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Prevalence of gastrointestinal helminths infection in cattle based on breed, sex, age, location and management system

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Abstract. *Helminths are parasitic worms that live in the animals or humans that feed on the host to obtain nourishment and protection, sometimes causing morbidity and mortality if not treated. A cross sectional study was carried out to determine the distribution/prevalence and risk factors associated with gastrointestinal (GI) nematode parasitism in cattle in three Local Government Areas of Nasarawa North, Nasarawa State, Nigeria. A total of 300 faecal samples of cattle of different sexes and ages were collected and examined for GI nematode eggs using floatation techniques. Descriptive Statistics was used to determine the prevalence rate through percentage and frequency distribution. The degree of association between the considered variables was determined using Chi-square test statistics. A total of 144 (48.00%) animals were positive for single or mixed infection with GI nematodes. The result of faecal examination revealed eggs of Trichostrongylus, Oesophagostomum, Cooperia and Haemonchus species. The results indicated that breed, sex and location had no significant ($P > 0.05$) effect on the prevalence of gastrointestinal nematodes except for age and management system. The results for age had significant ($P < 0.05$) effect with young cattle showing slightly higher prevalence with 52 out of 103 (50.49%), adult: 46 out of 97 (47.42%), old: 46 out of 100 (46.00%). The extensive system had 105 out of 150 (70.00%) as positive, intensive: 39 out of 150 (26.00%) were positive for gastrointestinal nematodes. In conclusion, age and management system significantly affected the prevalence, while breed, sex, and location had no significant impact. To reduce the prevalence of gastrointestinal helminths, it is recommended to improve management practices, particularly for cattle under extensive systems, and consider age-related susceptibility in helminth control programs.*

Keywords: prevalence, gastrointestinal nematodes, breed, sex, age

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Introduction

Helminths (cestode, nematode, and trematode) and protozoan parasites are the major cause of gastrointestinal infection in cattle. Helminth parasites infecting ruminants are classified into two phyla, namely *Nematoda* which are nematodes such as *Nematodirus*, and *Chabertia* and *Platyhelminthes* which include cestodes (example *Taenia*), and trematodes such as, *Fasciola* and *Schistosoma* (Urquhart et al., 2003). Transmission of GI parasites is mainly through ingestion of parasitic eggs and infective larvae on water, contaminated pasture, soil, transplacental, skin penetration, gastropod intermediate hosts, and arthropod (Greenland et al., 2015). Gastrointestinal parasitism in cattle is caused by various parasitic genera, including *Eimeria* spp. (protozoa) and *Fasciola* spp. (trematodes), which infect the digestive tract. These parasites damage gastrointestinal tissues, impair nutrient absorption, and disrupt normal physiological functions, leading to clinical signs such as diarrhea, weight loss, and anemia (Frias et al., 2023).

Meat from ruminants is very important to human nutrition in a largely agrarian economy like Nigeria, it has the potential of serving as a tool for poverty reduction. Animals play a vital role in rural economies through the provision of meat, milk, household income, manure and skins. In Nigeria, human food needs such as meat and dairy products are frequently obtained from ruminant animals such as cattle, sheep and goats. They serve as important sources of animal proteins for man (Owhoeli et al., 2014). Cattle, for instance, is widely distributed and reared in many parts of Nigeria; and its products consumed by many people (Anene et al., 1994). In addition, sheep and goats are equally reared and widely slaughtered at abattoirs in Nigeria, where they are sold to the public. Apart from these animals being a source of animal protein, their wastes are also used as manure in agriculture (Nwosu et al., 2007). Parasitic diseases, particularly those caused by helminths, coupled with inadequate management practices by livestock farmers hamper the productivity of these animals. In many farms, high prevalence of gastrointestinal helminth parasites usually constitutes a serious impediment to small animal production in

Nigeria.

Helminth infections in ruminants contribute significantly to livestock mortality in Nigeria; it is also believed to contribute to human morbidity in the country (Karshima et al., 2018). The free ranging animals that openly graze are mostly susceptible to helminth infection, as open grazing of pastures exposes the animals to graze very close to faecal materials, where the concentration of helminths infective stages are very high (Mondal et al., 2000). Like most livestock farmers elsewhere in Nigeria, framers in Nasarawa State frequently underestimate the importance of providing clean drinking water, good quality food, and a decent housing environment for their livestock. Therefore, this study was undertaken to determine prevalence of gastrointestinal helminths infection in cattle based on breed, sex, age, location and management system in Nasarawa State, Nigeria.

Material and Methods

Study location

This study was conducted in three Agricultural Zones of Nasarawa State, Nigeria. Nasarawa State is located between latitudes 7 and 9°N and longitudes 7° and 10°E. It is characterized by tropical sub-humid climate with distinct seasons. The wet season begins from April to October and the dry season between November and March. Annual rainfall figure ranges from 100 mm to about 200 mm. Temperatures are generally high during the day, particularly between the months of March and April. The mean monthly temperature ranges from 28°C-38°C (NiMet, 2008). The state is predominantly agrarian with surrounding hill forested vegetation in the southern zone. It is endowed with a lot of pasture and good rainfall pattern with suitable temperature for livestock production, farming such as cattle, sheep and goats. The majority of the cattle in the state are owned by the Fulani pastoralists, they are widely spread across the state and the neighboring states. Agriculture is the dominant occupation of the inhabitants of Nasarawa State. The study covered three local government areas (Akwanga, Nassarawa Eggon and Wamba).

Study population and sample size

Population of cattle kept under both extensive and intensive systems of production in Nasarawa Agricultural Zone constitutes the study population. A sample size of 300 cattle was randomly selected and subjected to qualitative and quantitative coprological examination. A hundred (100) cattle were sampled from each local government. Two districts were randomly selected and further stratified into one cattle farmer per district from each local government. The sample size was calculated as described by Vierron and Giraudeau (2007) using the formula below: $n = \frac{Z^2 P q}{d^2}$ Where: n = Sample size for the study Z Standard normal deviation (1.96). P = Prevalence of helminth (42%) from previous studies (Pam et al., 2020), $q = 1 - p$, degree of precision (5% or 0.05). Therefore, $n = 300$, using the prevalence rate of 42% obtained by Pam et al. (2020) in a study of helminths of cattle in Nasarawa State.

Design of the study

A cross sectional study was used in this study

and samples were collected from 300 cattle from the three local government areas. The data were collected with respect to breed, age, sex, location, management system. Age of the animals was determined based on dentition eruption technique.

Age classification of the cattle

Young Cattle (Calves/Weaners/Yearlings): According to Kabir et al. (2022), cattle <2 years of age are considered young. This includes calves (newborn to a few months old), weaners (recently weaned animals), and yearlings.

Adult Cattle: Cattle aged between 2-8 years are generally classified as adults. This group includes mature cows and bulls that have reached reproductive maturity and have calved or are actively producing (Kabir et al. (2022).

Old Cattle: Cattle older than 8 years are considered old (Rony et al., 2010). This age group shows signs of aging such as advanced tooth wear and may have decreased productivity and health resilience.

Table 1. Different ages of cattle and probable relationship in the infestations

Age Group	Approximate Age Range	Infestation Susceptibility and Characteristics
Young	< 2 years	Higher susceptibility due to immature immunity; variable parasite loads; vulnerable to pasture-borne parasites (Kabir et al., 2022).
Adult	2 to 8 years	Often higher parasite prevalence due to exposure; some acquired immunity; significant burden of ticks and GI parasites (Kabir et al., 2022).
Old	> 8 years	Highest ectoparasite prevalence reported; possible immune decline; more vulnerable to infestation and disease (Rony et al., 2010.).

Description of extensive, intensive systems and causes of infestations

Extensive system typically involves cattle being raised outdoors on pasture, allowing animals to graze freely and move around at will. It is common in upland farms with lower stocking rates per hectare. Animals are usually only brought indoors during harsh weather or specific periods like calving. Extensive farming in this context relies on natural grazing rather than concentrated feeding systems. Potential causes of cattle infestation in extensive systems include: parasite eggs and larvae survive in

soil and pasture, leading to reinfestation as animals graze repeatedly on the same land. Parasites such as stomach worms and *Coccidia* thrive in warm, moist pasture conditions, especially when animals are kept in the same grazing areas continuously. Young stock is particularly vulnerable to parasites when following older animals on pasture because their immune systems are less developed. Poor pasture management and high animal density can exacerbate parasite loads.

Intensive farming, often called factory farming, involves keeping animals in specialized buildings

where their diet, breeding, behavior, and disease management can be precisely controlled. Animals may remain indoors for their entire lives and are fed, watered, and cleaned using automated or semi-automated systems such as liquid feed lines and programmed meal hoppers. This system aims to maximize production efficiency on limited land. Potential causes of cattle infestation in intensive systems include: high animal density and overcrowding increase the risk of disease and parasite transmission, cattle confined in the same indoor spaces continuously can lead to buildup of parasites like *Coccidia*, poor ventilation, inadequate feeding or watering space, and stress factors such as chilling or overmedication can lower animals' resistance to infections, contaminated premises, including soil, bedding, and feed, can harbor infectious agents, infectious diseases caused by bacteria, viruses, fungi, and parasites are common risks in intensive settings due to close contact among animals.

Sample collection

Fresh faecal samples were collected directly from the rectum of cattle using the disposable gloves. The faecal samples from each animal was placed into the labelled air and water tight bottles for each animal. The sample bottles were kept in the cold chain to avoid eggs from hatching while still at the field, taken to the laboratory and refrigerated.

Laboratory analysis

In the laboratory, each sample was crushed and out of the whole matter 2 g was weighed out and mixed with 60 ml of sodium chloride (Floatation solution). It was sieved and few drops of Amyl Alcohol were added to mix thoroughly. A sample was drawn using Pasteur pipette and Mc Master slide. This was observed under light microscope (x10) for identification of oocysts of different gastrointestinal protozoa as described by Souls (1986).

Identification of eggs in faeces to the genus level

To identify isolated helminth eggs to the genus level in cattle, the following steps were followed: After flotation, eggs were observed under a light

microscope at 10x to 40x magnification, to assess their morphological features. The Identification to genus level relies on key egg features such as size, shape, shell thickness, color, surface texture, and internal contents (e.g., presence of larvae or morula). For example; *Haemonchus* eggs are oval, thin-shelled, and contain a morula, *Trichostrongylus* eggs are smaller, oval, and thin-shelled. *Oesophagostomum* eggs are oval with a thin shell and contain a morula.

Data analysis

The data collected on gastrointestinal parasites of cattle and the risk factors were recorded in Excel sheet and analyzed using SPSS version 20. Descriptive Statistics was used to determine the prevalence rate through percentage and frequency distribution.

Results and Discussion

Prevalence of gastrointestinal helminths infection in cattle based on breed is presented in Table 2. The results indicated that breed had no significant ($P > 0.05$) effect on the gastrointestinal helminths. The prevalence based on breed indicated the following: Red Bororo: 52 out of 100 (52%), Sokoto Gudali: 46 out of 100 (46%) and White Fulani: 46 out of 100 (46%). It was also observed that a total of 144 out of 300 (48%) were found to be positive for gastrointestinal helminths in the population.

The results from this study, however, indicated that breed does not significantly affect the prevalence of gastrointestinal helminths, as no statistically significant differences ($P > 0.05$) were observed between the breeds (Red Bororo, Sokoto Gudali, and White Fulani). These findings are consistent with several studies that have shown that genetic resistance to helminth infections may vary between breeds but is not always statistically significant (Sissoko et al., 2014).

These values suggest that gastrointestinal helminths are a common problem across the studied breeds, with an overall prevalence of 48%. While the overall prevalence is relatively high, the lack of a significant difference between breeds

suggests that other factors, such as environmental conditions or management practices, may play a more significant role in the transmission of helminths (Hansen and Perry, 1994).

Since breed did not significantly affect the prevalence of gastrointestinal helminths, it is evident that focusing on genetic resistance alone may not be sufficient to control these infections. Instead, control measures should consider factors such as management practices, pasture management, and regular deworming programs, which can help reduce the overall burden of helminths (Maingi et al., 2005).

Additionally, since gastrointestinal helminths are a major cause of economic losses in cattle production due to reduced weight gain, lower milk yield, and increased veterinary costs (Kaplan, 2002), implementing effective and cost-efficient control measures is crucial for sustainable livestock farming. These measures may include rotational grazing, maintaining clean water sources, and the use of anthelmintic treatments to reduce the helminth burden in the cattle population (Chandrawathani et al., 2006). The uniform prevalence across the breeds indicates that all cattle, regardless of breed, are at risk for gastrointestinal helminth infections, reinforcing the importance of comprehensive parasite control programs that are not breed-specific.

Table 3. represents the prevalence of gastrointestinal helminths infection in cattle based on sex. The results indicated no significant difference in infection rates between male and female cattle. Chi-square value: 0.16 (not significant) and P-value: 0.690 (not significant). From the results, males: 77 out of 164 (46.95%), females: 67 out of 136 (49.26%) and the total prevalence: 144 out of 300 (48%) were positive.

This finding suggests that sex does not play a significant role in determining the likelihood of gastrointestinal helminth infections in the cattle population under study. This is a critical finding because, in some cases, males and females may show differential susceptibility to parasitic infections due to factors such as hormonal differences, behavior, or immune responses (Barger, 2001). In contrast, many studies suggest that parasitic

infections in livestock, particularly gastrointestinal helminths, are more heavily influenced by factors such as environmental conditions, management practices, and exposure to infective larvae, rather than sex-based biological differences (Geurden et al., 2015). The prevalence in this study was lower than the prevalence reported by Umar et al. (2018) who reported 75.3% and 73.2% for male and female, respectively in slaughtered cattle in Bauchi central Abattoir, Bauchi State, Nigeria.

However, the lack of significant difference in this study suggests that sex does not need to be considered as a primary factor when developing helminth control strategies for cattle. This finding aligns with other studies that have found no significant sex-based differences in the prevalence of gastrointestinal helminths (Githigia et al., 2008; Odoi et al., 2005). Since the study found no significant difference between male and female cattle, it implies that any effective control program should target the entire cattle population, irrespective of sex.

Table 4 presents the prevalence of gastrointestinal helminths infection in cattle based on age. There are significant differences ($P < 0.05$) in infection rates among age groups. Young cattle show slightly higher prevalence with 52 out of 103 (50.49%), adult: 46 out of 97 (47.42%), old: 46 out of 100 (46.00%) and the total prevalence revealed that 144 out of 300 (48%) were positive for the helminths in the cattle sample.

These results clearly indicated that younger animals may be more susceptible to infections which points to the need for targeted management strategies for younger livestock. As observed in this study, young cattle (under 2 years of age) exhibited the highest prevalence at 50.49%, followed by adults (2- 8 years of age) at 47.42%, and older cattle (>8 years of age) at 46.00%. Overall, 48% of the 300 cattle sampled were found to be positive for helminth infections and these findings align with the report of Umar et al. (2018) who reported that age significantly influenced the susceptibility of cattle to gastrointestinal helminths.

Similarly, Thapa et al. (2022) found that yearling cattle (12 to 24 months) had a prevalence of 90.8%, while calves (≤ 12 months) had 74.0%, and adults

(>24 months) had 84.9%. The higher prevalence in younger cattle can be attributed to several factors including underdeveloped immune systems and increased exposure to contaminated environments. The consistent pattern observed across different studies underscores the importance of age as a risk factor for gastrointestinal helminth infections in cattle. These findings highlight the need for targeted control measures, such as strategic deworming and improved management practices, especially for younger cattle to mitigate the impact of these infections on livestock health and productivity.

Prevalence of gastrointestinal helminths infection in cattle based on location is shown in Table 5. The results revealed that the prevalence rates are consistent across different locations, suggesting that geographical factors do not significantly ($P > 0.05$) affect the infection rates. There was no significant difference in prevalence among the locations. The prevalence observed was 49% (49/100) in Akwanga, 47% (47/100) in Nassarawa Eggon, and 48% (48/100) in Wamba, with an overall prevalence of 48% (144/300). The prevalence rates were consistent across the different locations, indicating that geographical factors may not significantly influence infection rates. This uniformity could reflect similar management practices or environmental conditions throughout the study areas. The lack of significant difference observed aligns with the findings of Obi et al. (2020), who reported no significant variation in the prevalence of gastrointestinal helminth parasites among trade cattle in Aguata and Orumba South Local Government Areas of Anambra State. These results suggest that factors commonly associated with geographical variation such as climate, vegetation, and husbandry practices do not markedly affect the risk of gastrointestinal helminth infection in cattle within these regions. Consequently, the transmission dynamics of helminth infections may be driven by comparable sources of infection and environmental conditions, as well as consistent farming practices across the study sites.

The observed findings could mean that the environmental conditions (such as climate and terrain) across Akwanga, Nassarawa Eggon, and Wamba might be relatively similar. If environmental

conditions such as temperature, humidity, and pasture availability are similar, it could result in uniform exposure to the same types of helminths across these locations, thereby reducing the influence of geographical factors on the prevalence (Obi et al., 2020). The no significant difference between the locations suggests that geographical factors (e.g., soil type, vegetation, climate) do not have a major impact on the prevalence of gastrointestinal helminths in cattle. This finding could be useful in directing research towards other factors that might play a more significant role, such as management practices, livestock density, among others.

Table 6 presents the prevalence of gastrointestinal helminths based on management systems. The results reveal a stark difference ($P < 0.05$) in infection rates based on management systems, with extensive systems showing a much higher prevalence. As observed, the extensive had 105 out of 150 (70.00%) as positive, intensive: 39 out of 150 (26.00%) were positive for gastrointestinal helminths while the total prevalence was 144 out of 300 (48%). Chi-square value: 58.17 (highly significant) with P-value: 0.000 (significant) confirming that there was significant ($P < 0.05$) difference between the two management systems.

These results reveal a stark contrast in infection rates based on management systems, with extensive systems showing a much higher prevalence and this is in agreement with the report of Mekuria and Bayessa (2017) who reported higher prevalence in extensive system over the intensive system. This could suggest that extensive systems expose cattle to greater helminth burdens due to less controlled environments confirming that the management system has a substantial impact on the prevalence of gastrointestinal helminths (Mekuria and Bayessa, 2017).

The findings suggest that animals in extensive management systems are more likely to be exposed to gastrointestinal helminths. This could be due to factors such as larger grazing areas, less controlled environments, and potentially less frequent monitoring and treatment for parasites (Alkadir and Ayana, 2024). In such systems, the animals are more likely to come into contact with contaminated soil, water, or vegetation that harbors

helminth eggs or larvae, leading to higher infection rates. That implies that the economic impact of these findings should not be overlooked because

higher infection rates can lead to increased costs for veterinary care and treatments, as well as potential losses in productivity and revenue for farmers.

Table 2. Prevalence of gastrointestinal helminths infection in cattle based on breed

Breed	No. of Animal Examined	No. of Animal positive (%)	Chi-square	Crammer's V.	P-Value
Red Bororo	100	52(52)	0.96 ^{NS}	0.06 ^{NS}	0.618
Sokoto Gudali	100	46(46)			
White Fulani	100	46(46)			
Total	300	144 (48.00)			

No.= Number, Figures in parenthesis are in percent, V= value, NS=Not significant

Table 3. Prevalence of gastrointestinal helminths infection in cattle based on sex

Sex	No. of Animal Examined	No. of Animal Positive (%)	Chi-square	Crammer's V.	P-value
Male	164	77(46.95)	0.16 ^{NS}	0.02 ^{NS}	0.690
Female	136	67(49.26)			
Total	300	144 (48.00)			

No.= Number, Figures in parenthesis are in percent, NS=Not significant

Table 4. Prevalence of gastrointestinal helminths infection in cattle based on age

Age	No. of Animal Examined	No. of Animal Positive (%)	Chi-square	Crammer's V.	P-value
Young (<2 yrs)	103	52(50.49) ^a	8.05 [*]	0.16 [*]	0.018
Adult (2-8 yrs)	97	46(47.42) ^b			
Old (>8 yrs)	100	46(46.00) ^b			
Total	300	144 (48.00)			

No.= Number, Figures in parenthesis are in percent, V=value, yrs= years

^{ab} letters within the same column with different superscripts differ (P<0.05) significantly. The letters; a, b, ranking is just in the order of numbers. In this case, numbers ranked letter b are significantly better than a, because the lower the value (prevalent), the better for the cattle.

Table 5. Prevalence of gastrointestinal helminths infection in cattle based on location

Location	No. of Animal Examined	No. of Animal Positive (%)	Chi-square	Crammer's V.	P-value
Akwanga	100	49(49.00)	0.08 ^{NS}	0.02 ^{NS}	0.961
N/Eggon	100	47(47.00)			
Wamba	100	48(48.00)			
Total	300	144 (48.00)			

No.= Number, N=Nassarawa, Figures in parenthesis are in percent, NS=Not significant

Table 6. Prevalence of gastrointestinal helminths based on management systems

M.S.	No. of Animal Examined (%)	No. of Animal Positive (%)	Chi-square	Crammer's V.	P-value
Extensive	150	105(70.00) ^a	58.17 ^{**}	0.44 ^{**}	0.000
Intensive	150	39(26.00) ^b			
Total	300	144 (48.00)			

No.= Number, Figures in parenthesis are in percent, V=value, M.S.= Management system

^{ab} letters within the same column with different superscripts differ ($P < 0.05$) significantly. The letters; a, b, ranking are just in the order of numbers. In this case, numbers ranked letter b are significantly better than a, because the lower the value (prevalent), the better for the cattle.

Conclusion

The slightly varying but statistically insignificant prevalence rates of gastrointestinal parasites across Akwanga, Nassarawa Eggon, and Wamba indicate that environmental factors, host susceptibility, and management practices likely play a uniform role in parasite transmission across these locations. Mixed infections remain a common challenge due to overlapping ecological niches of the parasites involved. The faecal examination revealed the presence of various gastrointestinal helminths, including *Trichostrongylus*, *Oesophagostomum*, *Cooperia*, and *Haemonchus* species.

The study found that breed, sex, and location had no significant effect on helminth prevalence, while age and management system did. Young cattle exhibited a slightly higher prevalence of gastrointestinal helminths (50.49%) compared to adult (47.42%) and old (46.00%) cattle. Cattle in the extensive management system had a significantly higher prevalence (70.00%) of helminths compared

to those in the intensive system (26.00%). Age, sex, and management system significantly affected the prevalence of specific gastrointestinal helminths, while breed and location did not. The extensive management system showed a significantly higher prevalence of all helminth species compared to the intensive system. Implement targeted deworming strategies, especially in extensive management systems and among young cattle, to reduce the prevalence of gastrointestinal helminths like *Trichostrongylus*, *Oesophagostomum*, *Cooperia*, and *Haemonchus*.

References

- Alkadir G and Ayana D**, 2024. Helminth Control Practices in Sheep and Cattle in Urban and Peri-Urban Areas of Adea District, Central Ethiopia. *Veterinary Medicine*, 15,181-195. doi: 10.2147/VMRR.S450106.
- Anene BM, Onyekwodiri EO, Chime AB and Anik SM**, 1994. Gastro-intestinal parasites in sheep

and goats of southeast Nigeria. *Small Ruminants Research*, 13, 187-192.

Barger IA, 2001. Helminths and the immune system of ruminants: A review. *Veterinary Parasitology*, 98,19-34.

Chandrawathani P, Mohamed M and Sharif A, 2006. Gastrointestinal helminth infections in livestock in Malaysia: Prevalence, control strategies and economic impact. *Veterinary Parasitology*, 135, 25-30.

Frias H, Maraví C, Arista-Ruiz MA, Yari-Briones DI, Paredes-Valderrama JR, Bravo YR, Cortez JV, Segura GT, Ruiz RE, Lapa RML, Valderrama NLM, 2023. Prevalence, coinfection, and risk factors associated with *Fasciola hepatica* and other gastrointestinal parasites in cattle from the Peruvian Amazon. *Veterinary World*,16, 546-553. doi: 10.14202/vetworld.2023.546-553.

Geurden T, Areskog M and Dalsgaard A, 2015. Epidemiology of gastrointestinal nematodes in ruminants. *Veterinary Parasitology*, 207, 166-177.

Githigia SM, Gathuma JM and Njeruh FM, 2008. Prevalence and control of gastrointestinal nematodes in smallholder dairy cattle in central Kenya. *Veterinary Parasitology*, 154, 130-135.

Greenland K, Dixon R, Khan SA, Gunawardena K, Kihara JH, Smith JL and Kumar S, 2015. The epidemiology of soil-transmitted helminths in Bihar state, India. *PLoS Negligence Tropical Disease*, 9, e0003790.

Hansen J and Perry B, 1994. The epidemiology, diagnosis and control of helminth parasites of ruminants. *FAO Animal Production and Health Paper*, 124. FAO.

Kabir MHB, Mondal MMH, Eliyas M, Mannan MA, Hashem MA, Debnath NC, Miazi OF, Mohiuddin C, Kashem MA, Islam MR and Elahi MF, 2022. An epidemiological survey on investigation of tick infestation in cattle at Chittagong District, Bangladesh. *Advanced Journal of Microbiology Research*, 16, 001-007.

Kaplan RM, 2002. Economic importance of helminths in cattle production and veterinary medicine. *Veterinary Clinics of North America: Food Animal Practice*, 18, 359-367.

Karshima SN, Maikai B and Kwaga JPK, 2018.

Helminths of veterinary and zoonotic importance in Nigerian ruminants: a 46-year meta-analysis (1970-2016) of prevalence and distribution. *Infectious Diseases of Poverty*, 7, 52.

Maingi N, Reinemeyer CR and Kanyari PW, 2005. Parasite control in smallholder livestock production in Kenya: A practical approach. *Tropical Animal Health and Production*, 3, 153-160.

Mekuria S and Bayessa M, 2017. Gastrointestinal helminths and their predisposing factors in different poultry management systems; Haromaya, Ethiopia. *Ethiopian Veterinary Journal*, 21, 40-53.

Mondal MM, Islam M, Hur J, Lee J and Baek B, 2000. Examination of gastrointestinal helminth in livestock grazing in grassland of Bangladesh. *Korean Journal of Parasitology*, 38, 187-190.

NiMet, 2008. Nigerian Meteorological Agency Lafia, Nasarawa State.

Nwosu CO, Madu PP and Richards WS, 2007. Prevalence and seasonal changes in the population of gastro-intestinal nematode of small ruminants in the semi-arid zone of North-Eastern Nigeria. *Veterinary Parasitology*, 44, 118-124.

Obi CF, Akata MC and Ezubelu OJ, 2020. Prevalence of gastrointestinal helminth parasites of trade cattle in Aguata and Orumba South Local Government Areas, Southeastern Nigeria. *Journal of Parasitology Disease*, 44, 546-552. doi: 10.1007/s12639-020-01227-3.

Odoi A, Osafo EA and Debrah A, 2005. Prevalence of gastrointestinal helminths in cattle in the central region of Ghana. *Journal of Helminthology*, 79, 357-361.

Owhoeli O, Elele K and Gboeloh LB, 2014. Prevalence of Gastro-intestinal Helminths in Exotic and Indigenous Goats Slaughtered in Selected Abattoirs in Port-Harcourt, South-South, Nigeria. *Chinese Journal of Biology*, e435913.

Pam VA, Ogbu KI, Igeh CP, Bot CJ and Vincent G, 2020. The occurrence of gastrointestinal and haemo parasites of cattle in Jos of Plateau State, Nigeria. *Journal of Animal Science*, 3, 97-102

Rony SA, Mondal MMH, Begum N, Islam MA and Affroze S, 2010. Epidemiology of Ectoparasitic Infestations in Cattle at Bhawal Forest Area, Gazipur. *Bangladesh Journal of Veterinary Medicine*, 8, 27-33.

- Sissoko M, Diallo B and Fofana A**, 2014. Breed-related variations in the susceptibility of cattle to gastrointestinal helminths in Mali: Implications for control programs. *Journal of Helminthology*, 88,230-235.
- Souls EJJ**, 1986. *Helminths, Arthropods and Protozoa of Domesticated Animals*, 7th edn. Bailliere Tindall, London. 1986, 167-174.
- SPSS**, 2007. Statistical package for social science 160 Brief guide Spssine 233south wacker drive, 11 floor Chicago IL 60606-6412 16.
- Thapa B, Parajuli RP and Dhakal P**, 2022. Prevalence and burden of gastrointestinal parasites in stray cattle of the Kathmandu Valley. *Journal of Parasitic Disease*, 46, 845-853. doi: 10.1007/s12639-022-01499-x.
- Umar YA, Babayo SA and Mao PS**, 2018. Gastrointestinal helminths of slaughtered cattle in Bauchi Central Abattoir, Bauchi State, Nigeria. *GSC Biological and Pharmaceutical Sciences*, 04, 058-06.
- Urquhart GM, Armour J, Duncan JL and Jennings FW**, 2003. *Veterinary Parasitology*, (2nd ed.). New Jersey: Blackwell publishers Ltd.
- Vierron E and Giraudeau B**, 2007. Sample size calculation for multicenter randomized trial: taking the center effect into account. *Contemporary Clinical Trials*, 28, 451-8. doi: 10.1016/j.cct.2006.11.003.