant differences in their seasonal prevalence in different site of study area.

Our results indicated that small ruminants were exposed to multiple nematode infections in most cases harboring various species of nematode with in one or both seasons. It was also noted that sheep and goats sharing common pasture were exposed to a variety of common parasites. The mean nematode burden and mean nematode fecal egg count was varied seasonally in three study sites indicating that season of the year is among influential factors in the biology and development of different nematode species.

Based on the above conclusive remarks, the following recommendations are forwarded:

- Veterinary infrastructure and services should be developed in all districts in order to improve the health of animals and protect them from various parasitic diseases

- Strategic use of broad-spectrum anthelmenthics should be implemented at the beginning of rain season and at the end of rain season

- Education of the pastoralist on the impact of gastrointestinal nematodes on small ruminants` production and productivity, training them on the appropriate utilization of pasture land via rotation should be practiced

- Further epidemiological studies should be conducted in other pastoralist areas in the regions and also economic losses due to nematode parasitism should be determined

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8. ANNEXS

Annex 1.Guide to differentiate adult nematodes of the small intestines

	Strongyloides	*Cooperia*	*Nematodirus*
Mature size	Usually only females are found, 3 to 6 mm long.	Males 4 to 6 mm long. Females 5 to 7 mm	Males 10 to 15 mm long. Females 15 to 20 mm.
	These worms lose the iodine stain quickly when de-colourized with hypo solution.	Usually coiled flat or in 1 or 2 tight coils.	Usually tangled shape due to twisting of the "thin neck".
Other features	Very long oesophagus, one third to one half total length of worm.	Body of female swollen at region of vulva.	Female tail has prominent spine protruding from a blunt end.
	Eggs expressed from females have a fully developed larva in them,	Male tail has short, stout spicules.	Male tail has very long, slender spicules usually extending beyond the bursa.
	Bunostomum		
Mature size	Male 12 to 17 ram long. Female 19 to 26 mm. A stout worm much thicker than any other round worms of the small intestine.		
	Large buccal cavity has prominent teeth. *B. trigonocephalum* of sheep and goats has one large and 2 small teeth.		
Head	*B. phlebotomum* of cattle has 2 pairs of subventral teeth.		
Other features	*B. trigonocephalum* has short, twisted spicules. *B. phlebotomum* has long, slender spicules.		

Annex 2. Guide to differentiate adult nematodes of the large intestines

Caecum	*Trichuris*		
Mature size	Male 50 to 80 mm long. Female 35 to 70 mm long. The anterior end is very thin, the posterior end is thick. It is called the "whip-worm" because of its shape.		
Other features	Male has single spicule in spine-covered protrusible sheath. Female produces barrel-shaped eggs with a transparent plug at each end.		
Colon	*Chabertia*	*Oesophagostomum venulosum*	*Oesophagostomum colombianum*
Mature size	Male 13 to 14 mm long.	Male 11 to 16 mm long.	Male 12 to 16 mm long.
	Female 17 to 20 mm.	Female 13 to 24 mm.	Female 15 to 21 mm.
Other features	Chabertia has a large globular buccal cavity that is visible to the naked eye in fresh specimens. There are no teeth in the buccal cavity.	Small buccal cavity surrounded by leaf crown. Cervical papillae are situated posterior to the oesophagus.	Small buccal cavity surrounded by leaf crown. Cervical papillae are situated opposite anterior region of oesophagus.

Source: Dunn, (1978), Veterinary Helminthology second edition

Annex 3. Microscope examination.

Large Intestine

Trichuris

Characteristics whip shaped, microscope confirmation is unnecessary.

Tail of female is bow shaped and that of male is spirally coild with one spicule.

Oesophagostumum

Relatively small bucal capsule; cephalic vesicle is with cervical groove behind leaf crowns and cervical alae often present.

Chabertia

Large bell shaped bucal capsule with out teeth and rudimentary leaf crowns.

<u>Small Intestine</u>

Trichostrongylus

Both sex excretory notch visible in Oesophageal region.
Male: spicules leaf shaped or spicules with "stap" near tip (T. colubriformis).
Female: Vulval flap absent; ovejectores present.

Strongyloides

Only female presents; long Oesophagus; ovaryand uterus show twisted thread appearance behind oesophagus; objectors absent.

Cooperia

Both sexs: small cephalic vesicule present, giving anterior end a cylindrical appearance; prominenet cuticular striation in oesophageal region.
Male: spicule have" wing" at middle region, bearing striation.

Nematodirus

Both sexes: Cephalic vesicles present

Male: Spicule long, slender and fused, with extended tip which is heart- shaped (N. battus); lanceolet (N. flicollis) bluntly rounded (N. spathiger).

Bursa show two sets ofparallel rays (N. battus) or four sets (other specie)

Bunostomum

Large bucal capsule

Abomasum

Haemoncus

Male: Dorsal ray of bursa asymmetric; spicule barbed near the tip.

Female: vulval flap usually lingforme, present gravid worm conteins several hundred eggs; ovary coiled around intestine.

Teladorsagia

Male: spicule slender, rod like (T. circumcincta) or stout with branch near middle (T. trifurcate)

Ttichostrongylus axei

Both sexes: excretory notch visible in Oesophageal region.

Male: spicule unequal in length

Female: vulval flap absent, gravid worme conteins 4-5 eggs pole to pole.

Annex 4**.** McMaster egg counting technique

Equipment

1. Beaker or plastic container

2. Balance
3. A tea strainer or cheesecloth
4. Measuring cylinder
5. Stirring device (fork, tongue depressor)
6. Pasteur pipettes and (rubber) teats
7. Flotation fluid (see the Appendix to this handbook for formulation)
8. McMaster counting chamber
9. Microscope

Procedure

(a) Weigh 4 g of faeces and place into Container 1.

(b) Add 56 ml of flotation fluid.

(c) Mix (stir) the contents thoroughly with a stirring device (fork, tongue blade).

(d) Filter the faecal suspension through a tea strainer or a double-layer of cheesecloth into Container 2.

(e) While stirring the filtrate in Container 2, take a sub-sample with a Pasteur pipette.

(f) Fill both sides of the McMaster counting chamber with the sub-sample.

(g) Allow the counting chamber to stand for 5 minutes (this is important)

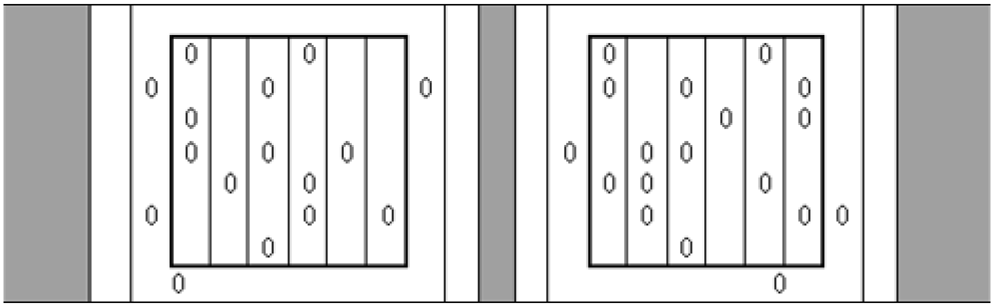
(h) Examine the sub-sample of the filtrate under a microscope at 10 x 10 magnification.

(i) Count all eggs and coccidia oocytes within the engraved area of both chambers.

(j) The number of eggs per gram of faeces can be calculated as follows: Add the egg counts of the two chambers together.

Multiply the total by 50. This gives the e.p.g. of faeces. (Example: 12 eggs seen in chamber 1 and 15 eggs seen in chamber 2 = (12 + 15) x 50 = 1350 e.p.g.)

(k) In the event that the McMaster is negative (no eggs seen), the filtrate in Container 2 can be used for the simple flotation method.



Annex 5. Post mortem examination procedure

Recovery of nematodes from the abomasums

Procedure:

1. Separate the abomasums from the intestine for wash
2. Open the stomach in bowl and collect the contents
3. Wash the stomach wall thoroughly under stream of water from the tap and rub the mucous membrane carefully with the fingers to remove any adhering to it.
4. Pour the contents of the bowl a little at a time to a wire mesh screen with an aperture of 0.15mm and then wash with a stream of water from a rubber tube attached to a tap until no more colored matter or feed particle pass through.
5. Flush the content on the sieve with a jet of water from the tap.
6. Fill the content of the bucket to 4 liters.
7. Agitate the whole content vigorously and take an aliquot of 200 ml by using a beaker and place in a glass Petri dish and examine under a stereomicroscope.
8. Adding few drops of iodine solution and allowing standing for 35 minutes can facilitate examination. Adding sodium thiosulphate leaving the parasites stained can also make depolarization of the stained debris.
9. Count the number of each species and multiply by a factor to arrive at the total parasite burden (in this case by 10 assuming total volume of 2 l.

Worm counting procedure

1. Add 2-3 ml of iodine solution to one of the 200 ml samples.
2. After thorough mixing, transfer 4 ml of suspension to a Petri dish, scored with line to

facilitate counting: add 2-3 ml sodium thiosulphate solution to decolorize debris.

3. Examine for the presence of parasite using a stereoscopic microscope and identify and count parasite as male, female and larval stage.

Annex 6. Determining the age of the goat (Mike Stell, 1996)

Age group	Teeth condition
Kid under 1 year	Eight sharp incisors
Yearling (1-2 years)	Central pair of baby teeth replaced by permanent ones
Young adult (3-4) years	4 permanent teeth
Adult 4-5 years	8 permanent teeth
Older adult > 5 years	Worm teeth and some missing

Annex 7. Estimation of the age of the sheep (Gaten, 1991)

Permanent incisors	Age of the sheep
None	Less than 1 year and 3 month
1 pair	1 year
2 pair	1 year 10 months
3 pair	2 year 4 months up to 3 year
4 pair	More than 3 years

Annex 8. Questioner survey format

Name of interviewed________________ Date_______________ PA______________

Village__________________ District__________ Zone__________ region__________

1. Production system

Pastoral_______________ Agro pastoral__________________

2. Livestock reared in the area in order of importance?

Cattle_____ Mule__________

Sheep_____ Horses___________

Goat______

Camel_____

Donkey_____

3. Grazing system in the area?

Private_______ Communal____________

4- What is the type of grazing in the area?

Free grazing_________ Stall feeding_________ Tether__________

4.1 In free grazing, method, do animals of different specie and age group graze together?

Yes________ No_____________

4.2- Which seasons/ months of the year, have a good pasture?

____

____

4.3-Mention seasons, or months during which food is least available?

____

____

5 - What are the most common disease affecting your animals? List in order importance.

1. __________________ 3. ___________________

2. __________________ 4. ___________________

6- Have you noted any diarrhea cases in your flock?

YES_____ NO______

6.1- If is you noted in which specie?

Cattle______ Goat______

Camel___ Sheep_____

6.2- In which season are more affected?

Wet season _____________ Dray season______

6.3- What control measure has been taken?

Antihelmentic__________________

Traditional medicine____________

Non_______

Annex 9**.** Post mortem examination result recording format

No	Date	Organe	Total Worme counte	Abomasum				Small Intestine							Caecum	Colon		Others
				Hae	*Os. tri*	*Os. cir*	*Trich*	*Coo. onc*	*Coo cur*	*Coo. .mcm*	*N. ba*	*T. col*	*Bun. tri*	*T. vit*	*Tric. ovi*	*Oe .co*	*Ch . ov*	

Annex 10**.** Prevalence (%) of GIT Nematode of sheep and goat in Ethiopia based on coprological and post-mortem examination

Region	Sheep		Goats		
	coprological	PME	Coprological	PME	Source
Tigray	88.1	95.6	84.3	90.5	Getachew(1998)
Amhara					
Gonder	94.9	100	90	100	Gebreyesus(1986)
Kombolcha	91	100	-	-	Genene(1994)
D/berhan	79.1	89.6	-	-	Achenef(1997)
Oromiya					
E/shewa	93.2	96.4	92.2	94.5	Melkamu(1991)
Wolega	-	-	96.5	-	Ahmed(1988)
Illubabur	90.2	-	81.3	-	Bayou(1992)
Bale	92.3	97.4	93	94.2	Tesfalem(1985)
Asela	86	93.3	-	-	Yosef(1993)
Somale					
Ogaden	96	-	-	-	Solomon(1987)
Ogaden	93.6	-	96.3	96.5	Esayas(1988)
Jijiga	-	-	76.9	-	Graber(1973)
SNNPRS					
Wolayita	91	90	86	98	Dereje(1992)
Wolaita	90.4	100	82.1	95.2	Haileleul(2002)
E.Ethiopia	92	95.6	91	100	Abebe and Esayas(2002)

Annex 11. Major nematode and their prevalence in different regions of Ethiopia based in post mortem findings

Region	*Haemoncus*		*Trichos. axei*		*Bunostumum*		*Oesophagostumum*		*Trichursi*		*Chabe*	Source
	Sheep	Goat	Sheep	Goat	Sheep	Goat	Sheep	Goat	Sheep	Goat	Sheep	
Tigray	95.5	90.4	28.9	68.7	-	18.1	82.2	24.1	6.7	8.1	---	Getachew(1988)
Gonder	36.4	45.8	6.8	2.08	34.1	81.3	77.3	68.8	54.6	60.4	---	Gebreyesus(1986)
Kombolcha	83.8	--	63.4	--	40.7	---	79.6	---	63.4	---	---	Genene(1986)
D/berhan	62.1	---	51.7	---	---	---	13.8	---	65.5	---	3.5	Achenef(1997)
Arsi and Wollo	66.8	--	89.4	---	34.4	---	57	---	83.2	---	4	Bekele *et al.*,(1982)
Ogaden	93.6	83.8	36.1	16.6	32	59.4	53	61.1	---	34.1	---	Solomon(1987) and Esayas(1998)
E/Shoa, Harar, and Sidamo	98.8		49.6 (T.Axei) 88.4(T. colub)	42		92	92		67.6			Kasambara(1999)
E/Shoa	89.5		78.1				77.1		54			Dessalegn(1999)
wolayta	80	81	10	13.6	10	17.2	90	88.2	50	27.8		Dereje(1992)

9. CURRICULUM VITEA

1. Personal Data

Full name	Dereje Shiferaw Ali
Birth Day	January 15, 1963 ETC
Place Birth	Harar
Martial status	Married
Nationality	Ethiopian
Member ship	Ethiopian veterinary association

2. Educational background

Elementary school	1969-1974 ETC in Ameha Desta elementary school Addis Ababa
Junior secondary school	1984-1987 GC in Cuba
High school	1988-1990 GC in Cuba
University	1991-1995 GC in Cuba
Post graduate studies	1998-2000 ETC in Addis Ababa University

3. Work Experience 1989-2000 ETC in Afar region as field veterinarian

4. Language ability

Spanish	Spoken and written
English	Spoken and written
Amharic	Spoken and written
Afrigna	Spoken
Tigringa	Spoken

5. Paper and publications

Study in prevalence of GIT nematode in small ruminant

6. Work shops and short term training

Advanced general pathology

TOT on community-based animal health services delivery

Veterinary drug supply management and rational use

Epidemiology of camel disease

Specialized course on pet animal’s treatment and surgery

10. SIGNED DECLARATION SHEET

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

Name Dereje Shiferaw Ali

Signature ______________

Date submission _______________

This thesis has been submitted for examination with my approval as university Advisor.

Dr. Yakob Hailu (DVM, Msc, PhD) ___________________________

Dr Dinka Ayana (DVM, Msc) ___________________________