EPIDEMIOLOGY AND SEASONAL DYNAMICS OF GASTROINTESTINAL HELMINTHOSES OF THE SMALL RUMINANTS IN EASTERN AND SOUTHERN SEMI ARID ZONES OF ETHIOPIA.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANOVA	analysis of variance
asl	above sea level
cm	centimeters
DVM	Doctor of Veterinary Medicine
epg	eggs per gram
GI	gastrointestinal
GIN	gastrointestinal nematodes
GIT	gastrointestinal tract
ILCA	International Livestock Centre for Africa
Km	kilometers
m	meters
ml	mililitres
mm	milimeters
µm	micrometers
PPP	prepatent period
PhD	Doctor of Philosophy
r.p.m	revolutions per minute

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ABSTRACT

This study was conducted to establish the prevalence of the gastrointestinal helminths infecting the small ruminants in eastern and southern semi arid zones of Ethiopia, to determine the seasonal dynamics and relative importance of gastrointestinal helminth infection, to determine the relationship between the faecal egg output and intensity of infection (worm burden) in infected subjects. A questionnaire survey was also conducted to gain insight into the farming system in operation and to study some herd health, management and social factors that may have some influence on the occurrence of gastrointestinal helminthoses. 300 households were randomly selected and the heads of the households were interviewed. Out of 300, 264 respondents were males and 36 were females.

Apart from the principal objectives the study tried to identify risk factors associated with the marketing system and helminth profile of the slaughtered animals from the place of origin to the abattoir.

The research period covered 8 months, from January to August, 1999. During this period 250 sheep and goats were examined: 250 gastrointestinal tracts and 170 livers were collected for examination. The following gastrointestinal helminths species were identified with respective prevalence rates: *Haemonchus contortus* 98.8%, *Trichostrongylus axei* 49.6%, *Bunostomum phlebotomum* 42.4%, *Trichostrongylus colubriformis* 88.4%, *Strongyloides papillosus* 44%, *Oesophagostomum columbianum* 92%, *Trichuris ovis* 67.6%, *Skrjabinema ovis* 31.2%, *Moniezia expansa* 21.2%, *Avitellina centripunctata* 25.2%, *Cysticercus tenuicollis* 40%, *Stilesia hepatica* 7%, *Fasciola gigantica* 0.58% and *Schistosoma spp* 0.4%. About 50% of the animals examined developed nodular oesophagostomosis.

The overall prevalence of gastrointestinal helminths was 47.2%: 64.3% for nematodes, 24.85% for cestodes and 0.48% for trematodes (*Fasciola* and *Schistosoma* spp).

The prevalence of GI helminths in sheep in the dry and wet seasons was 41.7% and 40.6% respectively. There was no significant difference in the prevalence in relation to seasons (X^2 =

0.65, P = 0.419). A similar situation was observed in goats where the prevalence rates in the dry and wet seasons were 54.9% and 51.3% respectively (X^2 = 2.54, P = 0.111). However a significant difference in prevalence of GI helminths was depicted between sheep and goats in the dry and wet seasons (dry season: X^2 = 37.74, P = 0.0000; wet season: X^2 = 18.95, P = 0.0000).

An analysis of variance (ANOVA) was used to test whether there is a significant difference between sheep and goats and also within these two animal species during the dry and wet seasons in relation to intensity of infection (worm burden). Five gastrointestinal helminth species were found to be significant and these are *Avitellina centripunctata*, *Cysticercus tenuicollis*, *Strongyloides papillosus*, *Trichostrongylus colubriformis* and *Skrjabinema ovis*. The worm burden was higher in goats than sheep except for *Avitellina centripunctata*. Nodular oesophagostomosis was also significant and was higher in sheep than goats. The worm burden of the above mentioned GI helminths was higher in the wet than in the dry season.

For the frequency of infection there was no animal without being infected with a helminth species. A minimum of two and a maximum of 10 different helminth species were identified from a single animal.

A univariate analysis of variance (ANOVA) was used to establish whether there is a significant difference or not between sheep and goats in the dry and wet seasons in relation to epg. It was found that there was a significant difference between these two host species (F = 5.172, P = 0.024) but there was no significant difference in seasonality between and within them (F = 0.485, P = 0.487; F = 0.055, P = 0.815).

The Spearman's rank correlation coefficient test has revealed a weak correlation between epg and the worm burden ($r<0.05$). The weak correlation reflects the true relationship which exists between them because there are a number of factors which have an influence on the number of parasite eggs in faeces and these are: the number of adult parasites established in the GIT, level of immunity, age of the host, species of parasite, stage of infection and parturition.

The results of the questionnaire survey revealed that on farm structure all the respondents are nomadic pastoralists entirely depending on livestock production. They all own both sheep and goats and these animals were inherited from parents. The grazing land and watering points are communal and animals from one herd do mix with others. This is very important in the epidemiology of GI helminthosis. Communal grazingland and communal watering points are potential sources of GI helminth infection.

All respondents have encountered gastrointestinal helminthosis of small ruminants. About 72.6% of them take measures such as medically treating the sick animals. 67.7% of them use herbs and the remaining 32.3% use drugs such as Tetramizole and Albendazole and they claime that the used drugs and herbs are all effective. 51.7%, 9.7% and 38.6% of the respondents have experienced that the young, the adults and both age categories respectively suffer from GI helminthosis.

In addition, 80.6% of the respondents indicated that GI helminthoses often occur during the rainy season while19.4% consider it as a dry and wet season problem and only 1 % of them think that it is a dry season concern. 86.7% and 13.3% of the respondends acknowledged receiving advice on drug usage and herd health management from fellow farmers and paravets respectively.

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1.0 INTRODUCTION AND OBJECTIVES

Ethiopia is one of the largest country in eastern Africa possessing an area of 1,128,176 sq. km. The climate is divided into:

a) Tropical zone with an annual temperature of 27° C and 510 mm of rain per annum and is 1830 m above sea level.

b) The subtropical zone which includes most of the highland plateau is between 1830 and 2440 m above sea level with an average temperature of 22° C and about 1110 to 1525 mm of rainfall per annum.

c) The temperate zone is about 2440 above sea level with rainfall of about 1270 and 1780 mm per annum.

Ethiopia with its great variation in climate and topography possesses one of the largest livestock population in the world which is managed by small holder farmers under extensive low input traditional system and adjunct to crop production. The latest estimate gives 31 million cattle, 24 million sheep, 18 million goats, more than 8 million equines and 59 million poultry (ILCA, 1993). In addition, the presence of an estimated 1.07 million heads of camels ranks the country 3rd in Africa. Small ruminants contribute about 30% of the total population and generate about 89% of cash income for the farmers (Gryseels and Anderson, 1983). They provide more than 30% of domestic meat consumption (Agyemang et al., 1985; ILCA, 1993) and generate cash income from export of meat mainly as live animals and skins. Hence an increase of small ruminant production is needed both to maintain self sufficiency in domestic meat consumption and increasing demand for exports.

75% of Ethiopia's 24 million sheep are raised in the highlands with altitude above 1500 m asl., receiving more than 700 mm of annual rainfall and sustaining 92% the human population. The rest 25% are reared in the lowlands. Goats are widely distributed in all climatic zones but with a high concentration in dry areas. This is because they are well adapted to hot and dry conditions and mainly to the fact that in dry zones there is less opportunity for alternative land use. Goats can survive on poor quality feed, reproduce in harsh environmental conditions and they have high reproductive performance and are drought resistance (Ademosum, 1994).

Cattle, sheep, goats and camels are the most important livestock species present in the arid and semi arid zones in Ethiopia and the dominant species being the goat. These animals are managed by small-holder nomadic pastoralists under an extensive low input system.

Inspite of the huge small ruminant population in Ethiopia however, underdeveloped infrastracture coupled with poor management practices, low nutritional status and diseases considerably affects productivity. The share of helminthosis in this regard has been anticipated to tantamount the combined effects of other causes of ill-heath. Available fragmentented information revealed that infection due to *Haemonchus contortus*, *Fasciola hepatica*, *Oesophagostomum columbianum*, *Trichostrongylus colubriformis*, *Dictyocaulus filaria* are responsible for the prevailing marginal productivity resulting from morbidities and mortalities in sheep and goats in different parts of the country (Bekele *et al.* 1982 and Tekleye *et al.*, 1987). However, owing to basic limitations in scope and coverage of most of these studies, a nation wide sound helminth control strategy has not yet been established.

The hypothesis subject to test is small ruminant helminthoses which are an important problem in arid and semi arid regions of Ethiopia. The principal objectives are therefore:

a) To establish the prevalence of helminths infecting small ruminants in eastern and southern arid and semi arid zones of Ethiopia.
b) To determine the seasonal dynamics and relative importance of helminth infection.
c) To determine the relationship between faecal egg output and intensity of infection (worm burden) in infected subjects.
d) To gain insight into the farming system in operation and to study some herd health, management and social factors that may have some influence on the occurrence of gastrointestinal helminthoses

Apart from the principle objectives, the study will try to identify risk factors associated with the marketing system and helminth profile of the slaughtered animals from the place of origin to the abattoir.

2.0 LITERATURE REVIEW

2.1 Important gastrointestinal helminthoses (Troncy et al.,1989)

2.1.1 Gastrointestinal strongylosis

It is caused by gastrointestinal nematode species in the Order Strongylida and belong to the three main families, namely: Ancylostomatidae, Strongylidae, and Trichostrongylidae. In these families the most important species are:

Ancylostomatidae: *Bunostomum* spp and are localised in the small intestines.

Strongylidae: *Oesophagostomum* spp. The larvae are found in the intestinal wall while the adults are commensal in the large intestines.

Trichostrongylidae: includes many genera but the most important ones are four, namely:

1) The genus *Haemonchus* which is a haematophagous parasite of the abomasum.
2) The genus *Nematodirus* - parasites of the small intestines.
3) The genus *Cooperia* - parasites of the small intestines.
4) The genus *Trichostrongylus* - parasites of the small intestines except for *T. axei* that occurs both in the abomasal mucosal of ruminants and gastric mucosa of many other animals.

All these nematodes are oviparous. The eggs are elliptical with thin greyish shell and an internal vitelline membrane. The size of the eggs range between 55-100 µm by 25-35 µm except in case of nematodirus eggs which are 150-230 µm in length.

2.1.1.1 Epidemiology

Gastrointestinal strongylosis is a cosmopolitan infection and occurs in marshy, muddy regions and wet pastures that are common during the rainy season. Its incidence increases under intensive management conditions. All ruminants can be affected by gastrointestinal strongylosis. The parasites are host specific and are rarely found in substitute hosts. Although wild ruminants such as buffalo, giraffes and various antelopes are often suspected of being potential sources of

Strongylida for domestic ruminants, the parasite species are different for domestic and wild animals except in rare cases. All strongylida species have a direct life cycle without an intermediate host. In all species larvae up to L_3 infective stage develop as free living larvae in the environment. The survival period of the eggs and larvae in the soil depends on the temperature and humidity conditions. Under moderate conditions this period does not exceed 2-3 months. Very long survival periods are observed in larvae kept in very dry conditions. They appear dead and desicated, but revive when moistened.

Penetration of larvae into the host may be by active or by passive way. Nematodes of the family *Ancylostomastidae (Bunostomum)* penetrate actively through the skin. The larvae migrate to the digestive system through the heart and lungs. It occurs mainly in muddy and not in very wet environment. In the *Strongylidae* and *Trichostrongylidae* infection is passive with the ingestion of 3^{rd} stage larvae present on grass blades in pastures. The possibility of an oral infection has been demonstrated for Bunostomum and the possibility of transcutaneous penetration has been shown in case of *Oesophagostomum*.

Transcutaneous infection obviously involves larval migration. In oral infection most species migrate deep into the intestinal mucosa. Migration is usually short and the larvae return into the lumen of the digestive tract after molting. Migration is very important in some species since the parasites are most pathogenic during this period; eg. *Haemonchus, Oesophagostomum* and *Bunostomum* spp. Migration is also important because of hypobiosis. It is a temporary cessation of development of larvae within the intestinal mucosa; eg. *Cooperia* spp. Certain authors believe that hypobiosis is also the cause of *nodular oesophagostomosis* (nodulosis). The infection is characterised by formation of relatively large nodules in the intestinal mucosa . Each nodule contain an inhibited larva.

Infestation occurs in muddy areas, in wet and marshy pastures. At the end of the dry season residual infection is negligible even in endemic areas. After on set of rains eggs shed by parasite carriers start to develop and the infective L_3 stage is reached after 3-10 days depending on the temperature. When the dry season sets in, the animals slowly clear themselves of their parasites except for the intramucosal inhabited larval forms. By middle of the dry season most of the nematodes have disappeared and only residual parasitism remains.

Favourable factors in the epidemiology of gastrointestinal strongyles are age, state of health, feed quality, genetic factors and herd management. Young animals are particularly susceptible to parasitism than adults which have some degree of immunity that limits reinfection. Pregnancy, parturient and lactating females are more susceptible than non-reproducing females. Under these conditions the resistance of individuals is weakened and encourages infection. Individuals with acute and chronic diseases or old animals are particularly susceptible.

In tropical Africa animals are less resistance when pastures are scanty especially in the dry season (Overend et al., 1994). The problem is worsened when there is no nutritional supplementation (Knox and Steel, 1996). Genetic factors may limit or favour parasite infection. Certain lines of sheep are more resistant or more susceptible to a given parasite than others. Some of the breeds which are resistant to parasitic infections are the Red Maasai, Florida Native and St. Croix sheep (Baker, 1995; Zajac, 1995).

Overstocking and prolonged grazing is harmful and encourages infection since the number of infective larvae increases with higher animal density on pasture (Barger, 1996). Several studies have suggested that animals with haemoglobin type AA (HbAA) are more resistance than type HbAB, which are more resistance than HbBB, to infection with *H. contortus* (Allonby and Urquhart, 1976; Altaif and Dargie, 1978; Kassai et al.,1990). It has also been revealed that genetically resistance sheep have higher numbers of leucocytes relative to non-resistant counterparts (Presson et al., 1988).

2.1.2 Strongyloidosis

It is caused by the presence of Rhabditida nematodes of genus *Strongyloides* in galleries excavated in glandular epithelium and submucosa of the small intestines. In ruminants the parasite is *Strongyloides papillosus*. It is a small worm (5-6 mm long and 50-60 µm in diameter) and is characterised by alteration of a free-living sexual generation and a parasitic parthenogenetic generation. Certain species have an endogenous cycle and are capable of developing from egg to adult within the host without a stage in the external environment. It is a common infection throughout the tropics and is more frequent in locations near the equator. Young animals are more susceptible while adults develop a certain degree of immunity.

Infection can occur either by ingestion of colostrum and the first milk immediately after parturition or through the skin in a humid or wet environment, such as wet and muddy enclosures, regions subject to flooding and the edges of pools and backwaters.

Clinical sings include intestinal with slight or serious dirrhoea. Depending on the degree of infection, age of the animals and their condition. Catarrhal lesions are observed in the intestines at autopsy. The parasites are only visible with a magnifying glass after scrapping the intestinal mucosa with a scapel.

Diagnosis is based on faecal examination. The Strongyloides egg is characteristic. It has a thin shell and contain a mobile embryo. The egg hatches rapidly in faeces kept at room temperature and a larva can be seen moving freely within the faecal mass.

Treatments with all benzimidazole compounds can be used quite effectively against Strongyloides. These include albendazole, fenbendazole, fenbendazole, oxfendazole, oxibendazole and thiabendazole. Thiabendazole is considered as a specific treatment for Strongyloidosis. Imidazothiazole derivatives such as tetramisole and levamizole are likewise effective.

Prophylaxis of Strongyloidosis is related to the more general problem of farm hygiene. The young become infected while suckling or as a result of unhygienic conditions in the enclosures. The adults can be infected in the enclosures, near or in pools where they wallow or drink. Animals should be kept in clean, dry, and if possible, concrete structures or enclosures. Adults should be kept away from pools and wallows where they may be infected. They should be provided with drinking water in raised, clean holes where mud can not collect.

2.1.3 Anoplocephalidosis

It is caused by cestodes which are large worms belonging to the family Anoplocephalidae. The most important species are *Moniezia expansa* (1-5 m by 0.5-1.5 cm), *Avitellina centripunctata*

(1.5 m by 0.5 cm), *Stilesia globipunctata* (50 cm by 0.1- 0.3 cm) and *Thysaniezia ovilla* (1- 4m by 0.8- 1 cm)

All these cestodes expel between 2 and 10 gravid segments per day with the faeces. Each of them contain embryonated eggs. A single worm can shed 15,000 to 20,000 eggs per day. The common characteristic of the eggs is that they always contain a six-hooked embryo.

2.1.3.1 Epidemiology

Cestodes of ruminants are cosmopolitan in distribution except Stilesia and avitellina species which are usually found in warm dry regions while Moniezia species have a more uniform distribution. The most frequent hosts are sheep especially lambs.

Cestodes need an intermediate host to complete their life cycle. Irrespective of the parasite species the intermediate host is always oribatid mites which are almost microscopic arthropods found at all latitudes. The mites live on and in humus on the soil surface. They prefer damp shaded areas, but some species are adapted to dry areas. During the day they migrate vertically depending on the relative humidity and temperature. They feed on microscopic plants and organic debris like algae, fungi and crumbled faeces.

The mites ingest embryonated cestode eggs while feeding on excreta of parasitised ruminants. Cestode eggs can survive for an estimated period of 4 months depending on the climatic conditions. A Moniezia egg resists desication for more than a fortnight but dies after 1 day.

In oribatid mites, a larval form called cysticercoid develops in 6-16 weeks. This infective larval form remains viable throughout the life period of the mite which is around 1-2 years. In contaminated pasture, the infection can persit for a long time.

Ruminants are infected while grazing where a mite carrying a cysticercoid is present. A mite is most likely to be swallowed as it moves on the grass blades in the morning or evening or during damp, cloudy weather. During wind, dry conditions, excessive heat or pouring rains it buries itself. The infection is acquired at pasture. Permanent stabled ruminants are rarely infected.

2.1.3.2 Clinical signs

Clinical signs include digestive disorders such as bloating or alternation of diarrhoea and constipation. In young lambs convulsive disorders and sometimes death are observed. The most important lesions are those found where the scolex of the worm is attached to the digestive tract wall. At these points, the mucosa degenerates or in the case of *S. globipunctata*, fibrous and protruding yelowish-white nodules where scolices are deeply lodged.

2.1.3.3 Diagnosis

Diagnosis is based on observation of gravid segments expelled with excreta. Examination of faeces for eggs is only simple in case of *Moniezia*, provided that gravid segments were expelled and lysed in the sample.

2.1.3.4 Control measures

Animals being treated should be kept in an enclosure as long as the worms are being expelled to avoid spreading viable eggs on pastures. Metal salts including tin arsenate, lead arsenate and copper sulphate are used to treat cestodes in ruminants.

Niclosamide is used in form of wettable powder and is a drug effective against all *Anoplocephalidae* and also certain trematodes. It is recommended that animals be restricted to water for 12 hours before treatment.

Benzimidazole derivatives like cambendazole is effective against *Stilesia, Avitellina, Thysaniezia* and *Moniezia*. It is embyonic in the early stages of gestation. Other benzimidazole derivatives used as cestodicides are fenbendazole, oxfendazole, mebendazole and albendazole. Recently developed cestodicides are Resorantel, Praziquantel and Febantel.

Drug prophylaxis should be carefully organised to limit the danger of parasitism while allowing immunity to develop. According to studies carried out in Central Africa, *Stilesia* and *Avitellina* are present throughout the year, while *Moniezia*, which is the most pathogenic, is abundant at the end of the rainy season. The population decreases towards the beginning of the dry season and almost disappears by the end of the season. Premunition against Moniezia therefore disappears while that of Avitellina and Stilesia persists.

The choice of cestodicide should be guided by the two standard requirements of cost and spectrum activity. An anthelmintic should be effective against *Moniezia*, the most pathogenic cestode and if possible against *Stilesia* and *avitellina*.

Prophylaxis through hygiene should theoretically focus on controlling the intermediate hosts-oribatid mites.

2.1.3.5 Hepatic stilesiosis

Hepatic stilesiosis is a helminthosis due to the presence of an *Anoplocephalidae* cestode, *Stilesia hepatica* in the bile duct of ruminants. It is exclusively an African parasite that appears to originate in certain antelopes, including the roan antelope, cobs, and water bucks, duikers and mainly bushbucks. Among the domestic ruminants sheep are the most frequent parasitized.

Animals are infected by ingesting oribatid mites which are the intermediate hosts. The symptoms are not very obvious. Usually there are no outward signs apart from slight emaciation in heavy infection.The importance of this disease is that the liver of the infected animal has to be rejected at meat inspection. Treatment is not given as all cestodicides are almost or completely ineffective.

2.1.4 Trichurosis

Ruminants also suffer from *Trichurosis*, a helminthosis due to the presence and growth in the large intestines and caecum of Enoplida nematodes of the family *Trichuridae* (whipworms) belonging to genus *Trichuris*. The most important ones are *T. globulosa* and *T. ovis*. They are medium sized worms (3-7 cm), with the body clearly divided into two parts, the anterior being more slender and longer than the posterior. The eggs of these parasites are laid unembryonated.

They have a thick brown shell with a plug at each pole. The infective larva L_1 remains within the egg until it is ingested by the difinite host.

Clinical signs are seen mainly in the young and appear only in the case of severe infection. These are usually digestive troubles with diarrhoea and general signs including emaciation, poor general condition and anaemia since *Trichuris* are haematophagous. The observable lesions are those of severe chronic and occasionally haemorrhagic typhlitis and colitis. Diagnosis is based on detection of the characteristic *Trichuris* eggs in the faeces.

Control measures: Treatment with Phthalofyne which is specific to Trichuris is not active against other nematodes. Other drugs are benzimidazole compounds like fenbendazole, oxfendazole, albendazole and mebendazole. Prophylaxis depends on general hygiene. In practice these measures are taken to prevent major helminth infections even if they may not be taken specifically for Trichurosis.

2.1.5 Oxyurosis

Oxyurosis in small ruminants is caused by an Oxyuridae nematode, *Skrjabinema ovis*. It is a parasite of the large intestine of sheep and may also be found in goats. *S. ovis* is not very pathogenic and normally escapes notice. It is generally found in faecal examination or at autopsy. Gravid females are sometimes expelled in faeces.

2.1.6 Fasciolosis

It is a helminthosis caused by Fasciolidae trematodes of the genus *Fasciola* (large flukes) which migrate in the hepatic parenchyma, and establish and develop in the bile duct. Fasciola are fairly large hermaphrodite worms with a leaf shaped body and a spiny cuticle. Two species are causative agents of fasciolosis and these are *Fasciola gigantica* and *Fasciola hepatica. F. gigantica* is exclusively tropical and measures 25-75 mm by 3-12 mm. *F. hepatica* is found in temperate reas or high altitude regions in east Africa and measures about 20-30 mm by 10 mm. The two species are haematophagous. Their eggs are elliptiform large with a thin shell containing a morular mass of cells surrounding the zygote.-These eggs are operculate at one pole and yellowish in colour.

In Ethiopia the distribution of *F. hepatica* is reported to extend in areas situated from 1800 meters and higher above sea level while that of *F. gigantica* is up to 1200 meters above sea level (Graber, 1978). It has also been shown that both species of *Fasciola* co-exist in Ethiopia.

The snail intermediate host of both species of *Fasciola* are principally two. These are *Lymnaea truncatula* which is the intermediate host of *F. hepatica* and *Lymnaea natalensis* which is the intermediate host of *F. gigantica* (Graber, 1978). *L. natalensis* is widely distributed in lowlands, irrigation canals and pockets of water with vegetation. It is strictly aquatic. It lives on or just under the surface of water during the day. This may make them susceptible to surface spraying with molluscides. *L. truncatula* is usually encountered in medium altitudes and highlands. The snails are usually found in small ponds, boarder of slow moving rivers and shallow streams.

2.2 Importance of gastrointestinal helminths

2.2.1 Global

The most serious problem affecting sheep and goat production worldwide is infection with gastrointestinal nematodes. Financial losses related to these parasites are caused by decreased production, treatment and prophylaxis costs and mortality. An epidemiological study carried out in goats and sheep (Pugh, *et al*, 1998) shows that the primary diagnosis was gastrointestinal nematode parasitism in 38% of sheep and 52.4% of the goats. They evaluated the effectiveness of the previous control programmes and came up with new strategic deworming programmes which produced the best results. They also found that a single programme is usually not effective.

Gastrointestinal nematode infection decreased goat productivity in Morrocan semi arid regions (Berrag and Cabaret, 1998). Nematode species found in naturally infected herd of goats include *Teladorsagia, Haemonchus, Trichostrongylus, Nematodirus, Trichuris, Oesophagostomum and Chabertia.*

In Saud Arabia an investigation was carried out to investigate the prevalence of gastrointestinal nematodes in adult goats (Alyousif, 1997). A total of seven different species of nematodes were identified: *Trichuris ovis, Nematodirus spathiger, Trichostrongylus probolurus, Haemochus contortus, Camelostrongylus mentulatus, Oesophagostomum columbianum and Marshallagia marshalli*.

Gastrointestinal nematode infections depend on age, state of health, season and breed. An epidemiological study of ovine GIN infection was carried out in semi arid zone of Rajasthan, India (Singh *et al*, 1997). It revealed that young sheep harboured more worms than did adults. Crossbred sheep had more *Haemonchus contortus* and native sheep more *Trichostrongylus axei. H. contortus* and *Strongyloides papillosus* were present throughout the year. *Trichostrongylus* species were present during the pre-monsoon period and *Oesophagostomum columbianum* during summer and monsoon. A similar study was conducted to evaluate the importance of seasonality and intensity of infection in sheep and goats (Beriajaya *et al*, 1997). It was concluded that intensity of exposure of both sheep and goats to *H. contortus*, *Trichostrongylus axei* and *Cooperia curticei* was similar throughout the year, but availability of infective larvae of *T. colubriformis* was higher during the dry than the wet season and vice versa for *O. columbianum*. Sheep had higher burdens of *T. colubriformis* than goats but similar numbers of other species.

It has been found that GIN infection rates were influenced by age, the presence of coccidia, the location of the farm and the type of the water source used (Mbaria *et al*, 1995). For sheep without coccidia, the nematode infection rate decreased with age. In sheep with coccidia the nematode infection rate increased with age.

The risk of parasite infestation has been quantified by simulation models which include factors such as season, irrigation, harbaceous biomass on pastures and pasture management. The main factors in GIS population variation are therefore environment, season, pasture management and also age of animals. The main sources of variation in parasite infestation risk are related to water and to host resistance (Aumont *et al*, 1996).

2.2.2 The Ethiopian situation

In Ethiopia, country-wide surveys undertaken in the area of gastrointestinal helminthoses indicate that the prevalence rates in different parts of the country are as follows: In Gonder it is

90.43% (Gebreyesus, 1986), Ogaden- 80.6% (Solomon, 1987), Bale- 92.33% (Tesfalem, 1989), Easten Shewa- 82.22% (Melkamu, 1991), Wolaita Sodo- 80% (Derege, 1992), Asella- 85.97% (Yosef, 1993), Kombolcha- 91.43% (Genene, 1994), and in Debre Berhan- 79.09% (Achenef, 1997).

Few studies were carried out to define the prevalence rates done on cestode infections of small ruminants in Ethiopia. *Moniezia* prevalence rates recorded include 57% in Addis ababa (Bekele et al. 1992), 27.7% in Gonder (Gebreyesus, 1986), 26.32% in Bale (Tesfalem,1989), 29.76% in Eastern Shewa (Melkamu, 1991), 30% in Wolaita Sodo (Derege,1992), 29.76% in Asella (Yosef, 1993), 12% in Wollo (Etagegnahu, 1992) and 22.56% in Gombolcha (Genene, 1994). Avitellina prevalence rates include 6.81% in Gonder (Gebreyesus, 1986), 7.8% in Bale (Tesfalem,1989), 9.52% in Eastern Shewa (Melkamu, 1991), 20% in Wolaita Sodo (Derege, 1992), 9.52% in Asella (Yosef, 1993), and 19.35% in Gombolcha (Genene, 1994).

2.3 Diagnosis

Diagnosis of gastrointestinal parasitic infections still depends heavily on parasitological findings such as detecting eggs and/or parasites in faecal samples (Kimberling, 1988; Smith, 1994).

Although these tests, if successful, provide unequivocal evidence of infection, they are limited especially when applied to low level infections where the parasite occurs in deeper tissues (Smith, 1994). Laboratory diagnosis of faecal examination is an important diagnostic procedure for GI strongylosis. Observation of nematode eggs is not enough to confirm a diagnosis. It is the quantity of eggs that determine the diagnosis and so a quantitative faecal examination is required. One can classify the severity of infection as light, moderate and severe depending on the number of eggs, species of parasite and species of animal considered (Troncy *et al*., 1989).

Though not widely employed in parasitology, a number of serological techniques are available for diagnosis of parasitic infections such as Indirect Fluorescent Antibody test (IFAT), Enzyme Linked Immunosorbent Assay (ELISA), Complement Fixation Test (CFT) and others (Kaufmann, 1996). Antigen detection is much more effective than the classical coproscopic examination for it enables us to detect infection to immature forms of helminths. Some studies have been done on the isolation of Fasciola gigantica specific antigens (17kDa and 69kDa polypeptide antigens) and their use in the serodiagnosis of fasciolosis in sheep by detection of circulating antigens (Guobadia and Fagbemi, 1997). An improved haemagglutination (HA) test using the purified specific f2 antigen of Fasciola hepatica has been evaluated with respect to its potential use in the diagnosis of caprine fasciolosis (Levieux, et al., 1994).

The best confirmatory method of helminth infections is postmortem diagnosis with detection and identification of parasite as the severity of the lesions give accurate information on disease incidence (Troncy *et al.*, 1989).

2.4 Treatment and Control Strategies

The most effective control strategies for helminths, using anthelmintics, are usually those based on the epidemiology of the parasites, with the treatments being designed to reduce both pasture contamination and host infection (Brunsdon, 1980). Improper timing of treatments and incorrect selection of anthelmintics are not only less effective in controlling the parasites, but are also costly and potentially harmful by selecting for anthelmintic resistance (Michel, *et al.*, 983; Waller, 1993). Regular treatments are, however, rarely applied by livestock owners because of the high cost of anthelmintics. Too frequent use of anthelmintics is also likely to select heavily for worms that develop resistance to the anthelmintics used (Waller, 1987).

Strategic control of *Haemonchus* and other nematodes in sheep using closantel, a long-acting narrow-spectrum salicylanilide anthelmintics against blood-sucking nematodes, in combination with broad-spectrum anthelmintics, has successfully been evaluated in Europe (Taylor, *et al.*, 1991). Closantel also plays a pivotal role in the Wormkill strategic control programme, implemeted with success in the tablelands of Australia (Dash, 1986; Dash and Waller, 1987; Rolfe, *et al.*, 1990; Waller, 1993). Hall, *et al* (1981) reported that a single oral dose of closantel at 10 mg/ kg body weight provided almost complete protection (99.4%) against reinfection of sheep with *H. contortus* at 30 days after drug administration and substantial protection (62.8%) at 60 days.

The effect of anthelmintic treatments is manifested in many ways, such as enhanced growth rate, reproductive perfomance and wool production. The effect could occur through an alteration in the onset, magnitude and duration of the availability of infective larvae on pasture, a phenomena that determine the worm burden (Darvil, *et al.*, 1978). Maingi, *et al.*, (1997) also found out that strategic control programmes based on the use of closantel and albendazole can provide effective control of gastrointestinal nematode infections in sheep. Treatments with albendazole once or twice during the dry season and with albendazole and closantel during the wet seasons resulted in reduced numbers of larvae on the pasture and lower levels of infection in the lambs, which then resulted in higher weight gains, wool production, PCV, and serum albumin and protein concentrations, compared to lambs that remained untreated.

Gatongi (1995) showed that treatment of sheep and goats with ivermectin at the end of dry season in Naivasha, a semi arid region of Kenya, reduced pasture infectivity during the subsequent wet seasons and improved flock performance. However, anthelmintic treatment when parasites have a low refugium, such as during a dry season, is thought to increase the selection pressure for anthelmintic resistance (Prichard, *et al.*, 1980; Donald, 1983; Martin, *et al.*, 1984). Although appearing to offer effective control of nematodes, anthelmintic treatment immediately before the rainy season may therefore not be an appropriate strategy. It would probably be better to give a combined closantel and a broad-spectrum anthelmintic treatment 2-3 weeks after the onset of the rainy season and a broad-spectrum anthelmintic treatment at the beginning of the dry season.

Brunsdon (1980) broadened the concept of intergrated control to include three interrelated approaches: grazing management, use of anthelmintics and enhancement of natural or artificially-induced immunity. He indicated that the most effective control is possible only through complete integration of all three facets and a full understanding of the epidemiology of infections. Availability of safe pasture at appropriate times for susceptible animals was listed as an essential requirement of intergrated control.

Barger (1993) emphasised on the minimal use of most effective anthelmintic, intergration of chemotherapy with grazing management, avoidance of underdosing, annual rotation of anthelmintic classes, the importance of adequate nutrition, monitoring of faecal egg counts and treatment efficacy and, above all, trying to convince farmers that broad-spectrum anthelmintics are a valuable and extremely limited resource that should not be squandered by irresponsible use.

There is overwhelming evidence that genetic variation can be exploited to increase resistance of sheep populations to parasitic nematodes. Of the novel approaches to worm control which are currently under consideration, breeding for resistance (Gray and Gill, 1993), nutritional supplementation (Knox and Steel, 1996) and improved grazing management (Barger, 1990) offer immediate prospects of application in the grazing sheep industries to complement the strategic use of anthelmintics. The Red Maasai (Baker, 1995), Frorida Native and St. Croix (Zajac, 1995) sheep have been the subject of a number of studies which have indicated that knowledge of the breed alone can have predictive value for resistance to parasitic infection.

It is unlikely that breeding alone will be used for worm control and therefore the interaction between genetic and nutritional approaches also deserves attention. Improved nutrition has repeatedly been shown to increase resistance to nematode infection in sheep (Coop, *et al.*, 1995). Apart from nutrition, interaction of genetic resistance with vaccination also needs attention although there is currently no vaccine available for the nematode parasites of the gastrointestinal tract of ruminants despite extensive research. Early attempts focused on the use of radiation-attenuated vaccines following the success of the commercial vaccine against lungworm in cattle (Taylor, 1979). These attempts were abandoned mainly on the basis that young sheep were not responsive to vaccination. One outcome of breeding for increased resistance may be to reduce the age of onset of responsiveness to vaccination (Colditz, *et al.*, 1996). For *Haemonchus*, data from papers published from 1959 to 1984 suggest a threshold for effective vaccination is around 6 months and Gray *et al.*, (1992) showed that one genotype selected for high level of resistance was able to develop almost complete resistance to incoming larvae as early as 5 months.

2.5 Factors influencing the number of parasite eggs found in faeces

The factors which have an influence on the number of parasite eggs in the faeces are: the number of adult parasites established in the gastrointestinal tract, level of immunity, age of the host, species of parasite, stage of infection and parturition (Hansen and Perry, 1994).

One way of regulating egg production is the worm length that is there is a positive correlation between the mean female worm length and the mean number of eggs per female. This implies that worm length and the number of eggs per female worm are both measures of worm fecundity or eggs in the faeces (Stear *et al.*, 1995).

A phenomenon which increases the number of nematode eggs in the faeces is termed as periparturient rise or spring rise in faecal egg count (Soulsby, 1986). The etiology of this phenomenon seems to result from a temporary relaxation in immunity associated with changes in the circulating levels of lactogenic hormone, prolactin. The possible source of spring rise are: maturation of larvae arrested due to host immunity, an increased establishment of infection acquired from the pastures and an increased fecundity of existing adult worm population (Urquhart et al.,1992).

The periparturient relaxation of resistance results in the dam´s inability to expel adult worms. As a result there is subsequent rise in faecal egg count which leads to serious pasture contamination (Hansen and Perry, 1994).

2.6 Factors affecting the size of gastrointestinal helminth infections

The factors that affect the size of GI helminth infections are as follows:

a) The number of infective larvae (L3) ingested by the host which in turn is influenced by climate, the amount of protection of larvae provided by vegetation, the livestock density and the grazing patern of the ruminants present.
b) The rate at which acquired resistance develops in the host which is influenced by species of the parasite and host, genetic factors, nutrition and physiological stress.
c) The intrinsic multiplication rates of the species of parasites present which are controlled by the fecundity, prepatent period, and environmental development and the survival rates of these species. Other factors are management particularly grazing patterns and also the use of anthelmintics, including the timing and frequency of administration (Hansen and Perry, 1994).

2.7 Immunity to nematode infections

Immunity to nematode infection is apparently concerned in the control of the parasite population and inhibition of parasite growth (Nobre, 1982). Parasites will present to their host with a very array of potential antigens to which a variety of immune responses may be made. Many of these responses will play no part in protective immunity because they will be directed against targets that are irrelevant to the continued survival of the parasites The immune responses that can provide protection against a given parasite are determined by the type of parasite concerned and its location in the body of the host (Smith, 1994).

The presence of parasites and their metabolites stimulate the host to react by producing antigens. Various immunoglobulin classes of antibody occur during infection. Immunoglobulin A (IgA) antibodies are detectable early in infection and IgE antibodies accumulate at the intestinal mucosal surface, being transported there by mast cells. An exponential increase in mast cells may occur in the intestinal mucosa and these through sensitisation by specific IgE antibody and subsequent reaction of vasoactive amines upon contact with parasite antigen, play an important role in the elimination of a parasite burden (Noble, 1982; Soulsby, 1986).

3.0 MATERIALS AND METHODS

3.1 Study design

3.1.1 Study area

The present study was based at Debre Zeit Export Abattoir where a significant number of sheep and goats are slaughtered for export to the Middle East (Arab countries). Debre Zeit is located 45 km south of Addis Ababa and lies at an altitude of 1800 m above sea level. The origin of these animals is from the eastern and southern semi arid regions of Ethiopia These regions are: East Shewa, Afar, Harragie and Southern Sidamo. Awash 7- Kilo, a semi arid district in Afar region, was selected for administration of the farmers questionnaire and further sampling. In all these study areas the dry and wet seasons extend from January to April and from May to August, respectively. The meteorological data from the study areas for the duration of study were compiled for analysis (Annex 5).

3 1.2 Study population

The number of sheep and goats slaughtered at the abattoir ranges from 500 to 1,000 per slaughter. Slaughters were done at a rate of twice per week and male animals only. The age of these animals ranges between 1 and 4 years and the majority being between 1 and 1½ years old.

From January to August, 1999, 250 sheep and goats were sampled (80 sheep and 170 goats). Out of 250, 210 animals were sampled at Debre Zeit export Abattoir and 40 were sampled from Awash 7- Kilo, a semi arid district in Afar region. The average sample size was thus, about 8 animals per week(Table 2a.b).

The blackhead Ogaden and the fat-tailed Adal are the predominant sheep breeds considered in this study. As for the goats the name of the breed or type depends on the place of origin (Afar goat, Ogaden goat, Borena goat, etc.).

Table 1a. The number of sheep and goats sampled from January to August, 1999.

Months	Sheep	Goats	Total
January	10	0	10
February	20	20	40
March	10	20	30
April	0	20	20
May	10	20	30
June	0	40	40
July	10	30	40
August	20	20	40
Total	**80**	**170**	**250**

Table 1b. Number of sheep and goats sampled at Debre Zeit Export Abattoir and in Awash, a semi arid district in Afar Region.

Place of sampling	Sheep	Goats	Total
Debre Zeit Abattoir	50	160	210
Awash 7- Kilo	30	10	40

3.1.3 Methods

Sampling: The work involved random collection and examination for parasites of 250 gastrointestinal tracts (abomasum, small and large intestines) and liver. Faecal samples from the rectum of each sampled animal was made for coproscopic examination employing the modified McMaster method.

3.1.3.1 McMaster method

3g of faeces are weighed and if faeces are diarrhoeic 3 tea spoonfuls are enough. The faeces are broken up thoroughly in 42 ml tap water. The mixture is poured through a fine mesh sieve with aperture 250 µm. The filtrate is collected , agitated and filled in test tubes for centrifugation at 2,000 r.p.m. for 2 minutes. The supernatant is discarded and is replaced by saturated salt solution to the previous level. Stir the suspension well in order to obtain a completely homogenous distribution of the eggs. Using a pasteur pipette the compartments of the counting chambers are filled without interruption. We make sure that there are no bubbles in the compartments. After a few minutes the eggs float to the cover slides and ready to be counted. If one chamber is examined we multiply the number of eggs under one etched area by 100 and if two chambers are counted we multiply by 100 (Urquhard et al.,1987).

Calculation of the amount eggs in 1g faeces (epg): It is obtained by multiplying with the dilution coefficient as: epg = N * 100

3.1.3.2 Post mortem procedures to determine the worm burden

Immediately after slaughter the viscera was removed and different gut segments ligated to prevent transfer of the content from one side to the other. Each segment was cut off and separately examined. The abomasum was opened along the greater curvature and the contents collected in a bowl. The abomasum wall is washed thoroughly under a stream of water from a tap. The mucous membrane being carefully rubbed with fingers to remove any worms adhering to it and the washings being caught in the same bowl as the abomasum contents. The contents of the bowl are poured a little at a time on a wire mesh screen with an aperture of 250 µm which then is washed with a stream of water from a rubber tube attached to the tap until no more colored matter or food particles pass through. When all material has been screened and washed in this way the screen is inverted over a trough and by a means of a stream water the food material and worms collected on the screen are washed into it. Small quantities are placed in a glass petri dish having parallel lines marked on it 5 mm apart, diluted with water and the worms counted under a dissecting microscope.

The small intestine is run off the mesentery and its contents removed by drawing 1.5-2 m lengths through fingers. Water is now run through the separate lengths by inserting a rubber tube attached to the tap into one end. The washings are added to the contents and delt with as described above for the abomasum contents. The large intestine is delt in the same way.

For easy worm counting, 2-3 ml Iodine solution is added to 200 ml samples to stain the parasites and 2-3 ml Sodium thiosulphate solution to decolourise debris. Samples are examined for the presence of parasites using a stereoscopic microscope (* 10 objective). They were identified and counted as male and female (Urquhart et al., 1987).

3.1.3.3 Examination of liver for the presence of *Fasciola*

The liver is removed from the carcass. The gall bladder is removed and transfered to a bowl cut open. The liver is cut into slices 1 cm thick and these are squeezed and thoroughly washed. Any flukes seen adhering to the liver are detached with forceps. The squeezing and washing is repeated and the pieces of liver are discarded. The washings are passed through a wire mesh screen with an aperture of 250 µm and flukes which are retained by the screen are recovered, counted and examined (Urquhart et al.,1987).

3.1.3.4 Questionnaire survey

The questionnaire survey was carried out in Awash, a semi arid district in Afar Region. Six villages were randomly selected for this purpose, namely Wassero, Daho, Alibete, Dudub, Kukura and Degadege. These areas are situated on the north east of Awash National Park.
The questonnaire was divided into two parts. The first part contains general information comprising of farm structure, social factors, herd composition and animal housing. The second part dwelt on gastrointestinal helminthoses and other diseases that are rampart in those selected areas. 300 households were randomly selected and the heads of the households were interviewed. Out of 300 respondents, 264 were male and 36 were females.

3.2 Statistical analysis

Th univariate analysis of variance (ANOVA) for the epg, worm burden and prevalence was used to detect significant differences between and within sheep and goats in the dry and wet seasons. Chi-square test was used for the overall prevalence of GI helminths in these two host species also for the dry and wet seasons. The Spearman rank correlation coefficient test was used to determine the relationship between the faecal egg output and the intensity of infection (worm burden).

4.0 RESULTS

4.1 Prevalence of gastrointestinal helminths

Of the 250 sheep and goats examined during the study period (January to August, 1999), the presence of the following species of gastrointestinal helminths was revealed with prevalence: 98.8% *Haemonchus contortus*, 53.2% *Trichostrongylus axei*, 42.4% *Bunostomum phlebotomum*, 88.4% *Trichostrongylus colubriformis*, 21.2% *Moniezia expansa*, 25.2% *Avitellina centripunctata*, 92% *Oesophagostomum columbianum*, 67.6% *Trichris ovis*, 31.2% *Skrjabinema ovis*, 44% *Strongyloides papilosus*, 0.4% *Schistosoma spp* and 50% of the examined animals developed Nodular oesophagostomosis. In addition *Stilesia hepatica*(7%), and *Fasciola gigantica* (0.58%) were found in the livers of examined animals. *Cysticercus tenuicollis* occurred in 40% of them and the cysticerci were found attached to the omentum, intestinal mesentery and serosal surface of the liver.

Table 2. Prevalence of gastrointestinal helminths in both sheep and goats

Helminth species	Number of animals examined	Positives	Prevalence (%)	Lower Limit (%)	Upper Limit (%)
Moniezia expansa	250	53	21.2	16.3	26.79
Avitellina centripunctata	250	63	25.2	19.94	31.06
Stilesia hepatica	170	12	7.1	3.7	12
Cysticercus tenuicollis	250	100	40	33.88	46.36
Fasciola gigantica	170	1	0.59	0.0	3.23
Schistosoma spp	250	1	0.4	0.0	2.2
Strongyloides papilosus	250	110	44	37.75	50.39
Trichuris ovis	250	169	67.6	61.42	73.36
Haemonchus contortus	250	247	98.8	96.24	99.68

Trichostrongylus axei	250	124	49.6	-43.25	55.96
Trichostrongylus colubriformis	250	221	88.4	83.77	92.09
Bunostomum phlebotomum	250	106	42.4	36.2	48.79
Oesophagostomum columbianum.	250	230	92	87.92	95.05
Oesophagostomum larvae (nodules)	250	125	50	43.63	56.37
Skrjabinema ovis	250	78	31.2	25.51	37.34

From Table 2 it is seen that 7 different genera of nematodes were identified from gastrointestinal tract of 250 sheep and goats. The overall prevalence of nematodes is 64.75%. For the cestodes, 4 different genera were identified with an overall prevalence rate of 23.4%. Other gastrointestinal parasites identified and reported for the first time in the semi arid regions of Ethiopia are *Fasciola gigantica* and *Schistosoma spp*. They were found only in sheep.

The overall prevalence of GI helminths in sheep in the dry and wet seasons was 41.7% and 40.6% respectively. There was no significant difference in the prevalence in relation to seasons (Chi- square = 0.65, P- value = 0.419). A similar situation was observed in goats where the the overall prevalence in the dry and wet seasons was 54.9% and 51.3% respectively (Chi- square = 2.54, P- value = 0.111). But there was a significant difference between sheep and goats in the dry and wet seasons (dry season: Chi- square = 37.74, P- value = 0.0000; wet season: Chi- square = 18.95, P- value = 0.0000).

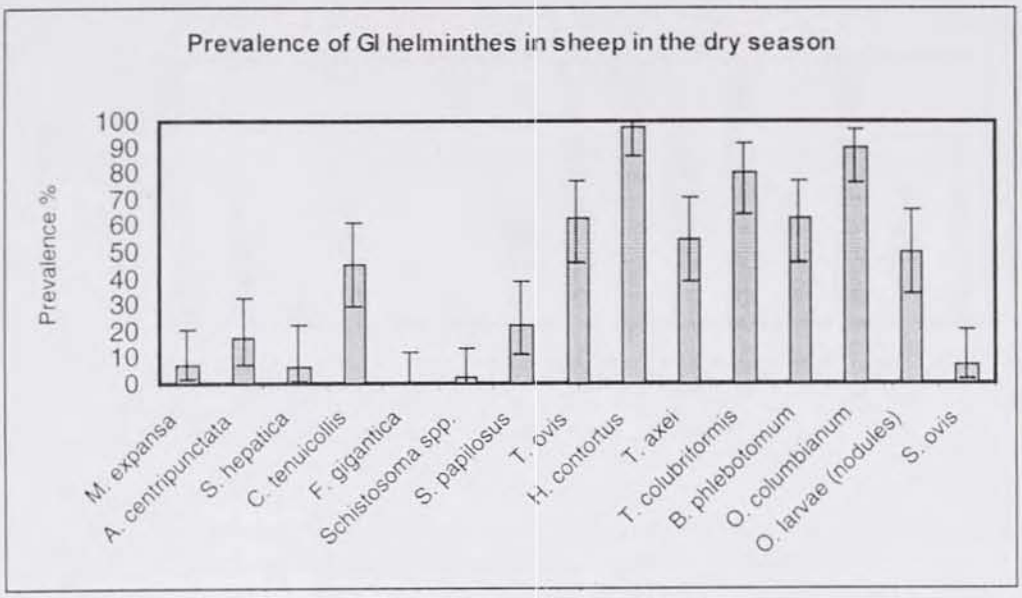

Fig. 1a Prevalence of GI helminths in sheep in the dry season

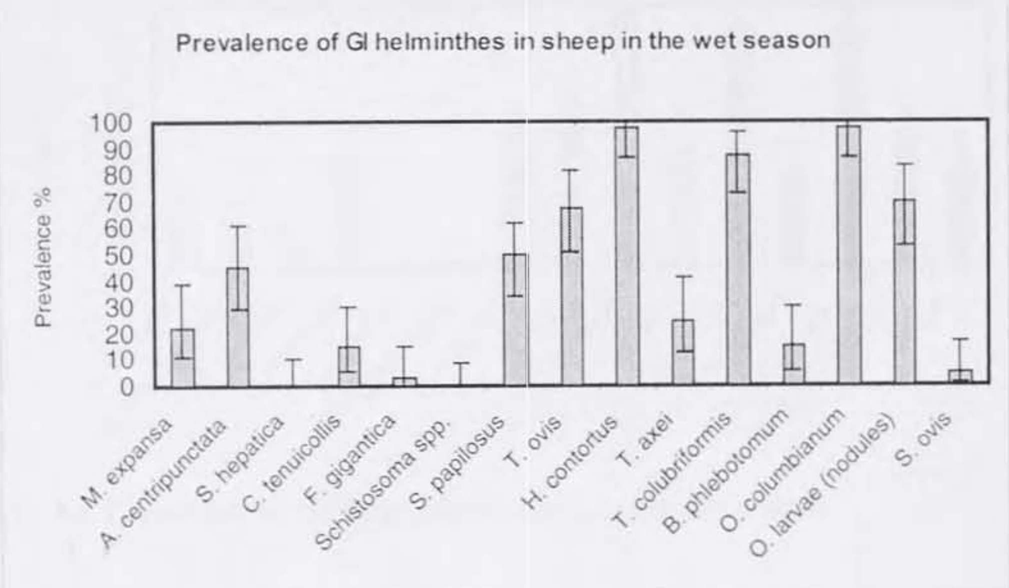

Fig. 1b. Prevalence of helminths in sheep in the wet season

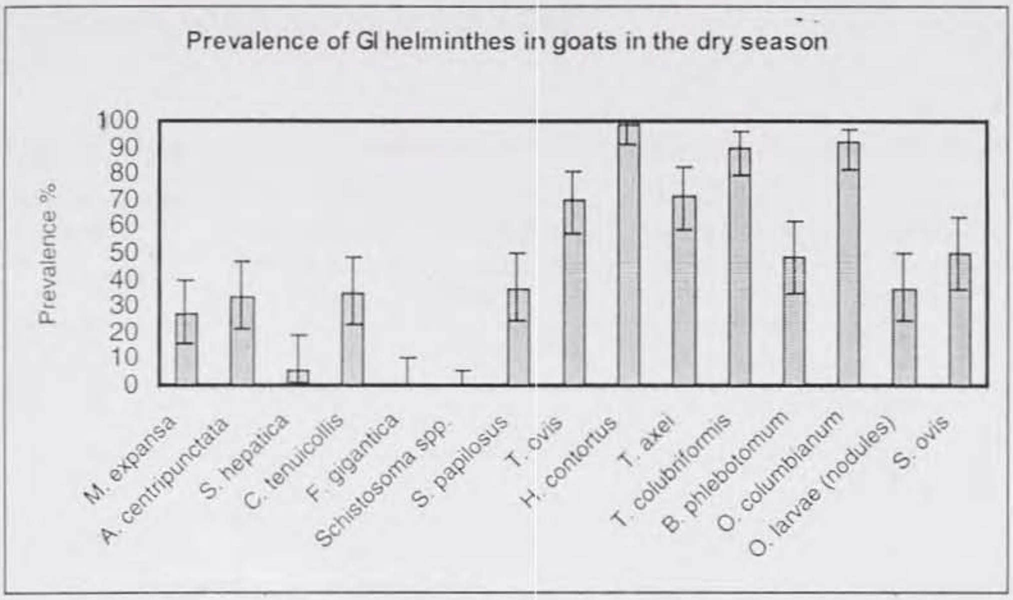

Fig. 2a. Prevalence of GI helminths in goats in the dry season.

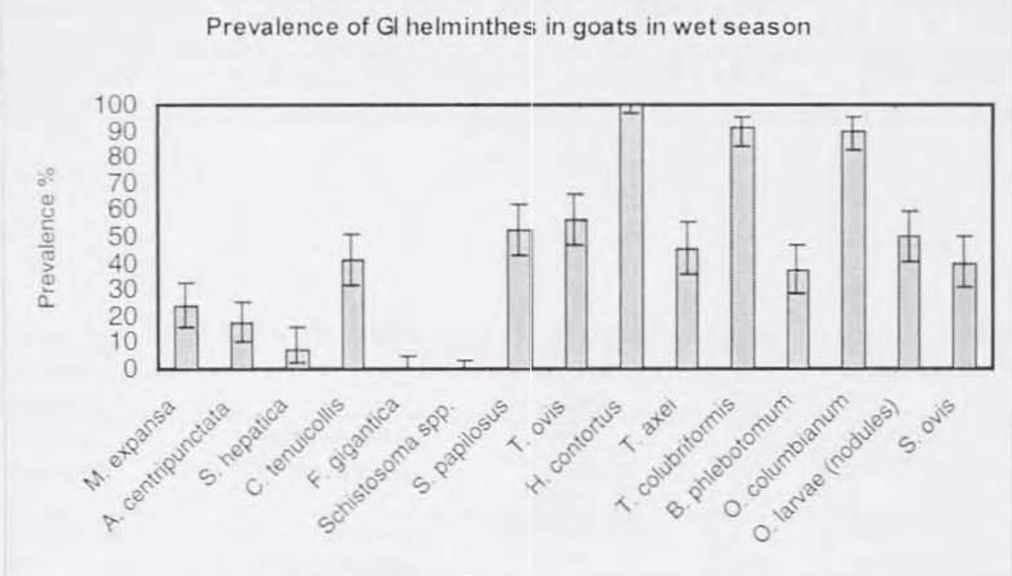

Fig. 2b. Prevalence of GI helminths in goats in the wet season.

But by performing an analysis of variance to the species level of GI helminths combining seasons and the species of animals involved, it was found that 6 GI helminth species showed a significant difference. These were *Bunostomum phlebotomum* (P-value=0.000), *Trichostrongylus axei* (P-value = 0.000), *Skrjabinema ovis* (P-value = 0.000), *Avitellina* centripunctata (P-value = 0.001), *Cysticercus tenuicollis* (P-value = 0.016) and Strongyloides papilosus (P-value = 0.005). Apart from these Oesophagostomum larvae (nodules) had a significant difference (P-value = 0.013).

4.2 Intensity of infection (worm burden)

Table 3. Mean intensity of infection (worm burden) and the standard errors

Helminth species identified	Mean and standard error in dry season in sheep	Mean and standard error in wet season in sheep	Mean and standard error in dry season in goats	Mean and standard error in wet season in goats
Fasciola gigantica	0	0.08 ± 0.08	0	0
Schistosoma spp	0.03 ± 0.03	0	0	0
Trichuris ovis	4.3 ± 1.4	5.8 ± 0.9	3.6 ± 0.06	6.4 ± 0.65
Haemonchus contortus	162.1 ± 24.4	166 ± 18.6	130.6 ± 10.1	135.3 ± 9.7
Trichostrongylus axei	17.9 ± 3.5	10.5 ± 3.9	25.8 ± 6.2	32.5 ± 7.9
Trichostrongylus colubriformis	61.5 ± 19	263.6 ± 64.9	103.4 ± 20.5	698 ± 83.3
Bunostomum phlebotomum	13.7 ± 5.9	7.9 ± 4.3	12.8 ± 2.8	10.2 ± 2.5
Oesophagostomum columbianum.	35.5 ± 8.27	31.3 ± 4.6	25.3 ± 3.9	39.9 ± 4.25
Skrjabinema ovis	4.7 ± 3	1.5 ± 1.2	20.5 ± 4.4	45.4 ± 11.5

Table 4. ANOVA for the worm burden in sheep and goats in the dry and wet seasons

Helminth species identified		Sum of squares	df	Mean square	F	P- value
Fasciola gigantica	Between groups Within groups total	0.189 8.775 8.964	3 246 249	6.300E-02 3.567E-02	1.766	0.154
Schistosoma spp.	Between groups Within groups total	2.100E-02 0.975 0.996	3 246 249	7.000E-03 3.963E-03	1.766	0.154
Trichuris ovis	Between groups Within groups Total	354.167 11053.497 11407.664	3 246 249	118.056 44.933	2.627	0.051
Haemonchus contortus	Between groups Within groups Total	51419.638 2969710,77 3021130,40	3 246 249	17139.879 12071.995	1.420	0.238
Trichostrongylus axei	Between groups Within groups Total	16619.094 929002.650 945621.744	3 246 249	5539.698 3776.434	1.467	0.224
Trichostrongylus colubriformis	Between groups Within groups Total	20351825,1 91886864,3 112238689	3 246 249	6783941,71 373523.839	18.162	**0.000**
Bunostomum phlebotomum	Between groups Within groups Total	950.257 184494.739 185444.996	3 246 249	316.752 749.979	0.422	0.737
Oesophagostomum	Between groups	8777.788	3	2925.929	1.741	0.154

columbianum.	Within groups Total	413359.108 422136.896	246 249	1680.322		
Skrjabinema ovis	Between groups Within groups Total	85400.474 1662199.22 1747599.70	3 246 249	28466.825 6756.907	4.213	**0.006**

An analysis of variance (ANOVA) was used to test whether there is a significant difference between sheep and goats and also within these two animal species during the dry and wet seasons in relation to intensity of infection (worm burden). Two gastrointestinal helminth species were showing significant difference and these were *Trichostrongylus colubriformis* (P-value = 0.000) and *Skrjabinema ovis (P-value = 0.006)*. The worm burden was higher in goats than sheep. The worm burden of the above mentioned helminths species was higher in the wet than in the dry season.

Throughout the study period from January to August, 1999, there was no animal without being infected with a gastrointestinal helminth. A minimum of two and a maximum of 10 different gastrointestinal helminth species were identified from a single animal. Figure 3 depict monthly the number of animals and the number of different helminth species each animal was habouring.

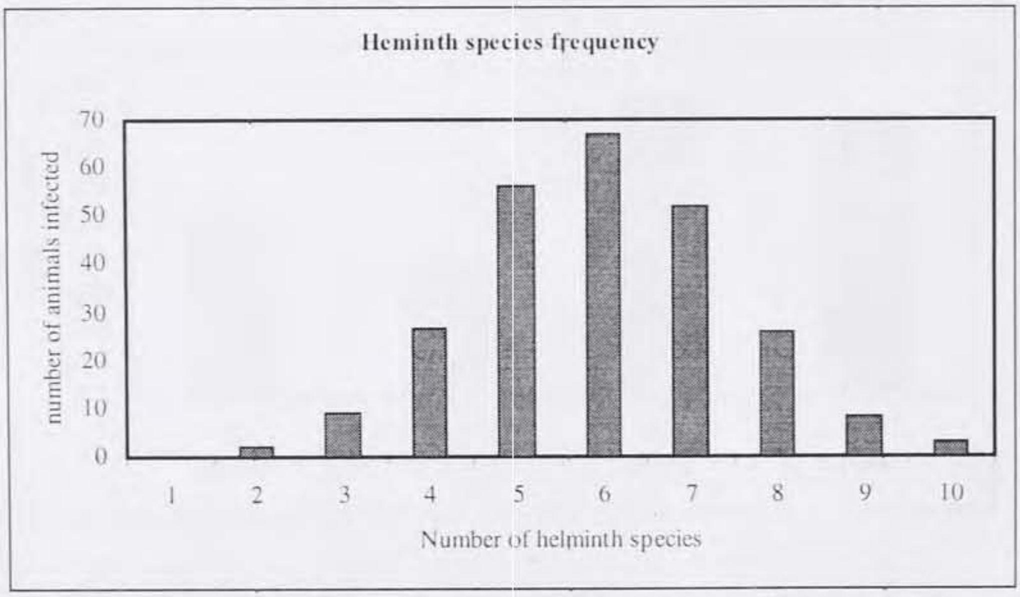

Fig. 3 Frequency of GI helminth species infecting both sheep and goats

4.3 Coproscopic results

Using the McMaster method for egg counting, the mean log epg results of quantitative examination of faecal samples for sheep and goats in the dry and wet seasons are presented in table 5.

Table 5. Mean log epg for sheep and goats in the dry and wet seasons

Animal species	Season	Number of animals	Mean log epg	Standard deviation	Standard Error
goats	Dry	60	3.5270	0.3808	0.0063
	Wet	110	3.4903	0.5696	0.0051
	Total	170	3.5032	0.5101	0.0030
sheep	Dry	40	3.3647	0.7990	0.0199
	Wet	40	3.2907	0.5850	0.0146
	Total	80	3.3277	0.6968	0.0087
Total	Dry	100	3.4621	0.5868	0.0058
	Wet	150	3.4370	0.5786	0.0038
	Total	250	3.4471	0.5808	0.0023

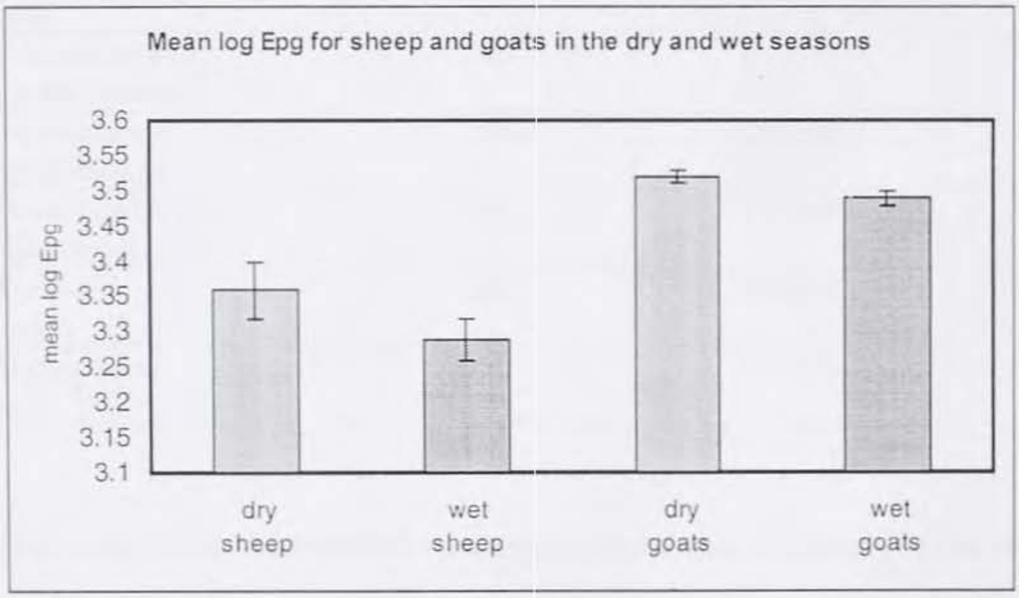

Fig. 4 Mean log epg for sheep and goats in the dry and wet season

Between sheep and goats: $F = 5.172$, $P =$ **0.024**

Seasonality: $F = 0.485$, $P = 0.487$

Animal species and season: F = 0.055, P = 0.815

A univariate analysis of variance was used to establish whether there is a significant difference or not between sheep and goats in the dry and wet seasons in relation to epg. It was found that there was a significant difference between these two host species (F = 5.172, P-value = 0.024) but there there was no significant difference in seasonality between and within them (F = 0.485, P- value = 0.487; F = 0.055, P-value = 0.815).

4.4 The relationship between the faecal egg output and worm burden (intensity of infection)

Table 6 The relationship between the epg and the worm burden (intensity of infection)

Nematodes species	Number of observations	Spearman's rho (r)	Test of Ho: epg and nematode species independent at 95% CI
Haemonchus contortus	250	0.4314	0.000
Trichostrongylus axei	250	0.2953	0.000
Trichostrongylus colubriformis	250	0.3004	0.000
Bunostomum phlebotomum	250	0.1098	0.0832
Oesophagostomum columbianum	250	0.4710	0.000
Trichuris ovis	250	-0.0629	0.3217
Skrjabinema ovis	250	-0.0206	0.7462

From table 9 it is observed that *Haemonchus contortus*, *Trichostrongylus axei*, *Trichostrongylus colubriformis*, *Bunostomum phlebotomum* and *Oesophagostomum columbianum* have a positive while *Trichuris ovis* and *Skrjabinema ovis* have a negative Spearman rank correlation. coefficients. The probability of whether epg and the worm burden are independent or dependent of each other for a given nematodes species, it was found that epg and *H. contortus*, *T. axei*, *T.*

colubriformis and *O. columbianum* are dependent ($P < 0.05$) while *B. phlebotomum*, *T. ovis* and *S. ovis* are independent of epg ($P > 0.05$).

4.5 Questionnaire survey results

4.4.1 Farm structure

All the people in these areas are nomadic pastorists. They do not grow any crop and every pastorist owns both sheep and goats. These animals were inherited from parents. The grazing land and watering points are communal and therefore animals from one herd do mix with others when grazing and drinking water. No supplementary feed is given to these animals. 62.8% and 37.2% of the households interviewed, the animals are herded by children and men respectively.

4.4.2 Social factors

None of the people interviewed has attended formal education. They acquired knowledge of keeping animals from parents and all of them keep animals to generate income and for food. They do not have any other job apart from rearing animals except for one respondent who is employed as a guard at a nearby state farm.

4.4.3 Herd composition

More goats than sheep are reared in these semi arid areas. On average each respondent has 29 goats and 18 sheep, i.e. 62% and 38% respectively. Most of the animals are between 1 and 3 years and very few are over 4 years of age. All the people interviewed are keeping other livestock species such as camels, cattle and donkeys.

4.4.4 Animal housing

Animal houses are thorny enclosures without roof structures. Enclosures built on a high ground have a better drainage than those on a low ground. 9.7% of the respondents enclosures are built on a high ground and therefore water and mud do not accumulate after rains while the rest 90.3% are on low ground. Water and mud accumulate after rains. General hygiene is also very poor to all the households interviewed.

4.4.5 Gastrointestinal helminthoses

All the respondents have encountered gastrointestinal helminthoses in their farms. About 72.6% of the respondents take measures such as medically treating the sick animals and the rest do not take any measure. 67.7% of them use herbs and the remaining 32.3% use drugs such as Tetramizole, and Albendazole bought at markets at nearby trading centres. They claim that the used drugs and herbs are effective. 51.7% of the respondents say that the young is the age group which suffer most, followed by both the young and the adults (38.6%) and lastly 9.7% say it is the adults.

About seasonality of gastrointestinal helminthoses, 80.6% of the respondents say that they occur during the rainy season , 19.4% - both during the dry and rainy season and 1.7% - during the dry season.

Concerning who advises them on the use of drugs or any herd health management, 86.7% are advised by fellow farmers and 13.3% by paravets. Other diseases mentioned as rampart in these areas are pneumonia, mange, Pasteurellosis, footrot and lameness. Summary of questionnaire survey results are found in the annexes (annex 2a and 2b).

4.6 Identification of risk factors associated with the marketing system and helminth profile of the slaughtered animals from the semi arid zones to the abattoir.

Debre Zeit Export Abattoir has its own transporting trucks of small ruminants from the semi arid regions. Sheep and goats are bought from animal markets and it takes one or two days for them to reach the abattoir depending on the distance between the markets and the abattoir. The abattoir has also its own quarantine for animals at Wonji in East Shewa Region. It is about 50 Km east of Debre Zeit. Animals transported from very far distant areas spend one or two days before being transported to the abattoir. This means that within two or three days they reach the abattoir. From the described situation, there is no risk of being infected on the way. Considering the prepatent period of GI helminths which is on average around 21 days, there is no chance of the animals getting sick or contaminating the environment.

5.0 DISCUSSION

Gastrointestinal helminthoses are major constraints in sheep and goats from the semi arid regions of Ethiopia. The present study confirms their continued present in these regions.

The results on the prevalence agrees with most of the work previously done in Ethiopia on gastrointestinal helminths: 21.2% *Moniezia expansa*, 25.2% *Avitellina centripunctata*, 7% *Stilesia hepatica*, 40% *Cysticercus tenuicollis*, 0.59% *Fasciola hepatica*, 0.4% *Schistosoma* spp, 44% *Strongyloides papilosus*, 67.6% *Trichuris ovis*, 98.8% *Haemonchus contortus*, 49.6% *Trichostrongylus axei*, 88.4% *Trichostrongylus colubriformis*, 42.4% *Bunostomum phlebotomum*, 92% *Oesophagostomum columbianum*, 31.2% *Skrjabinema ovis*, and 50% of the small ruminants examined developed nodular oesophagostomosis (Brook, 1983; Solomon, 1987; Tesfalem, 1989; Melkamu, 1991; Derege, 1992; Yosef, 1993; Genene, 1994; Achenef,1997; Alyousif,1997; Berrage and Cabaret,1998).

In relation to seasonality and animal species, the overall prevalence of GI helminths in sheep and goats was 41.7% and 40.6% respectively. There was no significant difference in the prevalence in relation to seasons ($X^2 = 0.65$, $P= 0.419$). A similar situation was observed in goats where the prevalence in the dry and wet seasons was 54.9 and 51.3 respectively ($X^2 = 2.54$, $P = 0.111$). But there was a significant difference between sheep and goats in the dry and wet seasons (dry season: $X^2 = 37.74$, $P = 0.0000$; wet season: $X^2 = 18.95$, $P = 0.0000$).

But by performing an analysis of variance to the species level combining seasons and the host species of animals involved, it was found that 6 GI helminth species identified had a significant difference. These were *Bunostomum phlebotomum* (P= 0.000), *Trichostrongylus axei* (P=0.000), *Skrjabinema ovis* (P=0.000), *Avitellina* centripunctata (P=0.001), *Cysticercus tenuicollis* (P=0.016) and Strongyloides papilosus (P=0.005). Apart from these Oesophagostomum larvae (nodules) were also showing a significant difference (P-value = 0.013).

The results on the intensity of infection (worm burden) in relation to seasonality and animal host species involved, sheep and goats, revealed 2 gastrointestinal helminth species were showing significant difference and these were *Trichostrongylus colubriformis* and *Skrjabinema ovis*. The worm burden was higher in goats than sheep. The worm burden of the above mentioned GI helminths was higher in the wet than in the dry season. These results agree with a similar study which was conducted to evaluate the importance of seasonality and intensity of infection in sheep and goats in West Java (Beriajaya et al., 1997). They concluded that intensity of exposure of both sheep and goats was similar throughout the year.

Throughout the study period from January to August, 1999, there was no animal without being infected with a gastrointestinal helminth. A minimum of two and a maximum of 10 different gastrointestinal helminth species were identified from a single animal. Figure 3 depicts monthly the number of animals and the number of different GI helminth species each animal is habouring.

A univariate analysis of variance was used to establish whether there is a significant difference or not between sheep and goats in the dry and wet seasons in relation to epg. It was found that there was a significant difference between these two host species ($F = 5.172$, P- value = 0.024) but there there was no significant difference in seasonality between and within them ($F = 0.485$, $P= 0.487$; $F = 0.055$, $P= 0.815$). This means that throughout the year the pastures are contaminated by eggs and infective larvae.

The Spearman rank correlation coefficient test has revealed that there is a weak correlation between epg and the worm burden. The weak correlation reflects the true relationship which exists between them because there are a number of factors which have an influence on the number of parasite eggs in faeces and these are: the number of adult parasites established in the GIT, level of immunity, age of the host, species of parasite, stage of infection and parturition (Hansen and Perry, 1994).

The results on the questionnaire revealed that on farm structure all the respondents in these areas are nomadic pastorists. They do not grow any crop and every pastorist owns both sheep and goats. These animals were inherited from parents. The grazing land and watering points are communal and therefore animals from one herd do mix with others when grazing and drinking water. No supplementary feed is given to these animals. 62.8% and 37.2% of the households interviewed, the animals are herded by children and men respectively.

The most important observation is that the grazing land and watering points are communal and no supplementary feed is given to the animals. This is very important in the epidemiology of gastrointestinal helminths. Communal grazing land and watering points are the major sources of infection and they are contaminated throughout the year. The findings of Aumont et al. (1996) revealed that the risk of parasite infestation include factors such as season, irrigation harbaceous biomass and pasture management. Nutritional supplementation (Knox and Steel, 1996; Coop et al., 1995) and improved grazing management (Barger, 1993) has repeatedly been shown to increase resistance to nematode infection.

On social factors it was found that none of the people interviewed has attended formal education. They acquired knowledge of keeping animals from parents and all of them keep animals to generate income and for food. They do not have any other job apart from rearing animals except for one respondent who is employed as a guard at a nearby state farm.

On herd composition it was found that more goats than sheep are reared in these semi arid areas. On average each respondent has 29 goats and 18 sheep, i.e. 62% and 38% respectively. Most of the animals are between 1 and 3 years and very few are over 4 years of age. All the people interviewed are keeping other livestock species such as camels, cattle and donkeys.

Animal houses are thorny enclosures without roof structures. Enclosures built on a high ground have a better drainage than those on a low ground. 9.7% of the respondents enclosures are built on a high ground and therefore water and mud do not accumulate after rains while the rest 90.3% are on low ground. Water and mud accumulate after rains. General hygiene is also very poor to all the households interviewed. This poses a threat to the spread of many diseases including zoonotic.

All the respondents have encountered gastrointestinal helminthoses in their farms. About 72.6% of the respondents take measures such as medically treating the sick animals and the rest do not take any measure. 67.7% of them use herbs and the remaining 32.3% use drugs such as Tetramizole, and Albendazole bought at markets at nearby trading centres. They claime that the used drugs and herbs are effective.

51.7% of the respondents say that the young is the age group which suffer most, followed by both the young and the adults (38.6%) and lastly 9.7% say it is the adults. About seasonality of gastrointestinal helminthoses, 80.6% of the respondents say that they occur during the rainy season , 19.4% - both during the dry and rainy season and 1.7% - during the dry season.

Concerning who advises them on the use of drugs or any-herd health management, 86.7% are advised by fellow farmers and 13.3% by paravets. Other diseases mentioned as rampart in these areas are pneumonia, mange, Pasteurellosis, footrot and lameness.

To comment on social factors, animal housing and gastrointestinal helminthoses it was found that the nomadic pastorists had no formal education and about 87.7% of the respondents are advised by fellow farmers in terms of herd health and management. This means that veterinary extension services are very limited. Tetramosole and Albendazole are bought are markets and they treat their animals without veterinary advice. This means there is a possibility of under- or overdosing of the anthelmintics and animals are treated only when they are sick. There are no control measures in place. The most effective control strategies for helminths, using anthelmintics, are usually those based on the epidemiology of the parasites, with the treatments being designed to reduce both pasture contamination and host infection (Brunsdon, 1980). Improper timing of treatments and incorrect selection of anthelmintics are not less effective in controlling the parasites, but also costly and potentially harmful by selecting for anthelmintic resistance (Michel et al., 1983; Waller, 1993).

There are no risk factors identified which are associated with the marketing system and helminth profile of the slaughtered animals from the semi arid zones to the abattoir. The reason is that it takes 2 to 3 days for the sheep and goats to reach the abattoir from the animal markets in the semi arid zones. Considering the prepatent period of GI helminths which is on average about 21 days, there is no chance of the animals getting sick or being a source of infection.

6.0 CONCLUSION AND RECOMMENDATIONS

This study has shown that Gastrointestinal helminthoses are real threats to sheep and goat production in the semi arid regions of Ethiopia.

In the prevalence study 13 GI helminths species were identified and these were *Moniezia expanza, Avitellina centripunctata, Cysticercus tenuicollis, Fasciola gigantica, Strongyloides papilosus, Trichuris ovis, Haemonchus contortus, Trichostrongylus axei, Trichostrongylus colubriformis, Bunostomum phlebotomum, Oesophagostomum columbianum and Skrjabinema ovis.* Apart from these, *Schistosoma spp* were also found. There was no significant difference in the prevalence of GI helminths in sheep or goats in the dry and wet seasons but there was a significant difference between them in the dry and wet season.

The results on the intensity of infection (worm burden) in relation to seasonality and animal species involved revealed that out of the 9 GI helminth species, 2 were showing significant difference and these were *T. colubriformis and S. ovis.* The worm burden was higher in goats than sheep and was higher in the wet than dry season.

For epg, it was found that there was no significant difference between and within sheep and goats in the dry and wet seasons. In other words, seasonality had no effect on egg output. The Spearman´s correlation coefficient has revealed that there is a weak correlation between the egg output and the worm burden ($r < 0.05$).

The questionnaire survey results revealed that the grazing land and watering points are communal, no supplementary feed is given to the animals, the nomadic pastorists have no formal education, no veterinary services are available and poor hygiene in animal houses. Because of the above mentioned problems first and foremost the veterinary service should be improved. It should actively be involved in educating and advising the pastorists on herd health. Thereafter strategic control programmes based on the use of anthelmintics can provide effective control of GI helminths in sheep and goats. Treatments with Albendazole, which is available in these areas, once or twice during the dry season and with Albendazole and Closantel during the wet season can result in reduced number of infective larvae on pasture and lower levels of infection which results in higher weight gain. Ivermectin treatments can also be used for strategic control at the end of the dry season. This reduces pasture infectivity during the subsequent wet seasons and improve flock perfomance.

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8.0 ANNEXES

Annex 1

QUESTIONNAIRE: Epidemiology and seasonal dynamics of gastrointestinal helminthoses in small ruminants.

FARM LOCATION: GPS: Date:
Village:

I. GENERAL INFORMATION

Farm structure:

1. Farm owner: Sex: Age:

2. Occupation:

3. Farm address:

4. Type of small ruminants kept: a) goats
b) sheep
c) both

5. When did you start keeping small ruminants?

6. Who herds the animals? a) herd boy
b) children
c) man
d) other

7. Farm size:....................................ha.

8. Where do your animals graze?

grazing land	size	season
a) communal		
b) private		

9. Where do you water your animals? a) communal watering point
b) private watering point.
c)both

10. Do your animals mix with other herds when grazing or at watering points? Yes No

11. Do you give supplementary feed to your animals? Yes No
If yes, specify

12. Do animals graze the crop land after harvest? Yes No

If yes, specify the crop land: a) own land
b) other land

Social Factors

13. What was the last school you attended? a) elementary
b) junior high school
c) college or university
d) none

14. Professional qualification:

15. How did you acquire knowledge of keeping small ruminants?
a) agricultural training: level
b) from extension agents: Which ones
c) from parents
d) other

16. How did you start keeping small ruminants? a) inherited
b) bought the animals
c) other

17. Reasons for keeping small ruminants: a) to generate income
b) for food
c) as a hobby
d) other

18. Do you have any other jobs? Yes, specify
No

Herd Composition

19 Number of animals kept

Animal species	Age (years)	Number of Animals
Goats	≤ 1	
	> 1- ≤ 2	
	> 2- ≤ 4	
	> 4	
Sheep	≤ 1	
	> 1 ≤ 2	
	> 2 ≤ 4	
	> 4	
		Total

20. Breed of small ruminats kept: goats

sheep

21. Do you keep other species of livestock apart from small ruminants? Yes No
If yes, specify

Animal Housing

22. Type of housing: a) with roof
b) without roof
c) no housing provided

23. Is the roof structure rain proof? Yes No

24. Drainage system: a) excellent (water does not accumulate after rains)
b) good (a little dampness after rains)
c) poor (alot of water and mud accumulate after rains)

25. Ventilation system: a) excellent (more than two windows)
b) good (one window)
c) poor (no windows)

26. General hygiene: a) very clean
b) clean
c) very dirty

II HELMINTHOSES

27. Have you encountered gastrointestinal, or any worm burden in the farm last year?
Yes No

28. What measures do you take when you have such problems?
Measures:

29. What kind of drugs do you use to treat your animals?
Name of drugs and dosage:

30. Where do you get the drugs?

31. Which animals are dewormed? a) the young b) the adults

32. Are the drug treatments effective? Yes No

33. Who advises you on the use of drugs or any herd health management?
a) vet assistants or extension agents
b) fellow farmers
c) other

34. Which age group suffer the most? a) the young
b) the adults

35. When do you encounter such problems: a) during the rainy season
b) during the dry season

36. What other diseases do affect your flock?
Names of diseases:

Name of interviewer:

Annex 2a

Summary of questionnaire results on farm structure, social factors and herd composition at six selected villages in Awash 7- Kilo District in Afar Region.

Questions	Wassero N=60	Daho N=50	Alibete N=35	Dudub N=25	Kukura N=60	Degadege N=70
Sex of owner						
Male	57	47	27	21	60	52
Female	3	3	8	4	0	18
Average age (years)	44	50	40	43	44	40
Occupation : All are nomadic pastorists	60	50	35	25	60	70
Type of small ruminants kept: All keep Sheep and goats	60	50	35	25	60	70
When did you start keeping small ruminants? All since childhood	60	50	35	25	60	70
Who herds the animals?						
Children	39	32	20	14	38	45
Man	21	18	15	11	22	25
Where do graze your animals? All graze in a communal land	60	50	35	25	60	70
Where do you water your animals? All Use communal watering points.	60	50	35	25	60	70
Herds mixing when grazing or at watering points: All mix their herds	60	50	35	25	60	70
Do you give supplementary feed to your animals? All do not give	60	50	35	25	60	70
Do animals graze the crop land after harvest? All do not have crop land	60	50	35	25	60	70
What was the last school you attended? All have not attended formal education	60	50	35	25	60	70
Knowledge of keeping small ruminants: All acquired the knowledge from parents	60	50	35	25	60	70
How did you start keeping small ruminants? All inherted from parents	60	50	35	25	60	70
Reasons for keeping small ruminants						
To generate income	60	50	35	25	60	70
For food	60	50	35	25	60	70
As a hobby	0	0	0	0	0	0
Do you have any other jobs? All do not Have other jobs except for one	59	50	35	25	60	70
Number of small ruminants kept:						
Average number of goats	28	25	25	27	24	43
Average number of sheep	20	19	10	25	15	16
Breeds of sheep nd goats: All are keeping the Afar sheep and Afar goats	60	50	35	25	60	70
Do you keep other species of livestock? All are keeping other livestock	60	50	35	25	60	70

Annex 2b

Summary of questionnaire results on animal housing and GI helminthoses at six selected villages in Awash 7- Kilo District in Afar Region.

Questions	Wassero N=60	Daho N=50	Alibete N=35	Dudub N=25	Kukura N=60	Degadege N=70
Animal housing:						
with roof	0	0	0	0	0	0
without roof	60	50	35	25	60	70
no housing provided	0	0	0	0	0	0
Drainage system:						
Excellent	0	0	0	0	0	0
Good	10	7	7	2	1	2
Poor	50	43	28	23	59	68
General hygien:						
Very clean	0	0	0	0	0	0
Clean	0	0	0	0	0	0
Very dirty	60	50	35	25	60	70
Have you encountered GI worm burden?						
Yes	60	50	35	25	60	70
No	0	0	0	0	0	0
Measures taken when animals are having such problems:						
Yes	45	36	22	18	45	52
No	15	14	13	7	15	18
Drugs and herb used:						
Drugs: Albendazole and Tetramisole	38	21	0	8	13	17
Herbs	7	15	22	10	32	35
Where do you get the drugs? Those who use drugs get from the market.	38	21	0	8	13	17
Which animals are dewormed?						
Young	5	13	3	4	35	0
Adults	5	3	2	0	25	0
Both	50	34	15	15	0	52
Drug or herb effectiveness						
Yes	38	21	0	8	13	17
No	0	0	0	0	0	0
Who advises you on herd health management?						
Extension agents	12	22	0	6	0	0
Fellow farmers	48	28	35	19	60	70
Age group which suffer most:						
Young	5	32	35	17	40	26
Adults	5	4	0	0	20	0
Both	50	14	0	8	0	44
When do you encounter such problems?						
Rainy season	23	33	31	25	60	70
Dry season	5	0	0	0	0	0
Both	32	17	4	0	0	0
Other diseases affecting your flock						

Pneumonia	33	24	31	16	35	35
Mange	35	23	35	22	38	43
Pasteurellosis	2	30	0	0	0	1
Epilepsy	6	0	0	2	7	3
Footrot	0	0	0	5	8	13

Annex 3

SUMMARY OF THE WORK DONE PREVIOUSLY IN ETHIOPIA ON GIT HELMINTHS

REPORTED PREVALENCE IN %										
Year	Author	Area	*Haemonchus*	*Trichostrongylus*	*Ostertagia*	*Bunostomum*	*Oesophagostomum*	*Trichuris*	*Moniezia*	*Avitellina*
1973	Graber	Shewa	72.7	-	-	-	-	11.3	-	-
1975	Graber	Wollo	58.3	-	-	-	-	-	-	-
1982	Bekele	Addis Ababa	67	89	-	34	53	83	57	-
1983	Brook	Debre Zeit	-	-	-	-	22.9	-	-	-
1983	Brook	Debre Berhan	84.3	-	-	-	-	-	-	-
1983	Brook	Asella	32.8	-	7.8	-	-	49	-	-
1983	Brook	Awassa	-	1.4	-	-	82.1	-	-	-
1986	Gebreyesus	Gondar	36.36	6.81	1.8	34.09	77.27	54.55	27.7	6.81
1987	Solomon	Ogaden	93.61	3.3	-	32	52	92	-	-
1988	Ahmed	Wellega	88.23	29.4	-	-	-	76.47	58.82	-
1989	Tesfalem	Bale	59.4	38	-	55.2	76.32	61.84	26.32	7.8
1990	Gebrekiros	Awassa	75.7	18.4	-	-	31.1	9.7	-	-
1990	Njau	D. B. ILCA	2.9	19.4	1.5	-	-	25.4	-	-
1991	Melkamu	E. Shewa	65.4	39.29	-	44	72.62	60.71	29.76	9.52
19991	Bayou	Illubabor	58	20	-	-	86	24	18	10
1992	Derege	W. Sodo	80	10	-	50	90	50	30	20
1992	Etagegnahu	Wello	42.9	34	44	-	-	12	-	-
1993	Yosef	Asella	63	54.76	-	40.4	85.71	59.52	29.76	9.52
1994	Genene	Kombolcha	83.87	63.44	-	40.7	79.56	63.4	22.56	19.35
1997	Achenef	Debre Berhan	62.87	51.72	-	-	13.79	65.51	-	-

Annex 4a

GENERAL DESCRIPTION OF GASTROINTESTINAL HELMINTHS (cestodes)

Parasite	Host	Site	species	Identification	Life cycle	Pathogenesis	Clinical signs
Moniezia	ruminants	Small intestines	*M. expansa* *M. benedeni*	Long tape worms 2m or more, unarmed possessing only suckers, segments are broader than their length and contain two sets of genital organs and interproglotidal glands, eggs are triangular.	It is indirect, prepatent period is around six weeks.	Little pathogenic significance, in heavy infection unthriftness, diarrhoea and intestinal obstruction	Redused weight gains, intestinal obstruction.
Avitellina	Sheep, goats, dromedary and rarely cattle	Small intestines	*A. centripunctata*	Adults reach 1.5m long and about 0.5cm wide, segments are poorly marked, peruterine organs show an opaque line in the medial portion of the progrotids.	As above	As above	As above

Stilesia	Sheep, goats, dromedary, and rarely cattle	Small intestines	*S. globipunctata*	Adults are 45- 60 cm long and up to 2- 5 mm wide.	indierct	As above	As above
Cysticercus tenuicollis (larval stage of taenia hydatigena)	Sheep, goats, cattle, pigs and horses	Cysticerci are found attached to the omentum, intestinal mesentery and serosal surface of the liver.		Adults tapeworm is 75- 500 cm and have two rows of 26 and 46 rostellar hooks. The fully developed cyst is a large soft semitransparent bladder within which the head is clearly visible. The cyst has a thin long neck.	indierct	The migrating cysticercus causes traumatic and necrotic hepatitis. These two conditions cause hepatitis cystircercosa. Mature cysts usually cause no harm.	In heavy infection there is unthriftness due to liver damage.

Annex 4b

GENERAL DESCRIPTION OF GASTROINTESTINAL HELMINTHS (nematodes)

Parasite	Host	Site	Species	identiffication	Life cycle	Pathogenesis	Clinical Signs
Trichostrongylus (hair worm)	Ruminants, Horses, pigs Fowl, etc	Small intestine except T. axei and T. tenuis	*T. axei* *T. colubriformis* *T. vitrinus* *T. capricola* *T. tenuis, etc*	Adults are small and hair like, less than 7mm long, no obvious bucal Capsule. Excretory notch is in the oesophageal Region. In T. axei the spicules are unequal in length. No vulval flap	Direct, ppp is around 20-25 days.	Haemorrhages and oedema of intestinal mucosa, loss of plasma protein, reduced appetite, enteritis, dirrhoea, weight loss.	Reduced appetite, Weakness, weight loss, diarrhoea and constipation.
Bunostomum (small ruminant hook worm)	ruminants	Small intestine	*B. trigonocephalum* *B. phlebotomum*	1- 3 cm long, does not have dorsal teeth, bucal capsule bears a pair of cutting plates and a large dorsal cone. Characteristically hooked at the anterior end, spicules are slender.	Direct, Infection with L3 may be percutaneous or oral, ppp ranges between 1-2 months	Multiple haemorrhages may be found in lungs, due to its blood sucking habit it causes anaemia, hypoalbuminaemia, Loss of weight and dirrhoea	Anaemia, bottle jaw, Weight loss and foot stamping and sings of itching
Haemonchus (stomach worm)	Sheep, goats, cattle, dromedary	abomasum	*H. contortus* *H. placei* *H. longistipes*	15- 20 mm long , using male worms by measuring spicules one can identify *Haemonchus* to species level	Direct, prepatent period is around 25 days	As above	Hyperacute: death may occur within one week of heavy infection. Acute: severe anaemia accompanied by generalised oedema. Chronic: anaemia, progressive weight loss

Annex 4c

GENERAL DESCRIPTION OF GASTROINTESTINAL HELMINTHS (nematodes)

parasite	host	Site	Species	Identification	Life cycle	Pathogenesis	Clinical Signs
Oesophagostomum (Nodular worm)	Ruminants and pigs	Caecum and colon	*O. columbianum* *O. venulosum* *O. radiatum* *O. dentatum*	Stout white worm 1- 2 cm long, bucal capsule is small, it has an inflated cuticular cerphical papillae and leaf crown arrangement is used for species identification	Direct, ppp is about 45 days.	Extensive nodules formation in the intestines and this affects digestion, absorption and bowel movement.	Inappetence, loss of weight and emaciation.
Trichuris (whip worm)	Sheep, goats, cattle, dromedary, etc	caecum	*T. ovis* *T. globulosa* and others.	Adults are 4- 6 cm long, long slender anterior end and a much thicker posterior end, male tail is coiled and possesses a single spicule, female tail is merely curved, eggs are lemon shaped with a plug at both ends.	Direct, infection is acquired by ingestion of egg containing infective larvae, ppp is about 1-3 months.	Haemorrhages and irritation of the caecal mucosa, heavy infection causes thickening of caecal wall.	In heavy infection colitis and secondary infection.

Annex 4d

GENERAL DESCRIPTION OF GASTROINTESTINAL HELMINTHS (nematodes)

Parasite	Host	Site	Species	Identifcation	Life cycle	Pathogenesis	Clinical Signs
Strongyloides (Intestinal thread worm)	Sheep, goats, cattle and others	Small intestines, caecum in poultry	*S. papilosus* *S. westeri* *S. avium, etc*	Slender hairy worm less than 1 cm long, the long oesophagus may occupy up to a third of the body length, the uterus is interwined with the intestines, in herbivores the larvated eggs which come out, the tail has a blunt point.	Has both parasitic and free living reproductive cycles, only females are parasitic, infection is either by ingestion or skin penetration of L3, transmammary infection occurs. Ppp is 8- 14 days	Skin penetration causes erythematous reaction which allows the entry of bacteria, multiple haemorrhages on the lung surface, oedema and erosion of the intestinal epithelium.	Coughing, fever and pneumonia, digestive disturbances and intermittent diarrhoea.
Skrjabinema (Small ruminant pin worm)	Domestic and wild ruminants	caecum	*S. ovis* *S. caprae* *S. alata*	Small about 3- 8 mm Long and have 3 large lips and 3 small lips, the oesophagus terminates in a large spherical bulb, the male has a single spicule.	Direct, the eggs are embryonated when are deposited by the female in the perianal region.	Non pathogenic	unknown

Meteorological data for East Shewa, Afar, Harragie and Sidamo regions

Place (Region)	Parameters	Jan	Feb	March	April	May	June	July	August
Metahara (East Shewa)	Min. temp. °C	14.1	14.5	18.9	18.7	19.5	21.1	18.9	18.6
	Max. temp. °C	32	34.8	32.8	36.3	37.2	36.8	32.9	32
	Rainfall (mm)	0.0	0.0	2.4	0.2	0.5	0.6	4.4	4.9
	R. humidity %	45 %	38 %	57 %	47 %	46 %	43 %	62 %	62 %
	sunshine hours	6.9	7.5	8.5	9.9	9.4	9.5	7.0	7.3
Awash 7-Kilo (Afar)	Min. temp. °C	16.8	18.4	20.1	21.5	23.1	22.9	20.3	20.6
	Max. temp. °C	31.9	34.9	30.7	35.5	37.5	37.8	32.9	31.8
	Rainfall (mm)	0.0	0.0	2.5	0.1	0.3	1.2	4.5	4.2
Jijiga (Harragie)	Min. temp. °C	11	10.4	11.7	9.8	9.5	7.9	17.6	16.9
	Max. temp. °C	29	29.7	30.2	30.1	29.4	29.3	26.6	27.1
	Rainfall(mm)	3.8	0.0	0.59	1.2	2.8	1.3	0.56	0.95
Negele-Borena (Sidamo)	Min. temp. °C	16.0	16.8	13.5	12.5	13.6	No data	No data	No data
	Max. temp. °C	29.5	30.6	28.1	28.4	27.2			
	Rainfall (mm)	0.0	0.0	3.4	0.7	2.1			
	R. humidity	35 %	37 %	66 %	73 %	79 %			
	sunshine hours	10.7	10.5	5.7	7.7	6.6			

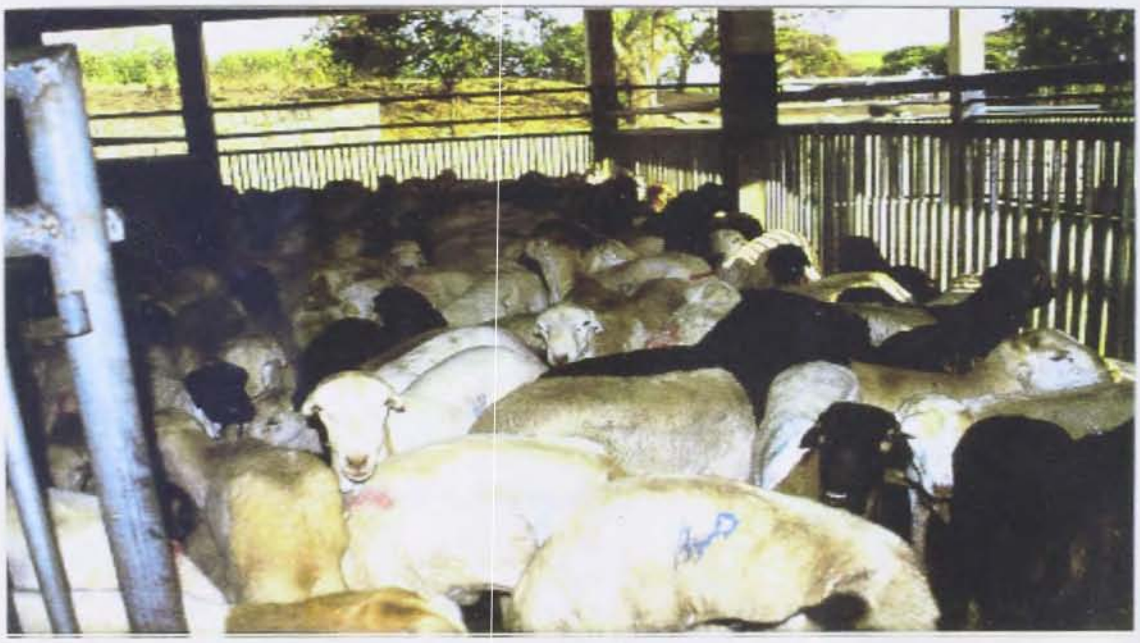
Source: National Meteorological Services Agency, Addis Ababa, Ethiopia).

Picture 1

Picture 2

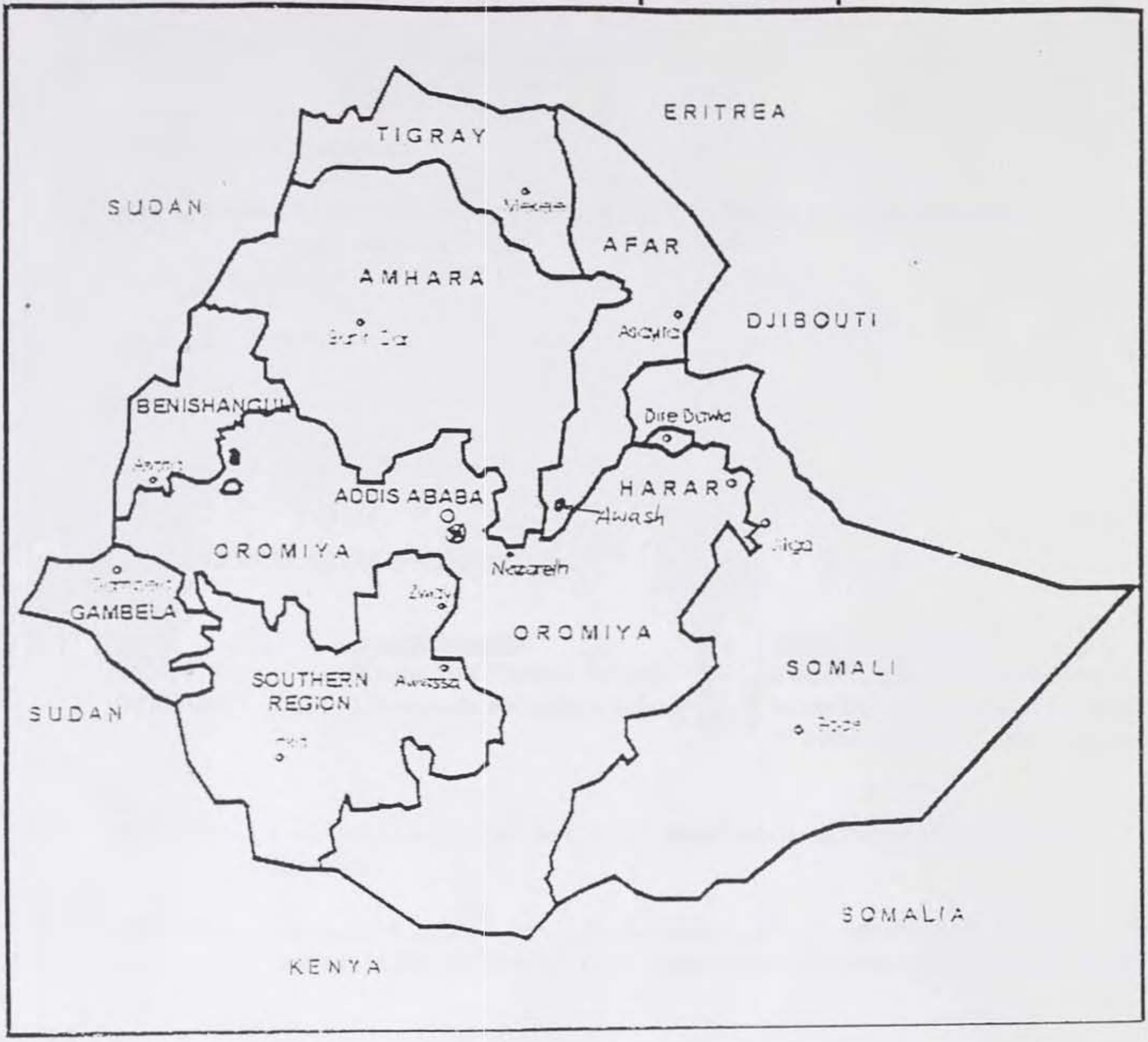
Pictures 1 and 2: Goats and sheep in Awash, Afar region, Ethiopia.

Picture 3: The blackhead Ogaden sheep at Debre Zeit Export Abattoir.



Picture 4: The fat-tailed Adal and the blackhead Ogaden sheep at Debre Zeit Export Abattoir.

Administrative Map of Ethiopia



⊗ Debre Zeit Export Abattoir

9.0 CURRICULUM VITAE

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Nationality: Malawian

Date of birth: 9th April, 1962

Place of birth: Karonga, Malawi

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Period	School attended	Certificate obtained
1969-1977	Bwiba Full Primary School	Primary School Leaving Certificat
1977- 1981	Chaminade secondary School	a) Junior Certificate of Education b) Malawi Certificate of Education

NB:

1981- 1982 I worked as a Coding Clerk with Lepra Evaluation Project at Chilumba in Karonga.

1983- 1984 I attended a preparatory course in Bulgarian Language, Physics, Chemistry and Biology at the Higher Chemical Technological Institute in Burgas in Bulgaria.

PROFESSIONAL QUALIFICATION

Period	University attended	Degree obtained
1984- 1991	Higher Institute of Zootechnics and Veterinary Medicine, Stara Zagora, Bulgaria.	Master of Science i Veterinary Medicin

Graduation thesis defended: Veterinary medical regulation of reproductive process in dairy co

WORK EXPERIENCE

Period	Place of work
June- December, 1991	Majerito Dairy Farm, Stara-Zagora, Burgaria
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10.0 Signed Declaration Sheet

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

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Signature: [signature]

Date of submission: 15th Nov, 1999.

This thesis has been submitted for the examination with our approval as university advisors.

Prof. Dr. R. Schuster [signature]

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C-1.

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Epidemiology And Seasonal Dynamics
of Gastrointestinal Helminthoses Of
The small Rominants In Eastern And
Southern Semi Arid Zones Of Ethiopia

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