

**PREVALENCE OF GASTROINTESTINAL HELMINTHOSIS IN SMALL
RUMINANTS KEPT UNDER TRADITIONAL MANAGEMENT SYSTEM IN
MERU DISTRICT, TANZANIA**

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**A RESEARCH PAPER SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTERS IN PREVENTIVE
VETERINARY MEDICINE OF SOKOINE UNIVERSITY OF AGRICULTURE.
MOROGORO, TANZANIA.**

DECLARATION

I, VICTOR VITA HAULE do hereby declare to the Senate of the Sokoine University of Agriculture that, this paper is my own original work and has not been submitted for a degree award in any other University.

Name and Signature of Candidate
(MPVM Candidate)

Date

The above declaration is confirmed by

SUPERVISOR

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Date

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DEDICATION

This paper is DEDICATED to, my late father **AMITWISE HAULI** and to my lovely mother **DOROTHY HAULI** for their moral concern in my future carrier.

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MERU DISTRICT, TANZANIA**

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Formatted as per Tanzania Veterinary Journal

SUMMARY

A cross-sectional observational study was conducted in sheep and goats kept under traditional management system in Meru district, Tanzania in September 2014, with the objective of determining the prevalence of gastrointestinal helminthosis in small ruminants, identification of the most prevalent helminths, determination of helminth infection intensity in traditional management system and assessment of farmers awareness on small ruminants helminth control practice. In this study a total of 380 fecal samples were collected from 215 goats and 165 sheep and examined using standard parasitological procedures. The fecal samples examined revealed an overall prevalence of helminthosis of 225 (59.2%) in the small ruminants. The prevalence of helminthosis per animal species was 125 (58.1%) in goats and 100 (60.6%) in sheep. Strongyle eggs were more prevalent 188 (49.5%) followed by trematode eggs 25 (6.6%) and cestode eggs 12 (3.1%).

Faecal culture was conducted on samples positive for strongyle type of eggs and larvae stage three (L₃) of *Haemonchus* sp (43.5%), *Trichostrongylus* sp (29.4%), *Oesophagostomum* sp (16.7%), *Cooperia* (6.4%), *Strongyloides* sp (2.7%) and *Bunostomum* sp (1.2%) were obtained. The study revealed higher prevalence of helminthes in sheep than in goats, in adult animals than in young and in female than in male animals, but the differences were not statistically significant ($p > 0.05$). Agroecological zone was found to be associated with prevalence and species of parasite found even though there was no significant difference.

Questionnaire survey regarding farmers awareness on the helminth control practice revealed that 98.1% of farmers were using anthelmintic to control worm infections, 72.2% knew how to treat their animals, 46.3% dewormed their animals after every six month,

40.7% deworm their animals after every three month and 88.9% of farmers got information from livestock field officers. This study showed that, although farmers were aware on the use of anthelmintics to control worms in their animals, the prevalence of helminthosis was still high. Thus a sustainable integrated helminth control strategy and more farmer education is needed in order to increase small ruminant productivity and hence improving farmers livelihood.

Key words: Prevalence, helminthes, sheep, goats, Meru district

Introduction

Background information

Currently Tanzania has 13.1million goats and 3.6 million sheep (MLDF, 2010). These livestock are almost entirely managed by resource poor, small-holder farmers and pastoralists. However they make a critical contribution to food self-sufficiency for livestock keepers by providing meat, milk, skin, manure as well as generating income. In addition livestock are a source of risk mitigation against crop failure.

Gastrointestinal parasitism is one of the most important disease complexes of sheep and goats impacting on the resource-poor livestock farmers (Vata and Lindeberg, 2006). In Tanzania parasitic diseases contribute about 53.1% of diseases in small ruminants (Mboera and Kitalyi, 1992). Gastrointestinal parasite infection causes considerable economic losses through lowered fertility, involuntary culling, lower weight gains, lower milk production, treatment cost and mortality in heavily parasitized animals (Regassa *et al.*, 2006). In addition, losses occur due to condemnation of carcasses or certain organs during meat inspection (Kusiluka *et al.*, 1995).

Gastrointestinal parasites infection is caused by several species of worms which are divided into the classes; eucestoda (tapeworm), nematoda (round worms) and trematoda (Soulsby, 1982). Many studies in developing countries have shown that gastrointestinal nematode infection are of great importance since they impede the survival and productivity of sheep and goats (Kassuku and Ngomuo, 1997). There is greater variation in the prevalence and the geographical distribution of helminth infection in small ruminants in sub-Saharan Africa. Helminths generally spend part of their life cycle outside their definitive host (such as sheep and goats), either on the ground, on grass or within invertebrates such as snails, insects or earthworms. Temperature, rainfall and type

of soil determine the occurrence of a given species. However, helminth control strategies for one geo-climatic region and farming systems may not be necessarily appropriate for all farming systems and agroecological zones due to differences in climatic and management factors (Odoi *et al.* , 2007). Therefore, knowledge of their epidemiology in different ecological zones is essential for successful control strategies.

In Tanzania, studies to establish prevalence of helminthosis in small ruminants kept under traditional management system have been done in some parts of the country (Simbeye, 2013; Mhoma *et al.*, 2011). Other studies have been done based on abattoir data (Mellau *et al.*, 2010; Karimuribo, 2009). The information available indicates that parasites occur in all agroecological zones and production systems and economic losses may be high due to both clinical and sub-clinical infection. However in the current study area there was no recent report on prevalence of gastrointestinal helminth in small ruminants. Therefore the objective of the current study was to determine the prevalence of gastrointestinal helminth parasites and associated risk factors in order to develop integrated control strategies of gastrointestinal helminth in small ruminants in this area.

MATERIALS AND METHODS

Study area

The study was conducted in Meru district, which is one of the six districts in Arusha region northern Tanzania. The district is located between latitude 03° 00''S and longitude 36° 55'' E with an elevation of 1908 m above sea level. This area has bimodal type of rainfall short rains from November to December and long rains between March and June. Annual average rainfall ranges between 500 and 1200 mm and ambient temperature ranges between 22 and 25 ° C. Meru district is divided into three agro-ecological zones namely highland zone, middle zone and lower zone.

Study population

Study area of a large population of small ruminants which were kept under traditional extensive system a small population of small ruminants which are kept under zero grazing or tethered. In this study, 380 (215 goats and 165 sheep) were randomly selected for coprological examination. Sex, species of animals, age, and agroecological zone were recorded during sampling as important parameters for gastrointestinal helminthosis.

Sample size determination

Sample size (n) was calculated using the formula described by Thrusfield (2005), $n = Z^2 P(1-P)/d^2$ where n = required sample size, z = 1.96 (95% confidence level), d = precision level (5%). The expected prevalence (P) has been estimated at 45.3% according to Simbeye, (2013) in traditional small ruminants in Mtwara district, southern Tanzania.

Thus

$$n = \frac{(1.96)^2(0.453)(1-0.453)}{(0.05)^2} = 380$$

Therefore 380 animals were sampled.

Study design

A cross-sectional observational study design was conducted in nine villages which are Nambala, Ngesusojia, Malula, Ngongongare, Akheri, Nguruma, Nkoanekoli, Makiba and Lekitatu, selected randomly using the formula of probability proportional to size sampling technique (McGinn, 2004), based on their sheep and goat population as reported by district veterinary officer. Fifty four (54) questionnaires to assess farmers awareness on helminth control practice were administered through interview to consenting farmers on the study concurrently with the collection of fecal samples. Study animals were local breeds of small ruminants (managed under semi extensive and extensive husbandry system) found in three agro-ecological zones. From each agroecological zone three villages were selected, the villages that were sampled were Makiba, Nambala, Lekitatu (lower zone), Ngesusojia, Ngongongare, Malula (middle zone), Nkoanekoli, Akheri, Nguruma (highland zone). Animals up to 12 month were considered young and those greater than one year were considered adults according to the classification of age by Kumsa *et al.*, (2010). The sampling frame was household keeping goats and sheep and sampling was based on random sampling.

Sampling procedure and laboratory analysis

Fecal samples were collected per rectum using sterile examination gloves, labelled for identification of animals and farm later preserved in a cool box before being transferred to Tengeru Livestock Training Agency (LITA), Arusha for storage and laboratory analysis.

The collected fecal samples were processed and subjected to both qualitative and quantitative analyses. The McMaster counting techniques was used to determine the number of eggs per gram of faeces (e.p.g) for estimation of level of infection of with nematodes, cestodes and quantification of coccidia oocyst. Eggs per gram of faeces were

furthermore classified as light, moderate and massive infection for counts of 100 to 700, 800 to 1200 and over 1200, respectively. Sedimentation technique were used for recovery and identification of trematode eggs. Eggs were identified on the basis of their morphological features as described by Hansen and Perry (1994).

Fecal culture

Fecal sample which tested positive for strongyle type of eggs were preserved and kept under refrigeration thereafter transported to Sokoine University of Agriculture for culturing. The strongyle eggs of the common gastrointestinal nematodes differ so little from each other in appearance they could not be differentiated microscopically. Therefore fecal culture was used to identify helminth to genus level. Representative fecal samples were then pooled by location and animal species then cultured at room temperature for seven days to allow hatching of first stage larvae (L_1) and development to stage three (L_3). After seven days larvae stage three (L_3) were harvested using Baermann method then placed on microscope slide then immobilized and stained by lugos iodine then identified under microscope to genus level using identification keys adopted from Dikmans and Andrews (1933).

Statistical analysis

Data collected were entered and stored into Ms Excel and later exported to Epi info version 3.5.1 (CDC 2008) for analyses. Prevalence was calculated by dividing the number of animals harbouring a given parasite by the total number of animals examined for the parasite. Chi square test was used to compare proportions between prevalence and risk factors (species, age, sex and agro-ecology). In all analysis, confidence level was held at 95% and $P < 0.05$ was set for significance. SPSS version 16 (SPSS, Inc. III) was used for analyses of structured questionnaire

RESULTS

In this study, a total of 380 fecal samples from small ruminants (215 goats and 165 sheep) were examined for helminthosis and a species prevalence of 125 (58.1%) in goats and 100(60.6%) in sheep was obtained, with an overall prevalence of 59.2 %. Considering species, age, sex and agro ecology as a predisposing factor for helminthosis, it was observed that sheep had slightly high prevalence than goats, also adult animals were found to have higher prevalence than young animals and the prevalence was found to be higher in middle agro ecological zone than the others but in all predisposing factors there were no statistical significance ($p>0.05$) as it is shown in Table 1.

Table 1: Prevalence of gastrointestinal helminthes in the small ruminants by species, age sex and agro ecology

SPECIES	No. examined	Positive	prevalence%	χ^2	P value
Goat	215	125	58.1		
Sheep	165	100	60.6	0.23	0.6277
Total	380	225	59.2		
SEX					
Female	201	122	60.7		
Male	179	103	57.5	0.39	0.5322
Total	380	225	59.1		
AGE					
Adult	320	185	57.8		
Young	60	30	50.0	1.25	0.2625
Total	380	225	53.9		
Agro ecology					
Lower zone	119	65	54.6	2.75	
Middle zone	133	102	76.7		0.09703
Highland zone	128	58	45.3		
Total	380	225			

Sheep and goats were found to have different types of gastrointestinal helminths including nematodes, trematodes and cestodes. Of these, nematodes were found to account for the highest prevalence followed by trematodes and finally cestodes in both sheep and goats as it is shown in the Table 2 and 3

Table 2: Overall prevalence of GIT helminthes by types of helminthes in sheep and goats

Goats and sheep = 380		
TYPE	Positive	Prevalence
Nematodes	188	49.5
Trematodes	25	6.6
<i>Paramphistomum</i>	(22)	(0.88)
<i>Fasciola</i>	(3)	(0.12)
Cestodes	12	3.1

Table 3: Prevalence of GIT helminthes in sheep and goats by types of helminthes

TYPE	Goats = 215		sheep=165	
	Positive	Prevalence	Positive	Prevalence
Nematodes	106	49.3	82	49.7
Trematodes	12	5.6	13	7.9
Cestodes	7	3.2	5	3.0

The results of coprological examination in both sheep and goats have also shown the presence of several types of gastrointestinal helminthes eggs namely strongyle, *Fasciola*, Paramphistome and *Moniezia* eggs as it is shown in the Table 4.

Table 4: The prevalence of particular gastrointestinal worm eggs

Type	Goat=215		Sheep=165	
	Positive	Prevalence	Positive	Prevalence
Strongyle	106	49.3	86	52.1
<i>Fasciola</i>	1	0.5	2	1.2
<i>Paramphistomum</i>	10	4.6	12	7.3
<i>Moniezia</i>	7	3.2	5	3

The results of coprological examination in both sheep and goats in all three agroecological zones have also shown presence of spatial distribution of several types of gastrointestinal helminthes eggs namely nematodes, cestodes, and trematodes eggs. Middle zone had higher number of positive samples for strongyle eggs than other zones also there were no positive sample for cestodes and trematodes in highland zone as it is shown in the Table 5.

Table 5: The prevalence of particular gastrointestinal helminthes infection in different agroecological zone

Zone	Number of animals	Positive for nematodes	Positive for cestodes	Positive for trematodes
Low zone	119	49 (41.2 %)	4(3.4%)	12(10.1%)
Middle zone	133	81(60.9%)	8(6.0%)	13(9.8%)
Highland zone	128	58(45.3%)	0(0%)	0(0%)

During this study also a mixed types of helminthes eggs infections were observed in both sheep and goats as it is shown in Table 6.

Table 6: Mixed types of helminthes eggs in sheep and goats in the study area

Type Helminthes eggs	Goat = 215		Sheep = 165	
	Positive	Prevalence	positive	prevalence
Strongyle+ <i>Fasciola</i>	1	0.5	0	0
Strongyle+Paramphistomum	6	2.8	5	3
Strongyle + <i>Moniezia</i>	0	0	4	2.4
Strongyle+ <i>Moniezia</i> +paramphistomum	0	0	2	1.2

The degree of infection for the nematodes was classified as low (100-700), moderate (800-1200) and higher above 1200 with respect to the predisposing factors that is sex of animals, age, species and agro ecology. Out of 188 animals that were positive for strongyle type of eggs 65.4% (epg<700) of them showed low intensity of infection and only 7.4% showed high intensity of infection (epg>1200) as it is shown in the Table 7.

Table 7: Degree of infection with respect to predisposing factors in small ruminants

		Degree of infection		
Predisposing factors		Low%	Moderate%	High%
SPECIES	Goat	72(77)	18.7(20)	7.5(8)
	Sheep	63.9(46)	27.8(20)	8.3(6)
SEX	Female	66(68)	23.3(24)	10.7(11)
	Male	79.3(65)	14.6(12)	6.1(5)
Age	Young	70.4(19)	22.2(6)	7.4(2)
	Adult	74.5(114)	16.3(25)	9.1(14)
Agro ecology	Low zone	75.5(37)	42.5(12)	(0)
	Middle zone	69.1(56)	17.3(14)	13.6(11)
	Highland zone	79.7(47)	11.9(7)	8.5(5)

During this study four genera of nematodes were identified, the larvae that were most prevalence in both sheep and goats faecal culture were *Haemonchus sp* 43.5% followed by *Trichostrongylus sp* 29.4%, *Oesophagostomun sp* 16.7%, *Cooperia sp* 6.4% *Strongyloides sp* 2.7% and *Bunostomum sp* 1.2 %. Identified genera were further described based on their species and agroecological zone as it is shown in a Table 8 (a and b).

Table 8a: Genera of nematodes that were identified following fecal culture in respect with agro- ecological zones in goats

Nematode spp.	Low zone (%)	Middle zone (%)	Highland zone (%)
<i>Haemonchus</i>	50.4	64	32.4
<i>Trichostrongylus</i>	18.9	30	28.1
<i>Oesophagostomum</i>	17.7	0	22.8
<i>Cooperia</i>	8.8	0	10.5
<i>Bunostomum</i>	2.8	0	3.5
<i>Strongyloides</i>	1.2	6	2.6

Table 8b: Genera of nematodes that were identified following fecal culture in respect with agro-ecological zones in sheep

Nematode spp.	Low zone (%)	Middle zone (%)	Highland zone (%)
<i>Haemonchus</i>	68.6	52.6	44.3
<i>Trichostrongylus</i>	21.4	37.9	30.7
<i>Cooperia</i>	0	0	7.1
<i>Strongyloides</i>	0	6.3	17.9

Results of questionnaire survey regarding farmers awareness on the helminth control practice revealed that 55.6% of the farmers practice zero grazing and 38.9% practice free range system. To supplement grazing 61.1% of farmers provide their animals with concentrates, 5.6% supplement their animals with forage leaves and 33.3% did not supplement their animals. 48.1% of respondents use piped water as source of drinking water to their animals, 44.4% use well water and only 7.4% use water from the river as a source of drinking water to their animals.

Regarding helminth control practices 98.1% of respondents use antihelmintic drugs to control helminthosis. 51.9% of respondents use Ivermectin, 44.4% use Albendazole and 3.7% use levamisole to deworm their animals. 72.2% of respondents know how to deworm their animals on their own and 27.8% did not know how to treat their animals with antihelmintics. Moreover 46.3% deworm their animals once after every six month, 40.7% treat their animals after three month and 11.1% deworm their animals when illness occur . Additionally 55.6% use average body weight to deworm their animals and only 27.8% of the respondents deworm their animals as directed by veterinarian or livestock field officer.

DISCUSSION

During this study the coprological examination performed revealed high prevalence of gastrointestinal parasite infections with small ruminants in Meru district, with no much variation between sheep and goats. Strongyle eggs were more prevalent followed by trematodes eggs and finally cestodes.

This finding is higher than the results of other surveys in sheep and goat carried out in Tanzania based on fecal sampling (Simbeye, 2013), elsewhere in Ethiopia (Negasi *et al.*, 2012; Ibrahim *et al.*, 2014). This difference could be due to existence of favorable climatic conditions that support prolonged survival and development of most helminths.

In this study, higher prevalence of gastrointestinal parasites was observed in sheep than in goats which is in agreement with other finding by (Tekly, 1991; Negasi *et al.*, 2012; Waruiru *et al.*, 2005) but the difference was, however not statistically significant. This difference is assumed to be due to the grazing habit of the sheep where they graze closer to the ground fostering higher opportunity of exposure to parasites (Degnawew *et al.*, 2011).

The prevalence of helminthosis was high in female animals as compared to male animals but this difference was not statistically significant. This finding is in agreement with the general understandings of helminth infection that female animals are more prone to helminthosis. Urquhart *et al.*, (1996) documented that female animals are more susceptible to parasitism during pregnancy and peri-parturient period due to stress and decreased immune status.

The prevalence of helminthosis was higher in adult animals as compared to young animals though the difference was not statistically significant. This finding differs from other studies in Ethiopia (Negasi *et al.*, 2012; Degnachew *et al.*, 2011 and Raza *et al.*, 2007). The hypothesis that older animals have acquired immunity against gastrointestinal parasites has been supported experimentally by different scientists (Gamble and Zajac, 1992). However, in this study due to low number of young animals recruited in the study it was observed that was not possible to confirm this hypothesis.

The prevalence of helminthosis was higher in middle agroecological zone, as compared to the other two zones although the difference was not statistically significant. This higher prevalence in middle zone could be due to difference in management systems. In the middle zone animals are managed under extensive system where animals are left to graze almost throughout the year due to scarce availability of pasture and water which could increase the degree of pasture contamination leading to higher prevalence. In lower and highland zones animals are managed under semi extensive (agro-pastoral) and intensive system where few animals are kept together therefore reducing the degree of pasture contamination.

Nematodes and cestodes (*Moniezia*) were found in all zones but trematodes (*Fasciola* and Paramphistomes) were only found in lower and middle zone; Trematodes were not found in highland zone which may be attributed by good management and proper deworming regime, despite the fact that these animals were given fresh cut grass from other zones which could have metaceariae of *Fasciola* and Paramphistomes.

The coprological examination in this study revealed three types of helminth eggs in both sheep and goats which were strongyle type of eggs, trematode eggs and cestode eggs.

Among the helminths recorded in this study, the nematodes were found to account for the highest prevalence followed by trematodes and then the least were cestode. Moreover, strongyle eggs were highly prevalent in both host species in the area; this is in agreement with other finding by Simbeye, (2013), Odoi *et al.*, (2007); Regassa *et al.*, (2006) and Kumsa *et al.*, (2011). The only cestode observed was *Moniezia* with goats having high prevalence than sheep. The trematodes observed in sheep and goats were *Fasciola* and *Paramphistomum* and majority of animals had light infection with sheep having high prevalence of trematodes than goats. The presence of *Fasciola* and *Paramphistomum* in the area may be due to the presence of rivers, rice irrigation schemes and stagnant water in some parts of lowland and midland agroecological zones which may facilitate the existence of snail habitat in the area which are potential breeding areas for snail intermediate host for trematodes.

The study has shown presence of mixed infections characterized by the presence of two or more helminths types both in sheep and goats which has also been reported by works such as Simbeye, (2013) and Negasi *et al.*, (2012). This mixed infection has been suggested to be an important cause of morbidity and loss of production (Kumsa *et al.*, 2011). Additionally, the presence of mixed infection increases the chance of animals to succumb to disease and other parasites due to lowered immunity.

The degree of infection for the nematodes based on worm egg per gram were classified as low (100-700), moderate (800-1200) and higher above 1200. Most of animals which were positive for strongyle type of eggs showed low intensity of infection and only 7.4% showed high intensity of infection. The reason why the majority of animals showing low intensity can be associated with presence of large number of adults which have already develop immunity from sampled animals and good deworming regime. EPG was high in

male than female and in adult than young animals. EPG was high in lowland and midland as compared to highland which is consistent with the study in Ethiopia by Regassa *et al.* (2006).

In this study six genera of nematodes were identified following fecal culture namely *Haemonchus sp*, *Trichostrongylus sp*, *Oesophagostomum sp*, *Cooperia sp*, *Strongyloides sp* and *Bunostomum sp* in decreasing order of percentage in both hosts. The nematode genera that were identified have been reported to infect small ruminants in Tanzania by several authors including Simbeye (2013), Keyyu *et al.*, (2006) and in Kenya by Odoi *et al.*, (2007).

Questionnaire survey revealed that half of the farmers were practicing zero grazing. To supplement grazing most of farmers provide their animals with concentrates, while about one third 33.3% did not supplement their animals. Despite the fact that many farmers practice zero grazing; the level of helminthosis is still high due to usage of contaminated grass from areas which are practicing free range system and irrigation scheme. The observed absence of schistosoma infection in the study area may be due to the fact that few farmers were using water which might be contaminated with snails.

Although almost all of the respondents were using antihelmintic drugs to control helminthosis, only about a quarter of them were deworming their animals as directed by veterinarian or livestock field officers. Improper use of antihelmintics may lead to drug resistance

CONCLUSION

Small ruminants gastrointestinal helminthosis is found to be an important problem in the study area. In both sheep and goats, the nematode parasites were the most predominant parasites followed by trematodes and then cestodes. Therefore, a comprehensive study on species of gastrointestinal parasite present in the area, cost effective strategic control options and awareness creations to the farmers in the study area should be conducted in order to design a sustainable integrated strategy for controlling gastrointestinal helminthosis in different agroecological zones and management systems.

ACKNOWLEDGMENTS

Special thanks to my supervisor Prof. A. A. Kassuku for his comments and guidance during this study. I acknowledge President Office for the financial support of my studies at Sokoine University of Agriculture. I am grateful to Meru district veterinary officer, livestock field officer, management of LITA-Tengeru and farmers for their cooperation in this study. Technical assistance from Dr Kavishe of LITA- Tengeru and Mr Msalilwa of Sokoine University of Agriculture is also appreciated.

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STRUCTURED QUESTIONNAIRES

A QUESTIONNAIRE ON FARMERS AWARENESS ON THE USE OF ANTIHELMINTICS TO CONTROL WORMS IN MERU DISTRICT, TANZANIA, 2014

Part A: Farmer information

1. Respondent number.....Village name.....

Ward nameDistrict.....

2. Sex of respondent (tick one) i. Male ii. Female

3. What is your level of education.....

4. Number of animals/farm size

i) 1-50

ii) 51-100

iii) 101-200

5. Breed of small ruminants

i) Local breed

ii) Exotic breed

Part B: Information on animal management.

1. What type of grazing management do you use?

I) zero grazing

ii) Farm paddocks

iii) Communal grazing

2. What is the condition of the communal grazing area

i) Poor

ii) Average

iii) Very good

3. How long do animals graze in their grazing area?
 - i) Throughout the year
 - ii) During dry season
 - iii) During rainy season
4. Do you supply feed to your sheep and goats?
 - i) Yes
 - ii) No
5. What type of supplement
 - i) Hay
 - ii) Forage leaves
 - iii) Concentrates
6. Where do animals have access to drinking water.....

Part C: Information on helminth control practices

1. Which health problems have you encountered in your sheep and goats
 - i) Helminthosis(Worms)
 - ii) Diarrhea
 - iii) Infectious disease (CCPP)
2. When do you think the animal health deteriorates?
 - i) During wet season
 - ii) During dry season
 - iii) All year around
3. Do you know to treat animals with antihelmintics?
 - i) Yes
 - ii) No

4. How do you control helminth in your farm?

- i) By using antihelmintics
- ii) Pasture management
- iii) Other (specify)

5. Which antihelmintics are you using in deworming

- i) Levamisole
- ii) Benzimidazole
- iii) Ivermectin
- iv) Other (specify)

6. How many times do you treat you animals with antihelmintics?

- I) once per year
- ii) Once every six month
- iii) Only when illness occurs
- iv) Before and after rain seasons

7. How do you recognize worm infection in your animals?

- i) Diarrhoea and/or coughing
- ii) Emaciation
- iii) General weakness
- iv) Other (specify)

8. How do you choose the dosage for deworming the animals/

- i) By estimation
- ii) Using average body weight
- iii) As directed by a veterinarian

9. Where do you get information on antihelmintic usage for worm control?

- i) Livestock field officers
- ii) Drug seller

iii) From another experienced farmer

10) If you deworm your animal where do you obtain the drugs?

i) Open market

ii) Drug vendors

iii) Vet drug shop

iv) From other farmers

Thank you for your cooperation