MANAGEMENT FACTORS ASSOCIATED WITH THE PREVALENCE OF GASTROINTESTINAL PARASITES IN CATTLE: A CASE STUDY OF SMALL-SCALE FARMS OF THE NYAMAGANA DISTRICT IN MWANZA, TANZANIA

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ABSTRACT
Gastrointestinal parasites constitute a significant threat to livestock development; causing sickness and, as a result, decreased output and death. The traditional extensive communal grazing system practised by pastoralists increases exposure of cattle to the infective stages of gastrointestinal parasites. Different factors, such as geographical location, management practises, and production systems, may influence the occurrence of the parasites; thus, mitigation efforts should focus on local conditions. The aim of the study was to determine factors associated with the prevalence of gastrointestinal parasites in cattle in Nyamagana district in northern Tanzania. Faecal samples were collected from 323 cattle in the study area for laboratory analysis using simple flotation and sedimentation methods. A structured questionnaire was used to collect information from the farmers on their production systems and management practises. The overall prevalence of gastrointestinal parasites was 36.4%. The prevalence of Fasciola was 37.5%, Strongyles was 25%, Taenia was 20%, Paramphistomum was 12.5%, and Schistosoma was 5%. The likelihood of cattle being infested with gastrointestinal parasites was higher in the outdoor system of cattle production compared to the indoor system ($p = 0.049$) and in dirty cattle enclosures ($p = 0.002$). Further, the likelihood of cattle being infested with parasites was lower among native farmers compared to non-native farmers ($p < 0.001$), where vaccination against diseases was practised ($p = 0.032$), and extension services were available to the farmers ($p = 0.043$). To reduce the prevalence of gastrointestinal parasites, a combination of different strategies that focus on improving the immune system of cattle and reducing exposure to infective stages of the parasites is necessary.

Keywords: *Cattle, gastrointestinal parasites, management practises, prevalence*

INTRODUCTION
Cattle production is an important economic activity in Tanzania. It plays a significant role in the country's economy, food security, and the livelihoods of many communities (Michael *et al.*, 2018). Tanzania has Africa's second-largest cattle population, with an average of 60.39 million cattle (United Republic of Tanzania, 2021). About 96.5% of the cattle population is made up of indigenous breeds and 3.5% of improved breeds (crossbreds) (United Republic of Tanzania, 2021). The indigenous breeds are kept in an extensive system where they graze on natural pasture in communal grazing fields, whereas improved breeds are kept in semi-intensive and intensive livestock production systems (de Glanville *et al.*, 2020; Ministry of Livestock Fisheries Development, 2015). Small-scale cattle production is a common practise in the country, particularly among rural communities (Ministry of

Livestock Fisheries Development, 2015). Small-scale cattle production plays a crucial role in the livelihoods of pastoralists and agro-pastoralists by providing food, income, and socio-economic stability (Michael *et al.*, 2018).

Although Tanzania has the second-largest cattle population in Africa, the contribution of the livestock to the national GDP is still low, accounting for only 7.1% of the country's GDP (United Republic of Tanzania, 2021). The availability of animal health services remains one of the main challenges to livestock production in Tanzania, in addition to feed and genetic potential (Keyyu *et al.*, 2006; Swai *et al.*, 2017). Diseases and parasites constitute a significant threat to livestock, causing sickness and, as a result, decreased output, and growth (Coop *et al.*, 2002; Perri *et al.*, 2011; Swai *et al.*, 2017). Gastrointestinal parasites, such as trematodes, nematodes, and cestodes, as well as protozoans, are common cattle parasites in Tanzania (Keyyu *et al.*, 2003; Nzalawahe *et al.*, 2014; Swai *et al.*, 2017). The prevalence of gastrointestinal parasites varies depending on different factors such as geographical location, climate, management practises, and production systems (Sun *et al.*, 2018; Swai *et al.*, 2006; Thanasuwan *et al.*, 2021).

The traditional extensive communal grazing system practised by pastoralists and agro-pastoralists increases the exposure of cattle to infective stages of gastrointestinal parasites. The grazing cattle can inadvertently ingest parasite eggs or larvae found on vegetation, water sources, or soil (Keyyu *et al.*, 2005; Khan *et al.*, 2022; Tiele *et al.*, 2023). This consumption can lead to diseases and the spread of parasites among the herd. Continuous grazing on the same ground without adequate resting times can allow parasites to accumulate and continuously infect livestock. Local knowledge on grazing management plays an important role in reducing the transmission of gastrointestinal parasites. The local people may be aware of grazing grounds with high parasite counts, the seasonality of the parasites, and mixing livestock species (Jansen *et al.*, 2022; Karki, 2010). On the other hand, proper sanitation of animal sheds is important to control gastrointestinal parasites in both indoor and outdoor production systems. In the indoor production system, the animals are confined in the shed throughout the day, requiring frequent removal of manure, use of bedding materials, and disinfection to kill parasite eggs, larvae, and oocysts (Åkerfeldt *et al.*, 2021; Maqbool *et al.*, 2017).

Proper nutrition plays a significant role in reducing the susceptibility of cattle to intestinal parasites. Good nutrition helps to maintain the overall health and immune system of cattle, making them more resistant to parasite infections (Greer, 2008; Sweeny *et al.*, 2021). A diet rich in essential nutrients such as proteins, vitamins, and minerals helps maintain overall health and strengthens the immune system (Basabe *et al.*, 2008; Pathak, 2017). However, the extensive system of cattle production practised by pastoralists normally depends on the forage available on the communal rangelands without supplementary feed. The nutritional value of forage in the communal rangelands is low, so it cannot meet the nutrient requirements of livestock. In addition, the majority of these communal rangelands are degraded and unproductive, resulting in land-use conflicts (Ruvuga *et al.*, 2020; Selemani, 2014). As a result, the amount and quality of feed the cattle receive are not enough, especially during the dry season, and may increase their susceptibility to parasites (Njau *et al.*, 2013; Selemani, 2014).

Vaccination plays a crucial role in protecting cattle from diseases, improving their overall health, and strengthening their immune systems to fight parasites (Claerebout *et al.*, 2020; Sharma *et al.*, 2015). On the other hand, regular deworming programmes interrupt the parasite life cycle, kill adult parasites, and reduce parasite eggs in the grazing environment (Gunathilaka *et al.*, 2018; Namutosi *et al.*, 2019). However, resistance of gastrointestinal parasites against anthelmintic drugs renders deworming treatments ineffective and complicates parasite management strategies. Thus, effective control of gastrointestinal parasites in cattle should combine multiple strategies and practises such as pasture management, nutritional improvement, treatment, and the use of medicinal plants (Maqbool *et al.*, 2017; Namutosi *et al.*, 2019). Thus, educating farmers on the proper use of anti-parasitic drugs is important for the proper health manage-

ment of cattle. Animal factors such as breed, age, and sex are normally associated with the susceptibility of the animal to parasites (Squire *et al.*, 2013; Zvinorova *et al.*, 2016). Younger cattle, especially calves, are generally more susceptible to intestinal parasites compared to adult cattle because their immune systems are not fully developed.

Cattle production is a vital agricultural activity in the Mwanza region, providing income, food, and employment opportunities for the local population (Mawona, 2010; United Republic of Tanzanzia, 2017). The Mwanza region has the highest livestock density in Tanzania but has limited grazing land (Ernest *et al.*, 2016). The livestock population of the region is estimated at 1,175,115, of which 98% are indigenous cattle kept by pastoralists and agro-pastoralists (United Republic of Tanzanzia, 2017). The limited grazing land may increase the prevalence of intestinal parasites due to the high density of cattle, which favours spread of parasites (Maqbool *et al.*, 2017; Pfukenyi *et al.*, 2013). The study aimed to determine the management factors associated with the prevalence of gastrointestinal parasites in small-scale cattle production in Nyamagana district in the Mwanza region. The specific objectives of the study were to: (i) determine the prevalence of gastrointestinal parasites among agro-pastoralists in the study area; (ii) determine the effect of cattle production systems on intestinal parasite infestation; and (iii) determine the associations between feeding and housing on the prevalence of intestinal parasites.

MATERIALS AND METHODS

Study area

The study was conducted in Nyamagana district, which is one of the seven districts of the Mwanza Region of Tanzania. The region is located in the northern part of Tanzania, south of Lake Victoria. Nyamagana is a small district that, together with Ilemela district, forms Mwanza city. The mean temperature ranges between 25.7°C and 30.2°C in the hot months and 15.40°C and 18.6°C in the cooler months (Ernest *et al.*, 2016). The district receives an average annual rainfall of between 700 and 1000 mm in distinct short and long rainfall seasons. The short rains fall between October and December and the long rains between February and May (United Republic of Tanzania, 2021). The vegetation cover of the district is typical savannah, with scattered tall trees and tall grass.

Agro-pastoralism is the main activity in the rural areas, while fishing dominates areas close to Lake Victoria (United Republic of Tanzania, 2021). The major ethnic groups are Sukuma, Zinza, Kerewe, Kara, Haya, and Kurya. Poultry is the main livestock kept, followed by cattle. Cattle production in the district is dominated by indigenous breeds, which are kept for multiple uses such as milk, meat, and skin. An extensive system of cattle production is commonly practised in the district, where cattle graze on natural pastures (Ernest *et al.*, 2016). The main challenge facing livestock keeping in the Nyamagana district is the shortage of grazing land. The district has 5,280 ha of grazing land and a carrying capacity of 0.17 ha (United Republic of Tanzanzia, 2023). Worm infestation, anaplasmosis, and East Coast fever account for the highest causes of cattle morbidity in the region (United Republic of Tanzanzia, 2017).

Study design and sample size

A cross-sectional study was carried out between February and May 2023 to gather information about the gastrointestinal parasites that affect cattle in the study area and associated factors. The population of the study was all indigenous cattle kept by pastoralists and agro-pastoralists in the study area. Purposive sampling was used to obtain four wards among the twelve wards of the district based on cattle population. The wards were Mkolani, Buhongwa, Butimba, and Igoma (Figure 1). Two villages were selected randomly from each ward for household surveys and faecal sample collection. The sample size was determined based on the formula proposed by Thrusfield (Thrusfield, 2018), which is given as

$$N = \frac{1.96^2 \times P_{exp}(1-P_{exp})}{d^2}$$

where P_{exp} = expected prevalence, d = desired absolute precision, and N = the total sample size. Based on previous studies (Keyyu *et al.*, 2006; Swai *et al.*, 2006; Swai *et al.*, 2017), the expected frequency of gastrointestinal parasites was 70%. With a precision of 5% and a 95%

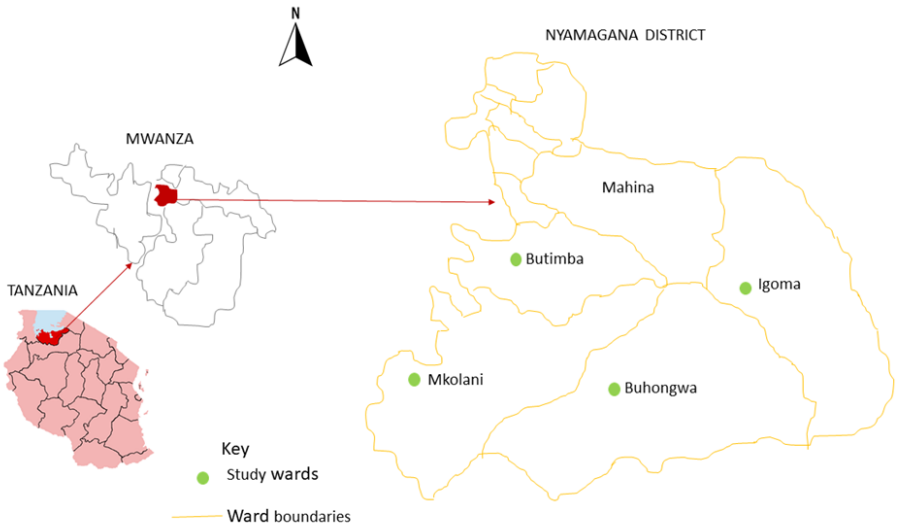

Figure 1. Map of the Nyamagana district showing the study wards.

confidence interval, the sample size of the study was 323 cattle.

Data collection

The sample size of cattle from each ward was determined based on the cattle population in the wards. Random sampling was used to obtain farmers and cattle from the wards. The selected farmers were visited for interviews. A structured questionnaire with both closed and open-ended questions was used to collect information about social-demographic aspects of the household, the production system of the cattle, housing, feeding, disease and parasite management practises, and the availability of extension services. Visual observations were made to collect information about the cattle house or enclosure. Faecal samples were collected directly from the rectum of the selected cattle under the supervision of a veterinary officer from the Tanzania Veterinary Laboratory Agency (TVLA) in the Mwanza region. A clean, new plastic glove was worn for each sample collection. The collected samples were placed in clean, zipped plastic bags and stored in a cool box. The faecal samples were then taken to TVLA for laboratory analysis. Simple faecal flotation and sedimentation methods were applied to separate parasite eggs from faecal materials. The parasite eggs were then viewed under a microscope to determine the species of the parasite. Consent for participation was obtained from all participants. In addition, the study adhered to the confidentiality of the participants. Ethical clearance for conducting the study was obtained from the University of Dodoma with reference MA.84/261/02.

Data analysis

The data was coded in Microsoft Excel for viewing and cleaning. Descriptive statistics, such as frequencies and percentages, were computed in Excel. The prevalence of intestinal parasites was calculated as the ratio of positive samples to the total number of samples. The data was then imported into the R software for further analysis. The presence and absence of parasite eggs in the faecal samples were converted into binary outcomes, where positive results were denoted as 1 and negative results as 0. Thereafter, a multivariate logistic regression was performed to determine the factors associated with the likelihood of parasite infestation. These factors were the production system of the cattle, age of the cattle, herd size, family size, whether the farmer was

native to the district, education level of the farmer, whether vaccination and deworming were practised, condition of the cowshed, and supplementary feeding of the cattle. In addition, Poisson regression was performed to determine the association between the age of the cattle, production system, and management practises and the number of parasite eggs observed. Using the variance inflation factor (vif), collinearity between the independent variables was determined. Generally, when a variable has a vif above 3, it indicates that it is correlated with other variables in the modal (Zuur *et al*. 2009). However, there was no variable with a vif above 3, indicating that there was no correlation between the independent variables.

RESULTS AND DISCUSSION

Five genera of gastrointestinal parasites were identified in the faecal samples: *Fasciola*, *Strongyle, Taenia, Paramphistomum,* and *Schistosoma*, with an overall prevalence of 36.4%. *Fasciola* had the highest prevalence (37.5%), followed by strongyles (25%), *Taenia* (20%), *Paramphistomum* (12.5%), and *Schistosoma* (5%). *Fasciola* is an important parasite of grazing cattle in the tropics, where both *Fasciola gigantica* and *Fasciola hepatica* are found (Ayaz *et al.*, 2014; Nyirenda *et al.*, 2019). The persistence of parasites and snails, which are intermediate hosts, is facilitated by mild temperatures, rainfall, and a longer grazing period (Fox *et al.*, 2011; Isah, 2019). The cattle get infested with *Fasciola* primarily through the ingestion of larvae of the parasite known as metacercariae (Fox *et al.*, 2011; John *et al.*, 2019). The larvae are present in contaminated water or vegetation (John *et al.*, 2019). As with *Fasciola*, cattle are infected with strongyles by consuming grass, feed, or water contaminated with infective larvae. The larvae can resist harsh environmental conditions because they form a protective sheath (Nielsen *et al.*, 2007). Strongylid nematodes are common in horses (Forteau *et al.*, 2020; Nielsen

Table 1: General characteristics of the households

Variable	Levels	Percentage	Chi square	p-value
Sex of the respondents	Male	67.3	24.89	< 0.001
	Female	32.7		
Age of the respondent (yrs)	25-29	20.0		
	30-34	25.4		
	35-39	30.9	20.45	< 0.001
	40-44	14.5		
	Above 44	9.1		
Education level of the respondents	Informal	7.3		
	Primary	49.1	63.37	< 0.001
	Secondary	30.9		
	College	12.7		
Native to the district	Yes	69.1	30.56	< 0.001
	No	30.9		
Cattle production system	Indoor	18.2		
	Outdoor	81.8	86.56	< 0.001
	Traditional medicine	18.2		
Provide supplementary feeds to the cattle	Yes	41.8	5.25	0.021
	No	58.2		
Is the cowshed roofed?	Yes	30.9	30.56	< 0.001
	No	69.1		
Condition of the cowshed	Clean and dry	40	8.02	0.004
	Full of manure	60		
Measures to control intestinal parasites	Deworming	81.8	86.56	< 0.001
	Use of traditional medicinal	18.2		
Received extension services	Yes	40	8.02	0.004
	No	60		

et al., 2007). Farmers normally keep donkeys and cattle in the same enclosure and grazing area, which may facilitate interspecific transmission of intestinal parasites. *Taenia*, *Paramphistomum,* and *Schistosoma* were also common in the outdoor system of cattle production. Grazing cattle can pick *Taenia saginata* eggs that were shed on the faces of infected humans in pastures and water (Held *et al.*, 2004; Mwasunda *et al.*, 2022).

Indoor and outdoor cattle production systems were practised in the study area, with the outdoor being the dominant production system. The frequency of observing intestinal parasites was higher in the cattle kept in the outdoor system compared to the indoor system (Figure 2). The likelihood of parasite infestation was significantly low in the indoor system, and where traditional methods like the use of medicinal plants were practised (Table 2). The indoor system protects animals from infective stages of parasites and allow farmers to maintain a controlled environment, including temperature, humidity, and ventilation (Kumar *et al.*, 2013). As a result, the indoor system can reduce the survival and proliferation of parasite eggs and larvae. However, this will be achieved only when cleanliness and proper sanitation are practised. Regular cleaning of barns, stalls, and equipment helps eliminate faeces, which often contain parasite eggs (Sudda *et al.*, 2017).

The majority of the farmers were native to the district, but some have moved there from neighbouring regions for business and employment. The likelihood of parasite infestation was lower among farmers who were native to the district than among non-native ones (Figure 3a). Local communities often have traditional practises for controlling diseases and parasites in cattle that have been acquired through experience and passed down through generations (Ndlela *et al.*, 2022). Indigenous knowledge varies among different cultures and regions; thus, non-native farmers may lack information specific to the area. These practises may involve the use of locally available medicinal plants or other natural remedies (Ndlela *et al.*, 2022; Sanhokwe *et al.*, 2016). Local knowledge on grazing management includes the seasonality of parasites and awareness of areas that harbour parasites in the communal grazing land (Nzalawahe *et al.*, 2014).

About 82% of the farmers practised deworming. However, the deworming practises were not associated with parasite infestation, but vaccination against diseases was associated with a lower parasite infestation (Figure 3b). Anti-parasitic drugs are widely used to control gastrointestinal

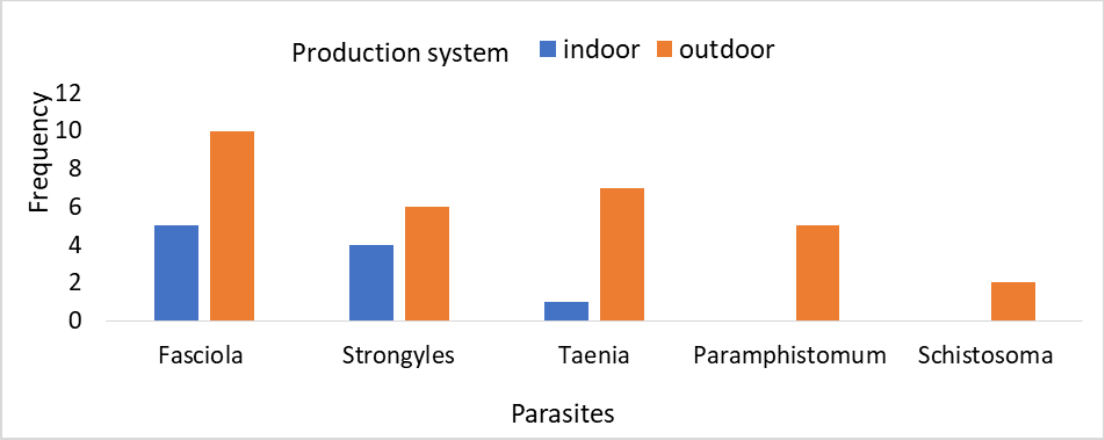

Figure 2: The association between the production system of cattle and the occurrence of different gastrointestinal parasites.

Table 2:Factors associated with the likelihood of intestinal parasite infestation in cattle

The likelihood of a cow being infected by intestinal parasites						
Variable	**Category**	**OR**	**SE**	***z***	***p***	**95% CI for the OR**
Intercept		15.10	2.05	1.324	0.018	15.1-66.5
Production system	Indoor	0				
	Outdoor	0.49	0.96	1.961	0.049	0.1-9.1
Age group of the cattle	Bull	0				
	Calf	0.92	0.93	0.087	0.931	0.1-5.9
	Cow	0.64	0.89	-0.495	0.620	0.1-3.8
	Heifer	0.53	1.32	-0.474	0.635	0.03-6.6
Are you native to the district?	no	0				
	yes	0.13	0.73	-2.690	0.007	0.03-0.5
Education level of the farmer	College	0				
	Informal	0.12	1.52	-1.351	0.176	0.03-1.9
	Primary	1.3	0.90	0.318	0.751	0.2-8.2
	Secondary	0.36	0.86	-1.165	0.243	0.06-1.9
Practise deworming?	No	0				
	Yes	1.4	1.07	0.300	0.763	0.1-10.9
Vaccinate the cattle	No	0				
	Yes	0.2	0.73	-2.137	0.032	0.04-0.8
Control of intestinal parasites	Deworming	0				
	Traditional medicine	0.5	0.749	-1.810	0.041	0.12-2.3
Is the cattle house roofed?	No	0				
	Yes	1.1	0.71	0.181	0.856	0.3-4.7
Condition of the cattle house	Clean and dry	0				
	Full of manure	8.4	0.698	3.54	0.002	2.3-37.5
Supplementary feed of the cattle	No	0				
	Yes	1.7	0.727	0.765	0.444	0.4-7.7
Extension services	No	0				
	Yes	0.3	0.54	-2.022	0.043	0.1-0.9
Household size		0.98	0.123	-0.128	0.898	0.7-1.2
Number of cattle		0.91	0.052	-1.785	0.074	0.8-1.0

parasites in cattle. These drugs have been effective in reducing parasite burdens and improving cattle health when used correctly. However, parasite resistance to anti-parasitic drugs is of concern in cattle production, particularly due to the overuse or misuse of the drugs (Ramos *et al.*, 2016; Wondimu *et al.*, 2022). The likelihood of parasite infestation was lower in cattle that were vaccinated against other diseases. This implies that disease prevention can improve the health of cattle and increase their ability to fight parasites. Thus, improving cattle health can help minimise dependency on anti-parasitic drugs while promoting more sustainable parasite control. This includes providing a well-balanced and nutritious diet to strengthen the cattle's immune systems, proper housing, biosecurity, sanitation measures, vaccination against diseases, and the use of natural remedies (Basabe *et al.*, 2008; Kumar *et al.*, 2013; Shalaby, 2013). By combining different strategies and tailoring them to specific farming conditions, we can create a healthier and more resilient herd with reduced susceptibility to intestinal parasites.

The majority of the farmers kept their cattle in non-roofed enclosures without bedding, exposing the cattle to harsh environmental conditions such as solar radiation and rainfall. Despite the fact that the likelihood of parasite infestation did not differ between roofed and non-roofed cattle enclosures, it was higher for farmers who kept the manure in the enclosure for a long time (Figure 3c). Manure is normally kept in the en-

closures until the rainy season, when it is used for crop production or sold to other farmers (Butterbach-Bahl *et al.*, 2020). Parasite eggs or larvae from infected animals can survive in the manure for an extended period of time. Thus, dirty cattle enclosures can act as breeding grounds for parasites (Kumar *et al.*, 2013).

Sixty percent of the farmers had received extension services, while 40% had never received extension services. The likelihood of cattle being infested by gastrointestinal parasites was higher among farmers who didn't receive extension services (Figure 3d). Extension services play a critical role in raising awareness, providing science-based knowledge, and promoting sustainable practises that help reduce gastrointestinal parasites in cattle (Pousga *et al.*, 2022). Extension services are crucial for pastoralists and agro-pastoralists because they are more vulnerable to scarcity of resources, disease transmission, and limited access to livestock health services (Gustafson *et al.*, 2015). By empowering farmers with the necessary information and skills, extension services contribute to improved cattle health, welfare, and profitability.

CONCLUSION

The study has indicated that pastoralists who rely on extensive grazing systems for their livestock face a higher prevalence of gastrointestinal parasites because grazing cattle are exposed to the infective stages of parasites in the grazing areas. On the other hand, in indoor systems, strict sanitation and manure management practises are

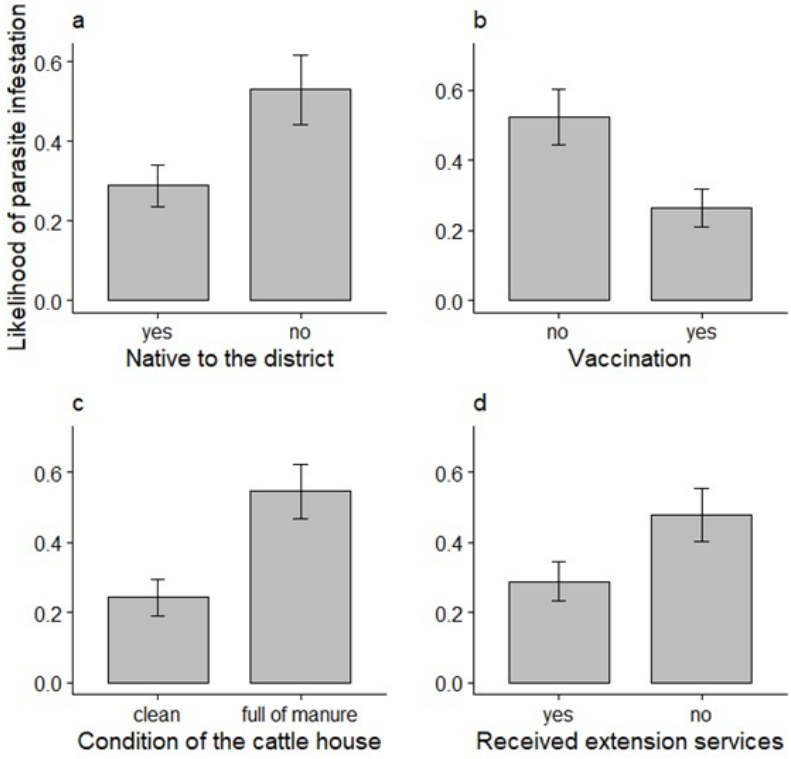

Figure 3. The associations between the likelihood of gastrointestinal parasite infestation and: (a) the origin of the farmers; (b) vaccination of the cattle against diseases; (c) the condition of the cattle enclosure; and (d) the availability of extension services to the farmers.

important to reduce parasite transmission. Local knowledge helps farmers identify areas within pastures that are more conducive to parasite transmission and traditional practises that have evolved over time to manage parasite infections. With the increased resistance of parasites against anti-parasitic drugs, a combination of different strategies that focus on improving the immune system of cattle and reducing exposure to infective stages of the parasites is necessary. Education through extension services can raise awareness about the importance of sanitation and proper manure handling among farmers.

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