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Prevalence and risk factors of gastrointestinal parasite infection in goats in Sironko district, Eastern Uganda

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Abstract

In Uganda, goat production is increasingly promoted to provide a necessary resource of socio- economic values and means of resilience against crop failures; particularly among the vulnerable marginalized small scale farming communities. However, gastrointestinal parasite infection is a single most constraint hindering their optimal production leading to economic losses. The objective of this study was to determine the prevalence and risk factors associated with gastrointestinal parasites (GIP) infections in goats in Sironko district, Eastern Uganda. Across-sectional study was conducted using laboratory and survey methods. Twenty eight (28) livestock farmers were interviewed using questionnaires to determine the risk factors. A total of 220 samples (fecal and blood) were collected from goats and analyzed for GIP using laboratory techniques. Majority of respondents were female representing 61% with average age of 47 years. Majority of respondents considered farming a full time employment at 92.9%. The results also showed a high overall prevalence of gastrointestinal parasite in goats of 74.5% and the most abundant category of GIP was nematodes at 61.82%. The level of infection of GIP species were; *Eimeria spp* (37.73%), *Haemonchus contortus* (36.36%), *Trichostrongylus spp* (43.64%), *Strongyloides* (14.55%), *Strongyle spp* (12.73%), *Nematodirus spp* (0.91%), *Moneizia spp (*14.55%) and *Fasciola spp* (11.82%). In addition, analysis revealed highest percentage of aneamic goats were adults (48.6%). Logistic regression model showed that physical location of the farm, production systems and frequency of deworming are the most significant risk factors influencing gastrointestinal parasites infections. The main challenges were; water scarcity and inadequate feeds (24.8%), and diseases (37.9%). The farmers' adaptive management practices included procuring forage and water, supplementation and treatment. The authors conclude that given a higher prevalence of gastrointestinal parasites coupled with moderate anaemia in the era of emerging climate changes; building resilience of the marginalized small scale farming communities through a climate smart agricultural system is critical. A comprehensive farmers' awareness programme is imperative to promote access to knowledge, gender responsive, customized climate smart technologies and adaptive management practices.

Keywords: Risk factors**,** gastrointestinal parasites, infection rate, resilience

Introduction

Globally, goat production is an important component of livestock sector that contributes to food and nutritional security, incomes and sustainable agriculture especially in developing countries (Solaiman, 2010, Thornton, 2010) [32, 33]. In Uganda, the enterprise has been prioritized for the marginalized small scale farmers in the rural and peri-urban areas with limited land. It is estimated that 4.5 million households (70.8%) in the country rear at least one kind of livestock. Of these, 48% small scale farmers largely depend on goat production for provision of socio-economic values including food, a source of income and organic fertilizer for sustainable crop farming (Katali *et al.*, 2015, UBOS, 2018) [10, 35]. More importantly, the enterprise has proven to be the best means enable resilience of the vulnerable marginalized small scale communities against crop failures resulting from changing environmental factors (Katali *et al.*, 2015) [10]. Despite the enormous contribution of goats to the livelihoods of the farming communities, contemporary information indicates that gastrointestinal parasite infection is a single most hinderance to the development of goat production in many parts of the world (Nganga, 2004, Negasi *et al.*, 2012) [21, 20]. The infection rate of gastrointestinal parasites is increasingly attributed to environmental changes, emerging anthelmintic résistance and herd management practices that favour parasite development

(Martinez *et al*., 2015) [16]. The emerging climate change characterized by alternating rainfall patterns, floods and prolonged droughts resulting from global warming have contributed to spatial and temporal distribution and abundance of pests and diseases that impact on animal health (Martinez *et al*., 2015) [16]. There is unequivocal evidence that gastro intestinal parasitic infections pose a serious health risks limiting the efficiency production of livestock. This in turn results into under production and productivity, morbidity and death (Sheikh, 2016, Nwosu *et al*., 2007) [27, 24]. reported decreased profitability of up to 15% and weight loss of up to 50% in goat production due gastrointestinal parasites. Though, clinical coccidiosis is of greater importance in young goats because of severe mortality of goats aged between four to then week (RUIZ *et al*., 2010) [26]. In Uganda, studies that have attempted to investigate the epidemiology of gastro intestinal parasitic infections in small ruminants have largely concentrated on nematodes, though, grazing goat are invariably infected with several of gastrointestinal parasites. For instance, Nsereko *et al*. (2015) [22] researched about nematodes and reported prevalence of 43% in goats while Magona and Musisi (2002) [15] focused on strongyloidosis and revealed a significantly high prevalence of 73.3%. These findings have not been explicit and provide limited information on the situation of gastrointestinal parasites infections in small ruminants, particularly the magnitude and extent of infection rate. Moreover, anecdotal evidence suggests that greater parts of marginalized small scale farming communities engaged in goat production suffer economic losses associated with gastrointestinal parasites infections. It is estimated that 21.5% small scale farmers engaged in goat production in Sironko district, Eastern Uganda frequently experience mortalities estimated at 40% due to gastrointestinal parasites infections (Unpublished report, 2015, UBOS, 2018) [35]. Notwithstanding, Uganda is extremely experiencing alternating rainfall patterns, floods and prolonged droughts which inevitably influence distribution and abundance of GIP in livestock production systems. As such, there is urgent need to understand the prevalence, distribution and risk factor of gastro intestinal parasites in goats to maximize on production and productivity. This case study was conducted to determine the prevalence, distribution pattern and risk factors associated with gastrointestinal parasites infections in goats in semi-arid areas in the Eastern Uganda.

Materials and methods

A cross-sectional study was conducted in Sironko district in three administrative units, namely, Sironko, Bukholo and Bukiyi. The study employed field survey and Laboratory methods. In the field survey, twenty eight (28) randomly selected respondents were interviewed using questionnaires to assess socio-demographic factors and risk factors including production related factors, management practices, among others which impact on the epidemiology of GIP infections in goats (Figure 1). In the laboratory, a total of two hundred and twenty (220) samples of feaces and whole blood with (EDTA) were collected from goats in the herds of households interviewed. Later presented for analysis using various laboratory techniques including feacal flotation, sedimentation, modified Mc Master and microhaematochrit methods (MAFF, 1986, Hansen, 1994) [14, 6]. Feacal floatation was used for detection of nematode, cestodes eggs and coccidia oocysts in the faeces. This method separates eggs from faecal material and concentrates them by means of flotation solutions (zinc sulfate and sodium chloride). Feacal sedimentation technique was used to detect trematodes eggs in the faeces because most of the trematodes eggs are relatively large and heavy compared to nematode eggs as such this technique concentrates them in sediment while modified Mc Master method and microhaematocrit centrifuge method were used to determine egg count and packed cell volume (PCV) respectively.

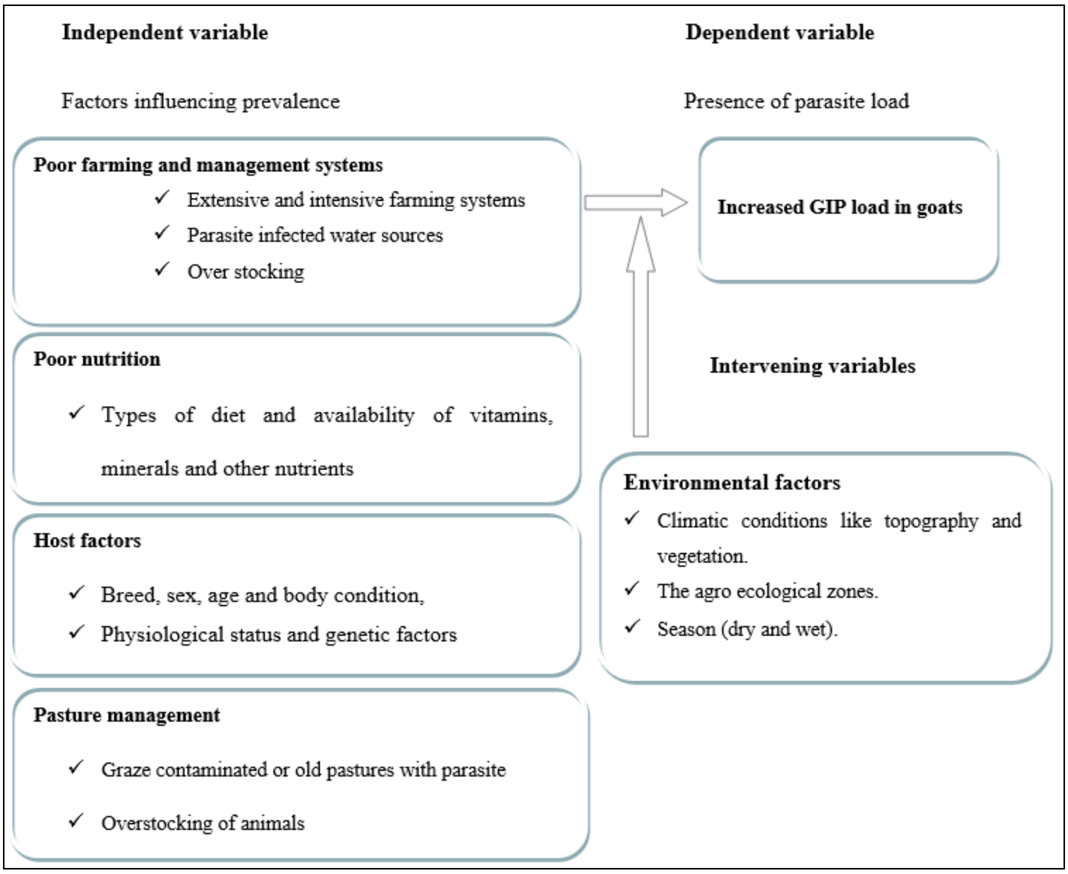

Fig 1: The conceptual frame work of gastrointestinal parasites (Source: Researcher)

Data analysis
Qualitative data collected from the field was coded; together with quantitative data from the laboratory was then transcribed into Microsoft excel (2007). Later exported to statistical package (SPSS version 20) and STATA Data Analysis system version 14 for descriptive and inferential analyses. Descriptive analysis generated information which was represented in tables and graphs. The binomial test was used to analyze categorical data obtained from the laboratory. Multivariate regression analysis was performed to determine which factors influence the prevalence gastrointestinal parasites. The infection rate of each parasite species was calculated using the formula: P = d / n * 100; where d is the number of animals affected (having a given parasite at that point in time) and n = number of animals at examined at that point in time (Thrushfield, 1995) [34].

Results
In this study, majority of the respondents were females 61% (n=17) with average age of 47 years. Most of respondents attained primary level education 57.1% (n=16) and majority of whom considered farming a full time employment 92.9% (n=26) (Table 1).

Table 1: The socio-demographic characteristics of respondents

Variables	Number	Percentages (%)
Location		
Sironko	28(10)	35.7
Bukhulo	28(10)	35.7
Bukiyi	28(8)	28.6
Age:		
Below 18	0	0
18-35	(28) 6	21.4
35-45	(28) 5	17.9
Above 45	(28)17	60.7
Sex:		
Male	(28)11	39.3
Female	(28) 17	60.7
Occupation:		
Non salary	(28) 26	92.9
Salary	(28) 2	7.1
Education level		
None	(28) 3	10.7
Primary	(28) 16	57.1
Secondary	(28) 7	25.0
Diploma	(28) 1	3.6
Degree	(28) 1	3.6

Prevalence of gastrointestinal parasites infections
The most abundant gastrointestinal parasites were nematode with prevalence rate of 61.82% (n=68). Other common GIP include; the coccidian 32.73% (n= 36), cestodes 14.55% (n= 16) and trematodes 11.82% (n=13). The overall prevalence of GIP infections was high at 74.5%. The summary of GIP Mean egg/ oocysts counts per gram indicated that goats were heavily infested with nematode parasites (*Trichostrongylus spp)* at 43.64% as indicated in Table 2& 3 as below:
The results also indicated infection rate for the various gastrointestinal parasites in different age groups. Young goats had a high prevalence of *Eimeria spp* 46.15% (n=12), *moneizia spp* 15.38% (n=4) and *Nematodirus spp* 3.85% (n=2) than adults goats. Though, in adult goats the prevalence of *Trichostrongylus spp* was higher with 45.25% (n=34), *Haemonchus contortus* 38.1% (n=32), Strongholds 15.48% (n=13), *Strongyle* 14.29% (n=12) and *Fasciola spp* 11.90% (n=10) than the young goats (Figure2).
The study revealed PCV mean values of 22.50% and 21.51% for young and adults respectively. More importantly, the highest percentage of anemic goats were adults with 48.6% (n=35) than young ones 45.5% (n=10) (Table4)
The most prominent gastrointestinal parasite which is highly distributed among different administrative units was *Trichostrongylus spp* with infection rate 45% (n=18), 40% % (n=16) and 46.67% (n=14) in Sironko, Bukhulo and Bukiyi parishes respectively. In addition, *Eimeria spp* was highly distributed in Bukiyi with a prevalence rate at 36.67% (n=11) than in Bukhulo and Sironko 25% (n=10) and 35% (14) respectively as shown in Figure 3 below:
The regression model showed that the most important factors which strongly influenced the increasingly high level burden of GIP were; location of farm, frequency of deworming and production systems. Others factors like feeding and water source were equally important though not very significant. Surpringly, breed type was found to be weakly associated with GIP burden because the negative coefficience (Table5).
Regarding farm production and management practices, the result established three production system, namely; tethering at 72.4% (n=21); semi-intensive at 17.2% (n=5) and intensively at 6.9% (n=2). The most common feeding systems for goats were; browse and supplement at 62.1% (n=17); cut and carry at 27.6% (n=8) and herding at 10.7% (n=3). The results also indicated that majority of the respondents dewormed their goats at intervals of 2-3 month representing 42.9% (n=12) and frequently used Albendazole 35.7% (n=10) (Figure 4).
The results also showed that the main challenges for the goat farmers were; diseases and inadequate water 37.9% together with scarcity of feeds 24.1% (Figure 5).
Interestingly, the farmers' main survival or copying strategy was treatment and procurement of forage at 17.2% together with procurement of water 6.9% (Figure 6).

Table 2: Prevalence of Gastrointestinal parasites in goats by location

Location	Species	No. of animals examined	No. of affected animal	Prevalence (%)
Sironko	*Eimeria spp*	40	10	25
	Haemonchus contortus spp	40	15	37.5
	Trichostrongylus spp	40	18	45
	Strongyloides spp	40	5	12.5
	Strongyle spp	40	8	20
	Nematodirus spp	40	1	2.5
	Moneizia spp	40	6	15
	Fasciola spp	40	8	20
Bukholo	*Eimeria spp*	40	14	35
	Haemonchus contortus spp	40	13	32.5
	Trichostrongylus spp	40	16	40
	Strongyloides spp	40	8	20
	Strongyle spp	40	3	7.5
	Nematodirus spp	40	0	0
	Moneizia spp	40	3	5
	Fasciola spp	40	5	12.5
Bukiyi	*Eimeria spp*	30	11	36.67
	Haemonchus contortus spp	30	12	40
	Trichostrongylus spp	30	14	46.67
	Strongyloides spp	30	3	10
	Strongyle spp	30	3	10
	Nematodirus spp	30	0	0
	Moneizia spp	30	8	26.67
	Fasciola spp	30	0	0
Overall	GIP	110	82	74.5

Table 3: Mean egg/oocysts per gram of gastrointestinal parasites

Parasite spp	Infection rate	Mean EPG	Std.	Min- Max(epg)	Recommended max epg
Eimeria spp	37.73	155.45	484.03	0- 4000	<300
Haemonchus contortus	36.36	132.73	250.18	0- 1150	<200
Trichostrongylus spp	43.64	404.09	980.41	0- 7100	<200
Strongyloides	14.55	45.00	131.67	0- 800	<200
Strongyle spp	12.73	20.91	63.67	0-350	<200
Nematodirus spp	0.91	0.91	9.54	0-100	<100
Moneizia spp	14.55	30.00	150.12	0-1450	<100
Fasciola spp	11.82	43.18	291.51	0-3000	<50

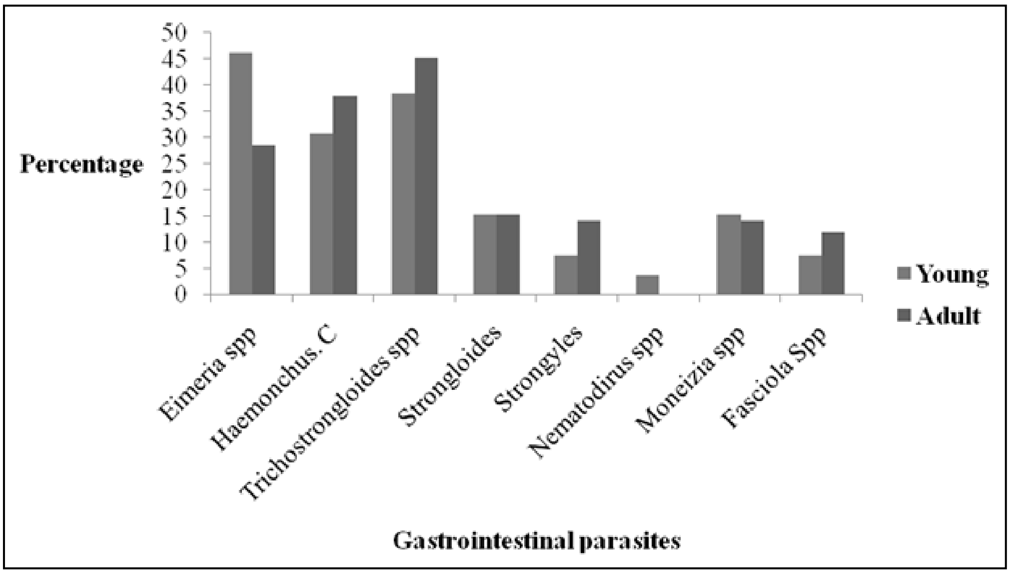

Fig 2: Prevalence of gastrointestinal parasites infection by age

Table 4: Results of PCV mean by age group

Age group	PCV (20-30%)	PCV (< 20%)	Mean	Std. Deviation	Std. Error
Young (22)	12(22) 54.5	10(22) 45.5	22.50	6.139	1.309
Adult (72)	37(72) 51.4	35(72) 48.6	21.51	5.624	0.591
Total (94)	49(94) 52.1	45(94) 47.9	21.74	5.730	0.591

( ) No of animals sampled

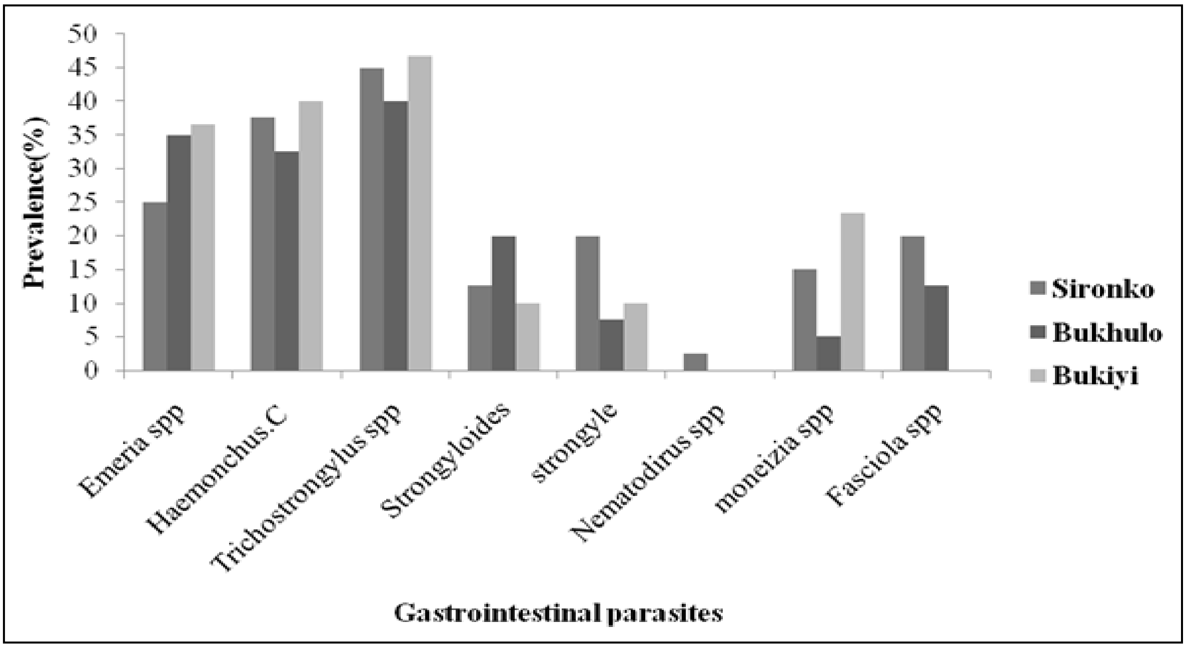

Fig 3: The distribution pattern of the gastrointestinal parasite species in Sirinko district

Table 5: Prediction of risk factors for gastrointestinal parasite infection in goats

Equation	Obs	Parms	RMSE	"R-sq"	F	P
GIP	8	6	2.695153	0.8541	0.7564112	0.0014
GIP	Coef.	Std. Err.	T	P>t	[95% Conf.	Interval]
Location	0.0092981	0026071	3.57	0.001	0039391	.0146571
Breed type	-1.131926	2.728575	-0.41	0.719	-12.87204	10.60819
Production system	4.742304	2.914206	1.63	0.045	17.28112	7.796511
Feeding system	4.704485	4.697007	1.00	0.422	-15.50511	24.91408
Water source	0.0976253	0.5179978	-0.19	0.868	-2.32639	2.131139
Freq of deworming	0.0949868	0.8645621	0.11	0.023	3.624924	3.814897
Age group of goats	1.5	2.223611	0.67	0.525	-3.940979	6.940979
Farmers education level	1.232143	.8883816	1.39	0.224	-1.051515	3.515801
Sex of farmers	1.089286	2.235711	0.49	0.647	-4.657793	6.836365
_cons	21.2489	16.18086	1.31	0.320	-48.37172	90.86952

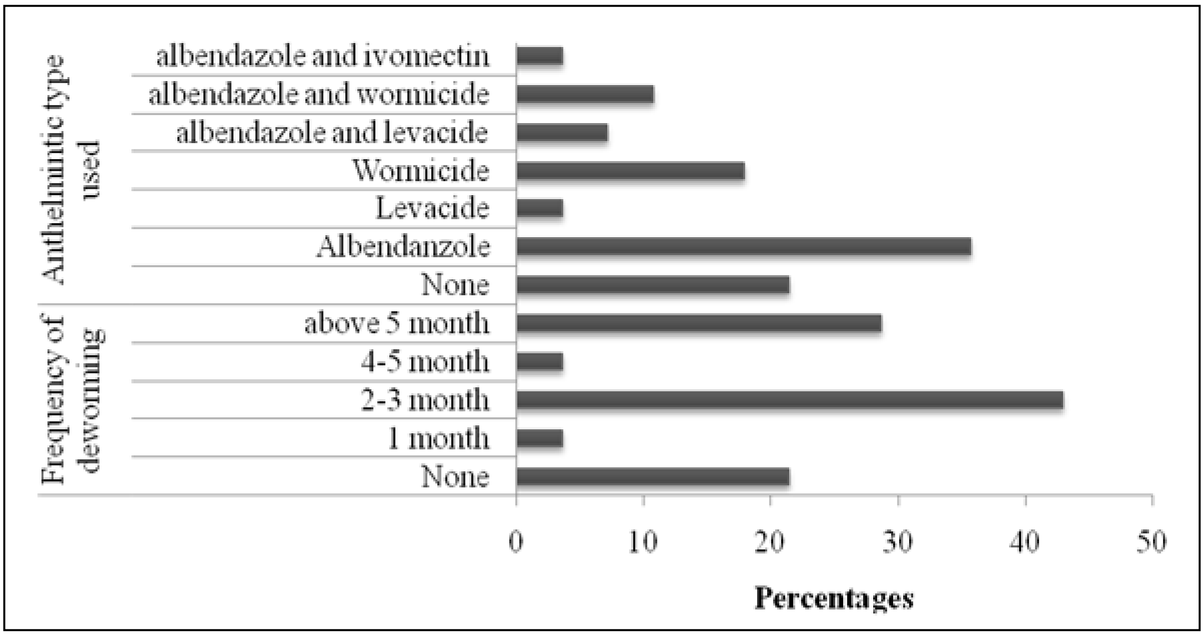

Fig 4: Anthelmintic type used and frequency of deworming

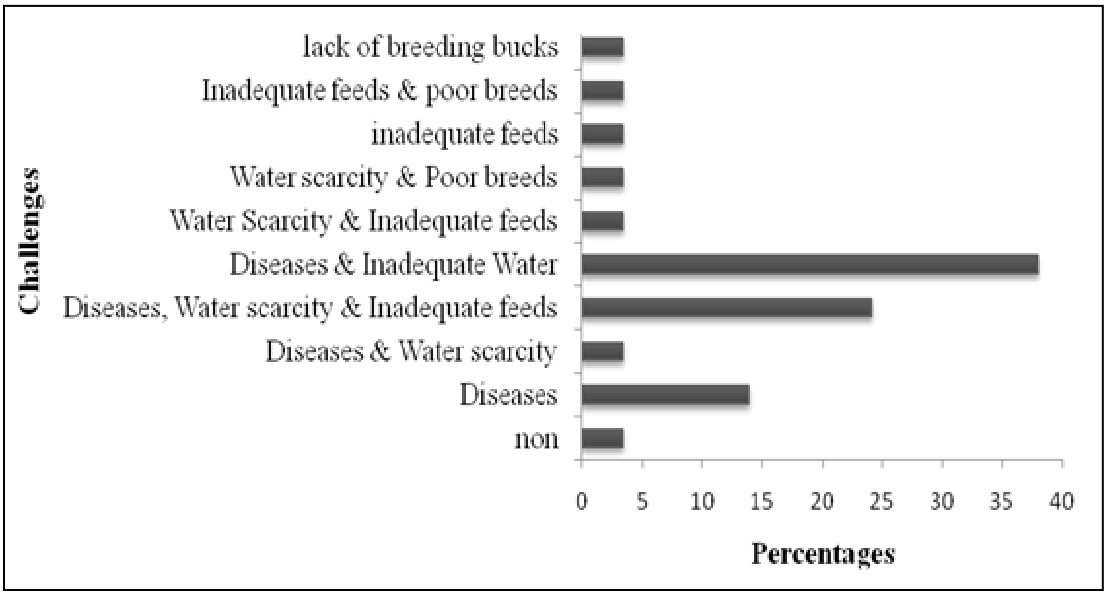

Fig 5: Challenges faced by goat farmers

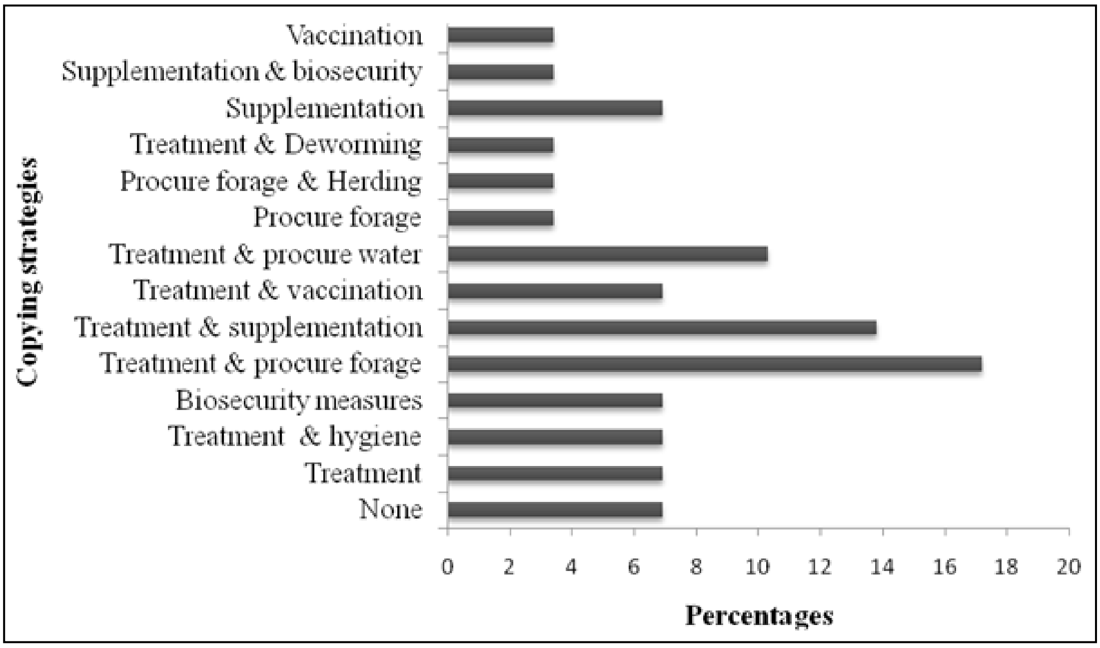

Fig 6: The copying strategies used by farmers

Discussions

Gastrointestinal parasite infections is increasingly becoming a serious threat to the health of small ruminants particularly in the marginalized small scale farming communities in the under developed countries including Uganda. This in turn has lead to significant economic losses attributed to under production, morbidity and death. The semi-arid areas of Eastern Uganda are extremely affected by the sweeping climate change of alternating rainfall patterns, floods and prolonged drought. As such, understanding the level of infestation and distribution of gastrointestinal parasite infections is important for a profitable and sustainable goat production. By and large, this study was the first of its kind in Uganda to investigate the prevalence and risk factors of gastrointestinal parasite infections in goats particularly districts in highland areas. The results showed a high prevalence of gastrointestinal parasites particularly nematode species. This finding was in agreement with the study by Singhi (2013) [30], who reported 75% of GIP infections. The results are also consistent with the findings of Meingi *et al.* (2001) [17] in Kenya, who reported prevalence of (62%) for nematodes. Similarly, Nsereko *et al.* (2015) [22] reported a prevalence of nematodes at 43%.

The study indicated that location of the farms, production system and management practices were the main risk factor influencing the abundance and distribution of gastrointestinal parasites in goats. Regarding location of the farm, it was evident that helminthes and protozoa were relatively abundant on farms in administrative units (Bukiyi) located on high altitude. This is consistent with contemporary information which indicates that goat farms located on higher altitude have a higher prevalence of gastrointestinal parasite infections because of the favorable climatic conditions for the development of the free-living stages of the GIP (Singh *et al*., 2017) [31]. Further, it's supported by Kantzoura *et al*. (2012) [9], who revealed that location of the farm was a risk factor for helminthes infections in small ruminants. In the same way, Dagnachew *et al*. (2011) [4] found differences in distribution of GIPs between highlands and lowlands agro ecological zones; highest prevalence of helminthosis especially strongyles in lowlands than mountains.

Equally important was production system, tethering system was observed predominant goat production system; which is largely recognized for exposing goat to GIP infections through contaminated pastures especially in the wet season. This was consistent with Nsereko *et al.* (2015) [22], who emphasized that tethering of goats results into increased possibility of picking nematode larvae because they eat little vegetation thus pick the parasites from the ground. More importantly, management practices particularly frequency of deworming partly contributed to the observed GIP infection rates. For instance, it was evident that a modest proportion of study indicated that frequency of deworming was a strong determinant influencing GIP infections. This is consistent with other studies by Nwosu *et al*. (2007) [24] and Akhtar *et al*. (2000) [1] which emphasized poor management practice and inadequate health control measures as predisposing factors for increased GIP infections. Contrary, GIP infections could be associated with prolonged use of a single type of anthelmintic (Albendazole) which results into selection and evolution of resistant strains. This was supported by Nsereko *et al*. 2015 [22], Katali *et al.* 2015 [10] and Nabukenya *et al*. 2014. More often goats treated with albendazole recommence pasture contamination with infective stages of the parasite sooner than those treated with levamisole or ivermectin (Iglesias *et al*., 2006) [7].

The study also established that goats are heavily infested with *Trichostrongylus spp* across all the administrative units. This concurs with studies by Olorunfemi (2015), who reported high prevalence of 16.1% in goats. The infection rate of *Trichostrongylus spp* is attributed to the production system which is mainly tethering together with frequency of deworming. This is consistent with findings of Nsereko *et al.* (2015) [22] and Beveridge (1989) [3]. Nonetheless, other major nematode parasites included; Strongyloides, Nematodirus and Strongyle which had low prevalence while Haemonchus was modest. This was in agreement with other studies by Jiregna (2018) [8] and Babjak (2017) [2], who reported prevalence of Strongyloides of 8.33% in Ethiopia and *Nematodirus spp* of 3.98% respectively; contrary to a study by Magona (1999), who reported a high prevalence of strongylodosis at 73.3% in goats. The observed low prevalence of some nematode species is more likely to be associated with deworming using different types of anthelmintics which enhances efficaciousness of drugs and reduces anthelmintic resistance. This is consistent with studies by Katali (2015) [10], who observed that regular use of anthelmintic drugs especially alternating albendazole and wormicide reduces the egg per gram counts of the parasites.

The study further found a modest prevalence of *Eimeria spp*. This was contrary to the findings by Zvinorova (2016) [36] who reported prevalence of 43%. The modest prevalence of *Eimeria spp* is attributed to production system, management practices and host attributes. It was observed that some respondents practiced intensive production systems, which inevitably predisposes animals to poor hygiene, contaminated feed or water and stress. This was in agreement with findings of Khodakaram (2017) [11], who noted that variation in infection rate and distribution of *Eimeria spp* was attributed to the differences in management and hygienic conditions, temperature, agro ecology, climate, weather conditions like wet conditions and the immunity of the goat. Another study by Nwigwe *et al*. (2016) re-iterated that increased rate of protozoa infections is an outcome of overgrazing, overstocking and poor hygiene practisssces. Host immunity is another attribute that determine severity of the GIP infections. Generally, adult goats are more resistant than young ones due to built immunity and as such the young ones are more severely affected. This partly explains the observed results of modest prevalence of *Eimeria spp* because majority of goats sampled were adults. This argument is strongly supported by another study which reported that young animals usually have a higher infection rate and worm burden than older ones due to the fact that adult goats have better immune status and established immuno competence resulting from repeated exposure to parasites (Silverman & Patterson, 1962, Komoin *et al*., 1999) [29, 12].

Equally important was *Fasciola spp* which detected on farms in two administrative units; Sironko and Bukholo though with low prevalence. This was contrary to findings by Lisa *et al*. (2014) [13], who reported a high prevalence of 68%. The variation in occurrence of *Fasciola spp* among the administrative units is attributed to physical location of the farms. Bukhulo and Sironko are located on low altitude relative to Bukiyi as such conditions (temperature and rainfall) favour the development d and hatching of Fasciola spp. This argument is supported by Ratanapob *et al*. (2012) [25], who recognized that different locations experience variations in temperature and rainfall patterns which influence parasite infective stages and severity of the parasite. This concurs with study by Kantzoura *et al.* (2011), who re-affirmed that altitude contributed to presence of *Fasciola spp* in small ruminants. Similarly, the results indicated a high prevalence of *moneizia spp* especially in high altitude areas of Bukiyi.

Furthermore, the severity of GIP infections was evaluated through determining the mean PCV values to depict the level of anaemia. Generally, most of the goats had their average PCV in the recommended normal range and a modest percentage of goats had low PCV which strongly suggested heavy infestation with GIP especially *Emeria spp, Haemonchus* and *Trichostrongylus spp*. These protozoa and helminthes are recognized to lead to loss of blood resulting into moderate level of anaemia which was predominantly observed in adult goats. This could be explained by fact that adult goat are more often exposed to contaminated pasture than the young ones which predisposes them to GIP infections. Equally, the moderate level of anaemia partly re-affirms regular deworming. This was consistent with the findings by Shivairo and Musalia (2002) [28], which re-iterated that the frequent anthelmintic usage over 83% in Baringo District of Kenya reduced anaemic level in goats to only 19.3% represented by PCV of less than 20%.

Conclusion

The study has established a high prevalence of gastro intestinal parasite infections in goats; particularly Trichostrongylus, Haemonchus and Eimeria which is widely spread across the administrative units. This heavy infestation with helminthes and protozoa is highly linked with the evident moderate level of anaemia in adult goats. The main risk factors influencing the prevalence and distribution of gastrointestinal parasites in goats were; physical location of the farm, production systems and frequent use of anthelmintics. Therefore, a comprehensive farmers' awareness programme is imperative to build resilient marginalized small scale farming communities; through access to information, knowledge, gender responsive climate smart technologies and adaptive management practices. Further studies ought to be undertaken to establish the socio-economic impact associated with gastrointestinal parasites in goat production.

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