Original Research Article

Farmer's Knowledge and Prevalence of Gastrointestinal Parasites of Rabbits in Maseru District, Lesotho

ABSTRACT

Rabbitry holds an important position for sustainable agriculture in developing countries and support vast majority of socioeconomic activities globally. However inappropriate management practices on control of gastrointestinal parasites infesting rabbits have hindered successful development of this sector. Therefore the study was carried out to evaluate rabbit owner's knowledge on health practices and to develop effective management strategies aimed at controlling gastrointestinal parasites of rabbits. The cross sectional study was conducted and a total of 300 faecal samples were collected from rabbits in six communities of Maseru district. In addition 120 farmers were interviewed to assess farmers' demographics, factors affecting growth of rabbit production and viability of rabbit production in relation to their management practices. Descriptive statistics was used in which to give report of collected data and percentages were used to measure knowledge of the respondents. The data was further subjected to Chi-square test to observe the association between farmers' knowledge on health management practices on rabbits. Considering prevalence of gastrointestinal parasites of rabbits, a modified McMaster egg counting technique was used to examine the faecal samples. Data was analyzed using generalized linear model and subjected to binary logistic regression to determine prevalence of gastro-intestinal parasites in response to location, sex and age of rabbits. The findings indicated that rabbit farming mostly dominated by male farmers 90 % than females 10 %. Additionally, farmers' gender showed no significance ($p>0.05$) with flock size of rabbits, most farming household were made up age ranging from 14 to 58 years, and majority of them were unmarried. The overall prevalence of GIPs was 76 %, 23 % and 13 % for coccidia, nematodes and cestodes respectively. Matala and Stadium Area had the highest 95 % prevalence of coccidia followed by Qoaling 75 %, Khubetsoana 71 %, Abia 63 % and Lithabaneng 59 %.

Keywords: Prevalence, coccidia, nematodes, cestodes rabbits

1. INTRODUCTION

It is nearly four years since Covid-19 has been declared as a pandemic issue. It has affected the economy of the world and majority of people lost their jobs in the process. In response to the consequences brought by this pandemic, farmers have engaged in rabbit production as one of the most lucrative project for their low investment. Rabbits are reared for their multi-purpose benefits of meat, wool, and leather [1]. Rabbits have been known to provide the most nutritious meat recommended for human consumption. Along with being high in protein, rabbit meat is also high in calcium, phosphorus, linoleic acid, and has a low fat and cholesterol content. As a result, selling rabbit brings in consistent revenue. Additionally, rabbit manure is used to enhance soil quality for growing crops and offers rapid turnover with minimal financial outlay [26].

However, this sector is hampered by a number of constraints, including limited knowledge of rabbit welfare and needs and general management practices. With regard to this these obstacles, gastro-intestinal parasites occupy first place in hindering the successful development of rabbit industry [22]. The most common intestinal parasites that have been

recorded in rabbit production include; coccidia, nematodes and cestodes. They cause major economic losses in rabbits due to high mortality and morbidity, poor growth and high treatment costs. Furthermore they invades and destroy the intestinal cells of infected rabbits leading to bloody diarrhoea, weight loss, lowered resistance to other diseases, cause electrolyte imbalance and poor absorption of nutrients [2].

According to [9] coccidiosis is primarily regarded as a problem in young rabbits while adult rabbits often act as carriers which continuously discharge oocysts into the environment. Rabbits become infected by ingesting sporulated oocysts with their feed and water. The severity of the disease depends on the number of infective oocysts ingested and this disease occurs mostly in intensively managed rabbits [5]. On the other hand, roundworms cause poor hair coat, weight loss and perineal dermatitis [27]. According to [14], worms can be found in various parts of the gastrointestinal tract (GIT) of the rabbit such as small intestines, large intestine and the colon. Rabbits are also infected by various species of tape worms thought the most prevalent species is Taenia pisiformis [8].

Gastrointestinal parasites cause huge health problems in rabbits because of high mortality rate which invariably affect the industry. Therefore, considering the economic importance of rabbits in Lesotho, the current study was designed to establish baseline information on general management practices and control strategies of GIPs for farmers and other relevant stakeholders. The findings of this study will also create awareness to farmers on potential factors predisposing rabbits to gastro-intestinal parasites infections.

2. MATERIAL AND METHODS

2.1 Study area

The study was carried out at the urban areas of Maseru district which is the capital town of Lesotho. The area is characterized by clear sky with warm summers and short dry cold winters. The district is 1600 m above sea level and occupies 138 km2 with a population of about 330 760 people of which 60 % of them lives in the urban areas. The average annual temperature is 14 ℃ and the precipitation is about 896 mm per year. The climate is mild, in winter there is much less rainfall than in summer [25]. The total of six communities was randomly chosen: Lithabaneng, Abia, Qoaling, Stadium area, Matala and Khubetsoana.

2.1 Study design

2.2.1 Sample size determination

Based on the previous study, the sample size set out to achieve 50% expected prevalence, 5% desired absolute precision at the 95% confidence interval (Thrusfield, 2007).

N = [(〖1.96〗^2* Pexp (1-Pexp))/d^2]

Where,

N is the required sample size,

Pexp accounts for the expected prevalence of GITs (50%),

D denotes desired absolute precision (5%), and

1.96 signifies the value of Z at a 95% level of confidence

A sample size of 140 people was obtained by randomly choosing 20 rabbit owners from each area. The majority of responders were household heads. Additionally, 300 rabbits took part in the data collecting procedure, and only those rabbits were eligible for inclusion in the study that had not had any anthelminthic treatment for at least one month previous to sample collection.

2.3 Data collection

A cross sectional study was undertaken from April 2022 to April 2023. Clean capture cages/boxes were set overnight with rabbits grouped based on breed, age and sex. Fresh faecal samples from the ground in the cages were picked and placed in a clearly labelled screw-capped plastic container and kept in a cooler box with dry ice packs. The samples were

transported on the same day of collection to the Department of Animal Science laboratory at the National university of Lesotho for examination. In the laboratory, faecal samples were refrigerated at 4 □ and processed within 24 hours as per (Elgoniemy, 2018).

2.3.1 Experimental

A modified McMaster egg counting technique was used to analyze the samples. All rabbit faecal pellets were thoroughly crushed, and two grams of each crushed sample was mixed with 58 ml of Sodium Chloride (NaCl) solution (floatation fluid) and blended. The saturated floatation solution was prepared by mixing one ml of distilled water with 4 g of NaCl. After obtaining a homogenous mixture, the blended solution was sieved with 0.15 mm mesh into a beaker. The disposable pipettes were used to draw few milliliters of the solution and fill the two chambers of the McMaster slides which were then viewed under the light microscope (100x magnifications). Eggs and oocysts in both chambers were counted using a laboratory cell counter and the eggs/oocysts per gram of faeces (epg/opg) were calculated. Eggs or oocysts per gram were calculated by counting the number of eggs/oocysts within the grid of each chamber ignoring those outside the squares and multiplying the total by 100 to get the eggs per gram of faeces. Identification of eggs or oocysts was based on the morphological characteristics of parasite eggs.

2.3.2 Survey

To gather data from rabbit farmers on demographics, the various anthelmintic types used, the frequency of treatment application, the method of application, the rotation of anthelmintic use, and the controls for gastrointestinal parasites, a structured questionnaire and an open-ended survey were used. In addition, problems with and remedies for daily rabbit management were investigated.

2.3.2 Data analysis

Data was entered into Microsoft Excel (2010) and exported to IBM Statistical Package for Social Sciences (SPSS), Version 20.0 for analysis. The descriptive statistics was used to describe data data on prevalence and intensity of gastro-intestinal parasites while generalised linear model (GLM) within which binary logistic regression was used to determine the effect of non-genetic factors (rearing location, rabbit's sex and age) on the prevalence of gastro-intestinal parasites. Moreover, Chi square test was used to assess the relationship between farmer's demographics, factors affecting growth of rabbits and viability of rabbit enterprise. In the analysis's, the level of confidence was set at 95 while significance was at 5%.

3.0 Results and Discussion

3.1 Demographic characteristics of rabbit farmers

The results presented in Table 1, reflect the summary of socio-economic characteristics of rabbit farmers. The findings indicated that rabbit farming is mostly dominated by males 96.0% than females 4.0 % with farmer's gender showing a non-significant ($p > 0.05$) association with flock size of rabbits. The findings of are in line with [6] who indicated that rabbits are mostly owned by men than women because rabbit production is an important generating income enterprise thus men are responsible for livestock management. Furthermore the scientific study conducted by [13] concluded that in most families' men are decision makers in livestock production and resource availability while women are occupied by house chores.

3.1.1 Age of rabbit farmers

The present study has revealed that all respondents interviewed were below the age of 24 and above 40 years, and all age groups are actively engaged in rabbitry. The relationship of age of rabbit and different rearing locations did not differ significantly ($p > 0.05$). The results of the current study are supported by [26] who concluded that most people have seen rabbit production as the potential agri-business and better option for generating income post Covid-19 challenge. According to [5], it has been noticed that the engagement in rabbit production increases with increase in age where young and middle aged groups are actively participating in rabbit rearing, but the interest declines when individuals get older, however the scientific study by [16], reported that rabbit production is dominated by elderly people as compared to young ones.

3.1.2 Education level of rabbit farmers

The results presented in Table 1 depicted that farmers' level of education significantly ($p > 0.05$) influences the number of rabbit's farmers in their respective rearing locations [7]. Farmers with mid-level and university education appear to keep more rabbits mainly for commercial purposes while those of basic education (Primary and Post primary level) keep fewer rabbits mainly for subsistence purposes (Kitavi eta al., 2016). Farmers with mid-level education are more commercially oriented and benefit from using new farming technologies and information from stakeholders and media enabling them to make more informed production decisions compared to those of higher education standards [21]. According to Redondo and Lozone (2010), educationally developed and agriculturally literate communities have the highest potential to achieve adequate rabbit development and growth targets. In addition, [28] stated that education enhances farming skills and productive capabilities of the famers have an immediate and positive effect on small unit productivity.

3.1.3 Experience of rabbit farmers

It has been reported by [10] that experience in any enterprise guarantee growth and success and farmers with more years of experience in farming are more efficient in their farm production. As farmers gain more experience in rabbitry, meat production is expected to increase [15]. Majority of farmers in a study conducted by [12] had more years of experience with rabbit farming and most farmers had higher production yields than those with fewer years of experience. In a study conducted by [13], majority of rabbit farmers had faming experience ranging between six to ten years and this was attributed by unemployment rate which was one of the driving forces for inexperienced people to venture into rabbit farming [19].

Table 1: Farmers demographics in relation to rabbit management practices in different rearing locations in Maseru district

Category	Small scale (%)	Medium scale (%)	Large scale (%)	Sig.
Gender				
Male	93.1	96.8	80.0	0.342
Female	6.9	3.2	20.0	
Age				
Below 24	33.4	38.7	38.7	0.020
25-30	31.4	31.0	28.8	
31-40	35.2	27.5	26.2	
Above 41	0.0	2.8	6.3	
Marital status				
Single	62.1	54.8	0.0	0.181
Married	31.0	38.7	78.0	
Widowed	6.9	6.5	22	
Education level				
Primary	13.8	9.7	0.0	0.001
Post primary	44.8	6.5	27.0	
Tertiary	41.4	83.8	76.0	
Experience in rabbit ownership				
< 1	2.9	1.4	0.0	0.025
1 – 5	43.7	40.6	43.8	
6 – 10	40.8	45.7	48.8	
> 10	12.6	8.0	1.2	

S. E = Standard Error, Sig = Significance level

3.2 Awareness of rabbit owners on health problems

The resutls presented in Table 2 indicated that majority of rabbit farmers on medium and large flock sizes seemed to encountered rabbit major health proplems with 51.6 % and 80.0 % respectively. Rabbit farmers reported that their rabbits suffer from a wide range of health issues including respiratory diseases, internal (coccidian and helminthes) and external parasites. Based on the results displayed in Table 2, majority of rabbit farmers on small and medium scales experienced external parasites with 51.7 % 48.4 % respectively while farmers with large flock sizes encountered internal parasites. The results of the large flock with high rate of internal parasites might be due to the cleaning frequency of the rabbit house. The present results concur with the findings of [17] who reported that rabbits are susceptible to several diseases such as respiratory diseases and parasitic diseases which are responsible for decreased productivity and high mortality.

Table 2: Farmers knowledge on health management practices on rabbit production in different rearing locations in Maseru districts

Category	Small (%)	Medium (%)	Large (%)	S.E	Sig.
Rabbit health problems encountered					
Yes	44.8	51.6	80.0	0.002	0.345
No	55.2	48.4	20.0		
Common rabbit health problems					
Respiratory inf.	17.2	9.7	20.0	0.031	0.462
Endo-parasites	31.0	41.9	60.0		
Exoparasites	51.7	48.4	20.0		

S. E = Standard Error, Sig = Significance level

3.3 Overall prevalence of gastrointestinal parasites

A total of 300 faecal samples from domestic rabbits were processed and examined for presence of gastrointestinal parasites. The overall prevalence was 76 %, 23 % and 13 % for nematodes, coccidian and cestodes respectively (Table 3). The results of the current study are in line with the findings of [22] who reported coccidia to be the most prevalent parasite followed by nematodes and cestodes respectively. However, the present findings are inconistant with the results of [20] who reported nematodes to be the most prevalent parasite followed by coccidia and cestodes respectively.

Table 3: overall prevalence of gastrointestinal parasites on rabbits in Maseru districts

Gastrointestinal parasites	No. examined	Overall prevalence (%)
Nematodes	300	76
Coccidia	300	23
Cestodes	300	13

3.4 Effect of rearing location on prevalence of gastrointestinal parasites in rabbits

The results presented in Table 4 summarise the results on the effect of rabbit rearing location on GIP prevalence. The findings showed that Matala and Stadium Area had the highest 95 % prevalence of coccidia followed by Qoaling 75 %, Khubetsoana 71 %, Abia 63 % and Lithabaneng 59 %. The results further showed that location of rearing insignificantly ($p > 0.05$) influences the prevalence of coccidia. In terms of nematodes, the results showed that area of rearing does not significantly ($p > 0.05$) influences the distribution of parasite. However the highest prevalence was recorded in Khubetsoana 50 % while there was no nematode eggs discovered from rabbit faecal samples assessed in Matala location. Considering cestodes prevalence, Matala was most predominant with 38.0 % while faecal samples of rabbits reared in Khubetsoana did not show any presence of cestode eggs.

The variation in the prevalence of coccidia depends on the differences in geographical location and season of the year [18]. Gastrointestinal parasites become more prevalent in areas that are humid [11]. Gastrointestinal parasites dynamics can be strongly affected by numerous biological and ecological factors. Stadium Area showed highest prevalence of parasites due to high humidity around the area. The results of the current study are further supported by [8] who reported that high temperature and humidity during the summer provides a conducive atmosphere for parasites.

Table 4: Prevalence of gastro-intestinal parasites of rabbits in different rearing locations in Maseru district

Communities	No. Examined	Prevalence (%)	Exp. B	Sig.
		Coccidia		
Lithabaneng	27	59	0.485	0.299
Ha Matala	21	95	6.667	0.107
Ha Abia	27	63	0.567	0.418
Khubetsoana	24	71	0.810	0.773
Stadium Area	22	95	7.000	0.098
Qoaling	16	75	1	
		Nematodes		
Lithabaneng	27	11	0.542	0.489
Ha Matala	21	0	6.863	0.999
Ha Abia	27	19	0.985	0.985

Khubetsoana	24	50	4.333	0.054
Stadium Area	22	41	3.000	0.156
Qoaling	16	19	1	
		Cestodes		
Lithabaneng	27	15	2.609	0.411
Ha Matala	21	38	9.231	0.048
Ha Abia	27	11	1.875	0.601
Khubetsoana	24	0	2.376	0.999
Stadium Area	22	9	1.500	0.750
Qoaling	16	6	1	

S. E = Standard Error, Sig = Significance level

3.5 Effect of sex on prevalence of gastrointestinal parasites in rabbits

The results displayed in Table 5 show the prevalence of coccidia between male and female rabbits. The prevalence of coccidian was significantly ($p < 0.05$) influenced rabbit sex while prevalence of nematodes and cestodes did not show any significant ($p < 0.05$) association in rabbits sex. The findings indicated that coccidian was more prevalent in female rabbits 83 % than in male rabbits 60 %. The results further showed that, the chances of female to be infected by male rabbits are less like to happen by 0.295, while odds ratio of infection for a change of sex from females to males increases by 1.004 times in terms of nematodes. With respect to cestodes, female rabbits were more infected with cestodes than male rabbits with males being 0.705 times less likely to be infected with cestodes than female rabbits.

The high prevalence of GIPs in female rabbits is reported by [16] who noticed that stress of breeding and cyclical hormonal changes in the females are influencing high prevalence of helminths. Moreover, the results are in line with the findings of [23] who reported that parturition and nursing of the young are stressors that can affect the immune system of female rabbits negatively. However, the results are not in agreement with the findings of [27] who reported that male rabbits are 1.15 times as risky as the female to get infected, because female animals are more resistant to parasitic infection than their male counterparts due to their hormonal performance.

Table 5: Prevalence of gastro-intestinal parasites in relation to sex of rabbits in different rearing locations in Maseru district

Sex	Examined samples	Prevalence (%)	Exp. B.	Sig.
		Coccidia		
Males	47	60	0.295	0.03
Females	90	83	1	
		Nematodes		
Males	47	23	1.004	0.993
Females	90	23	1	
		Cestodes		
Males	47	11	0.705	0.533
Females	90	14	1	

Exp. B - Exponential Beta, Sig. - Significant level

3.6 Effect of age on prevalence of gastrointestinal parasites in rabbits

The age of the rabbit significantly ($p < 0.05$) influenced GIP prevalence (Table 6). The result showed that young rabbits were significantly having higher (33 %) prevalence of coccidia than adult rabbits. The results further showed that young rabbits were 3.696 times more likely to be infected with coccidia than adult rabbits. With regard to nematodes, young rabbits had higher (34 %) prevalence of nematodes than adult rabbits. The results showed that the odds of young rabbits being infected with nematode increased insignificantly ($p > 0.05$) by 1.513 times for a change of age from adult rabbits to young rabbits. Furthermore the result on prevalence of cestodes showed that a change of age from young rabbit to adult rabbit revealed that the odds of the likelihood of rabbit's prevalence having higher (56 %) cestodes eggs increased significantly ($p < 0.05$) by 4.062 times.

The reseach study by [3] reported parasitic infections to be a leading health issue in young rabbits compared to older rabbits with coccidia being the most prevalent parasites while nematodes are the most prevalent in older rabbits. In addition, the research study by [19] associated high death rate in younger rabbits particular those around 2-3 months of age with parasites infection due to their weak immune system. According to [20], helminthic infection may cause deaths in all rabbit age groups particularly in young rabbits, weak and unthrifty survivors who may, have lowered body resistance

and reproduction capabilities. However, [4] stated that low prevalence in adults may be due to the immunological maturity as the animals get older and the development of acquired resistance due to repeated exposure.

Table 6: Prevalence of gastro-intestinal parasites in relation to age of rabbits in different rearing locations in Maseru district

Age	No. Examined	Prevalence (%)	Exp. B	Sig.
		Coccidia		
Young	38	33	3.696	0.022
Adults	99	12	1	
		Nematodes		
Young	38	34	1.513	0.340
Adults	99	26	1	
		Cestodes		
Young	38	56	4.062	0.007
Adults	99	24	1	

Exp. B – Exponential Beta, Sig. – Significance level

4. Conclusion and Recommendations

Although efforts are being made to raise the livelihoods status of communal smallholder farmers in Lesotho by starting small businesses like rabbit keeping on a commercial basis a number of constraints is making it difficult for these farmers to take up commercialization of rabbit production. Some of these constraints are the large household sizes in each family that require more of the rabbits to be kept for home consumption instead of for the market unless severe cash needs arise. Considering the results of the current study, it is concluded that rabbits in all communities have higher prevalence of protozoan coccidia. In addition female rabbits are more susceptible to parasite infection than males for coccidia and notably equally susceptible for nematodes and cestodes. The age of rabbits had an influence of prevalence of coccidia and young rabbits are more prone to the infection than adults. Therefore, based on the results of this study, it is advised that organisations and rabbit owners establish an integrated gastrointestinal control programme that would address the various types of rabbits and horses in various parts of the nation. It is advised that more research be done on factors influencing gastrointestinal prevalence, burden, and therapeutic methods.

REFERENCES

1. Abdelsalam, M. and Fathi, M., 2023. Improving productivity in rabbits by using some natural feed additives under hot environmental conditions — A review. Anim Biosci. 36(4): 540–554.

2. AL-Naimi, R.A.S., Khalaf, O.H., Tano, S.Y., AL-Taee, E.H., 2012. Pathological study of Hepatic coccidiosis in naturally infected rabbit. J Vet Med Sci. 2012; 11:63–69.

3. Al-Otaibi, B.O., Degheidy, N.S. and Al-Malki J.S, 2021. Prevalence, incidence and molecular characterization of tape worms in Al Taif governorate, KSA and the effectiveness of Spirulina platensis as a biological control in vitro. Saudi J Biol Sci. doi: 10.1016/j.sjbs.2021.06.086.

4. Dagnachew, S., Amamute, A., and Temesgen, W. 2011. Epidemiology of gastrointestinal helminthiasis of small ruminants in selected sites of North Gondar zone, Northwest Ethiopia. Ethiopian Veterinary Journal, 15(1), 57-68.

5. Duszynski, D.W. and Couch, L. 2013. The Biology and Identification of the Coccidia (Apicomplexa) of Rabbits of the World. Published by Oxford University Press, on behalf of the Society of Systematic Biologists. All rights reserved. DOI:10.1093/sysbio/syw006

6. FAO. 2013. Understanding and integrating gender issues into livestock projects and programme

7. Gebska, M., Grontkowska, A., Swiderek, W., and Barbara, G., 2020. Farmer Awareness and Implementation of Sustainable Agriculture Practices in Different Types of Farms in Poland. Sustainability 2020, 12(19), 8022; https://doi.org/10.3390/su12198022

8. Hadi, H. 2019. Internal parasites that infected local rabbits Endo and ectoparasites in rabbits. GSC Biological and Pharmaceutical Sciences, 15(2). DOI: 10.30574/gscbps.2021.15.2.0108

9. Hajipour, N., and Zavarshani, M. 2020. Ectoparasites and endoparasites of New Zealand white rabbits from North West of Iran. Iran J Parasitol, 15(2), 266.

10. Issa, F.O., Kagbu, J.H., and Abdulkadir, S.A. 2016. Analysis of Socio Economic Factors Influencing Farmers Adoption of Improved Maize Production Practices In Akara Local Government Area of Kaduna State Nigeria. National Agricultural Extension and Research Liaison Services. (NAERLS). Agroresearch.16 (2):15-24.

11. Jansen, M.S., Nyangiwe, N., Yawa, M., Dastile, M., Mabhece, V., Muchenje, V., and Mpendulo, T.C. 2020. Prevalence and seasonal variation of gastrointestinal nematodes and coccidia infection ovine grazing on communal rangelands in the Eastern Cape, South Africa. Parasitol Res, 119, 4169-4175. DOI: 10.1007/s00436-020-06927-6

12. Kompi, P., Molapo, S., Nts'aoana, E.S., 2021. Farmers Knowledge and Control Practices on Gastrointestinal Parasites of Horses in Maseru District, Lesotho. Medicine Advances in Animal and Veterinary Sciences. 9(5). DOI: 10.17582/journal.aavs/2021/9.5.715.721

13. Mailafia, S., Onakpa, M.M. and Owoleke O.E. 2010. Problems and prospects of rabbit production in Botswana – A review. Bayero Journal of Pure and Applied Sciences, 3(2), 20-25. DOI: 10.4314/bajopas.v3i2.63213

14. Metwaly, M.S., Dkhil, M.A., Gewik, M.M., Al-Ghamdy, A.O., Al-Quraishy, S. 2013. Induced metabolic disturbance and growth depression in rabbits infected with Eimeria coecicola. Parasitol Res 112(9):3109–3114.

15. Moreki, J.C., Mpho, K., Manyeula F., 2019. A survey on rabbit production in the city of Gaborone, Botswana. Journal of Animal Science and Veterinary Medicine. 4(3). DOI: 10.31248/JASVM2019.143

16. Ola-Fadunsin, S.D., Nuhu, A.A., Fabiyi, J.P., Sanda, I.M., Hussain, K., Rabiu, M., and Ganiyu, I.A., 2019. Prevalence and associated risk factors of Eimeria species in rabbits (Oryctolagus cuniculus) in Ilorin, Kwara State, Nigeria. Ann of Parasitol, 65(3), 267-273. DOI: 10.17420/ap6503.209

17. Ouertani, E., Dabboussi, I., and Mejri, A. 2016. The development prospects for rabbit sector in Tunisia based on a value chain diagnosis. International Journal of Environmental and Agriculture Research, 2(6), 75-83.

18. Prakashbabu, C.B., Thenmozhi, V., Limon, G., Kundu, K., Kumar, S., Garg, R., and Blake, D.P. 2017. Eimeria species occurrence varies betwwen geographic regions and poultry production systems and may influence parasite genetic diversity. Vet Parasitol, 15(233), 62-72. Doi: 10.1016/j.vetpar.2016.12.003

19. Pritt, S., Cohen, K., and Sedlacek, H. 2012. The Laboratory Rabbit, Guinea Pig, Hamster, and Other Rodents. In Parasitic Diseases (pp. 415-446). England: American College of Laboratory Animal Medicine.

20. Rewatkar, S.G., Deshmukh, S.S., Maske, D. K., and Bhangale, G. N. 2013. Occurrence of Gastrointestinal Helminths in Rabbits with Special Reference to Importance of Giardia spp. as Parasitic Zoonoses. Science, Technology and Arts Research Journa, 2(3), 142-143. DOI: 10.4314/star.v2i3.98754

21. Serem, J., Margaret Wanyoike, M., Gachuiri, C.K, Mailu, S.K., Gathumbi, P.K., Mwanza, R.N., Kiarie, N., Borter, D.K. 2013. Characterization of Rabbit Production Systems in Kenya. Journal of Agricultural Science and Applications 2(3). DOI: 10.14511/jasa.2013.020304

22. Szkucik, K., Pyz-Łukasik, R. and Paszkiewicz W., 2013. Occurrence of gastrointestinal parasites in slaughter rabbits. Parasitology Research volume 113, 59–64

23. Szkucik, K., Pyz-Łukasik, R., Klaudiusz Oktawian Szczepaniak K.O., Paszkiewicz, W., 2013. Occurrence of gastrointestinal parasites in slaughter rabbits. Parasitol Res. 2014; 113(1): 59–64. doi: 10.1007/s00436-013-3625-7

24. Szkucik, K., Pyz-Łukasik, R., Szczepaniak, K.O., and Paszkiewicz, W. 2013. Occurrence of gastrointestinal parasites in slaughter rabbits. Parasitol Res, 113(1), 59-64. DOI: 10.1007/s00436-013-3625-7

25. Thobei, T., Sutarno, S., Komariah, K., 2014. Effects of Climate Change on Crop Production in Thaba-Tseka and Mokhotlong Districts Lesotho Highlands. Journal of Agriculture and Veterinary Science 7(1):3744 DOI: 10.9790/2380-07143744

26. Waly, A.H., Abo El-Azayem, E.H., Younan, G.E., Zedan, A.H., El-Komy, H.M.A., Mohamed, R.A., 2021. Effect of propolis supplementation on growth performance nutrients digestibility carcass characteristics and meat quality of growing New Zealand rabbits. Egypt J Nutr Feeds. 2021; 24:65–73. DOI: 10.21608/ejnf.2021.210779

27. Yin, G., Goraya, M.U., Huang, J., Suo, X., Huang, Z. and Liu, X. 2016. Survey of coccidial infection of rabbits in Sichuan Province, Southwest China. Springerplus, 5(1): 870. Doi: 10.1186/s40064-016-2586-6

28. Zeleke, G., Teshome, M. and Ayele L., 2023. Farmers' livelihood vulnerability to climate-related risks in the North Wello Zone, northern Ethiopia Environmental and Sustainability Indicators. 17. Doi.org/10.1016/j.indic.2022.100220