



Environmental Factors Influence the Infestation of Gastrointestinal Nematodes in Cattle in Aceh Province

Pengaruh faktor lingkungan terhadap infestasi nematoda gastrointestinal pada sapi di Provinsi Aceh

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ABSTRACT. One of the obstacles faced by cattle breeders is the emergence of diseases caused by environmental influences, such as infestation with gastrointestinal nematode worm parasites (digestive tract worms) so that rearing results are non optimal. Due to this, it is necessary to create a model and strategy for controlling diseases that are often affected, especially those caused by environmental conditions, both from the micro environment (climate) and the macro environment (maintenance management) and this is a necessity in order to obtain maximum production and productivity. The goal of this study was to see how environmental conditions affected the presence of gastrointestinal nematode worms in cattle. This study focused on the prevalence and severity of gastrointestinal nematode worm infestation in cattle in Aceh Province's lowland and highland environments. The research was conducted between February-August 2017 in three lowland districts (<200 masl) with a sample 307 tail and three highland districts (>600 masl) with a sample 205 tail. According to the study's findings, topographic variations, wet days, and rainfall all had an impact on the prevalence and degree of gastrointestinal nematode worm infestation in cattle (lowland environments had a higher prevalence and degree of infestation than upland environments ($P<0,05$). In the meantime, lowlands maintenance management seemed riskier than highlands maintenance management ($P<0,01$).

Keyword: Aceh Province, cattle, environment, gastrointestinal nematodes, infestation

ABSTRAK. Salah satu kendala yang dihadapi para peternak sapi adalah munculnya penyakit yang disebabkan pengaruh lingkungan, seperti adanya infestasi parasit cacing nematoda gastrointestinal (cacing saluran pencernaan) sehingga hasil pemeliharaan tidak optimal. Oleh sebab itu, perlu dibuat suatu model dan strategi pengendalian penyakit yang sering terkena dampaknya, terutama yang disebabkan oleh kondisi lingkungan, baik dari lingkungan mikro (iklim) maupun lingkungan makro (manajemen pemeliharaan) dan menjadi suatu keharusan supaya mendapatkan produksi dan produktivitas yang maksimal. Tujuan dari penelitian ini adalah untuk mengetahui pengaruh faktor-faktor di lingkungan terhadap kehadiran cacing nematoda gastrointestinal pada sapi. Secara khusus penelitian ini menganalisis prevalensi dan derajat infestasi cacing nematoda gastrointestinal pada ternak sapi di lingkungan dataran rendah dan dataran tinggi Provinsi Aceh. Penelitian dilaksanakan antara bulan Februari-Agustus 2017 pada tiga kabupaten dataran rendah (<200 mdpl) dengan jumlah sampel 307 ekor dan tiga kabupaten dataran tinggi (>600 mdpl) dengan jumlah sampel 205 ekor. Hasil penelitian menunjukkan bahwa faktor lingkungan seperti perbedaan topografi, hari hujan dan curah hujan berpengaruh terhadap kemunculan cacing nematoda gastrointestinal pada sapi dengan lingkungan dataran rendah lebih tinggi prevalensi dan derajat infestasi daripada dataran tinggi ($P<0,05$). Sementara dari segi manajemen pemeliharaan terlihat sangat berisiko di dataran rendah daripada dataran tinggi ($P<0,01$).

Kata kunci: infestasi, lingkungan, nematoda gastrointestinal, Provinsi Aceh, sapi

INTRODUCTION

Process of raising cattle problems to low production and productivity so that until now the target set by the government has not been achieved. It is estimated that one of the Causes low production and productivity is that there are still many problems with livestock health, especially the emergence of diseases, including those caused by environmental influences in both the microenvironment (climate) and the

macroenvironment (maintenance management) (Aryal *et al.*, 2020). Among them, the high worm infestation in livestock, especially those from the gastrointestinal nematode group, continues to interfere with livestock growth. Such cases are reported epidemiologically in various regions in Indonesia, including in Aceh (Zulfikar *et al.*, 2018).

Aceh Province is currently one of the regions in Indonesia designated by the government as a center for cattle production with Aceh cattle as germplasm, in addition to Bali cattle and Madura cattle. Even so, Aceh Province currently is facing problems related to the development of cattle with low population and

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genetic quality. This is in accordance with the Aceh Dikeswannak report that the development of cattle production in Aceh Province in the last four years is very concerning, where from 2011 to 2014 the decline could reach 17.5%, from a total of 701,284 head in 2011 to 511,362 head in 2014 (BPS Provinsi Aceh; Putra & Nasir, 2015).

This also affects the selling price of livestock and beef, where currently the selling price of cattle and beef in Aceh Province is among the highest in Indonesia. Aceh Province has 23 districts and cities with various different environments (geographic, topography, climate). Currently, cattle raising in Aceh Province is generally more dominated in lowland areas, which account for almost 80% of the total cattle population. Meanwhile, the problem of raising cattle in the lowland environment is more complex than in the highland area, including the development of disease cases caused by the environment that is more prevalent than in the area, including diseases caused by worm-type parasites. So that the production and productivity of the cattle are disrupted (Zulfikar *et al.*, 2018).

This is consistent with the explanation of (Zulfikar *et al.*, 2023), stated that the increase in the spread of disease, especially gastrointestinal nematode parasites in recent years is closely related to climate change in certain areas, namely the survival process and the life stages of gastrointestinal nematodes in certain locations can be influenced by environmental conditions such as temperature, humidity, soil pH, topography, and climate (Tibebu *et al.*, 2018). It can be said that the increase or decrease in gastrointestinal nematodes on cattle farms is generally caused by several environmental factors, including climatic and other microenvironmental factors, including the difference in the number of rainy days that affect the development of cattle production in that location (Marskole *et al.*, 2016).

Several studies conducted in Indonesia and around the world on gastrointestinal worm parasites that attack livestock show that there are differences from one location to another. Several studies have shown that the infestation rate of intestinal worm parasites, both single and mixed, can reach 30%-80% (Hamid *et al.*, 2016; Handayani *et al.*, 2015; Huang *et al.*, 2014; Nugraheni *et al.*, 2018). A similar study conducted by (Fadli *et al.*, 2014), shows that the rate of gastrointestinal nematode infestation can reach 36% of the average raised cattle.

Worm parasites can attack all livestock which has an impact on the nation's economy and

also harms the environment. Worm parasites are also the cause of the decline in cattle body weight by up to 40% and milk production by up to 20%. This occurs due to the absorption of food juices, suck blood and body fluids, eat the body tissue of livestock. These worms also cause damage to intestinal epithelial cells so that they can reduce the ability of the intestine to digest and absorb food substances as well as the production of enzymes that play a role in the digestive process and cause blockage or obstruction so that the digestion process is disturbed (Ermiwati, 2018). Gastrointestinal nematodes also cause various problems such as low body weight gain, mortality in young animals, high medical costs and large economic losses (Yanuartono *et al.*, 2019).

High worm outside the host body can be influenced by among climate change, global temperature increases and maintenance management (Cable *et al.*, 2017). Suboptimal management, low body immunosuppression (Nejash, 2019) and inappropriate environment like regional topography, changes in season, temperature, humidity, rainfall, type of livestock, breed, age and sex (Jones & Garcia, 2018). Poor maintenance management such as poor nutrition, inappropriate housing, overcrowding of livestock in one location, inappropriate health management (Underwood *et al.*, 2020).

The high level of worm infestation is also caused by the intensity of human traffic, the high flow of livestock transactions, the low socio-economic status of breeders, land conversion, high vector populations (Navarro-Gonzalez *et al.*, 2013) and management systems that are still conventional and traditional (Zulfikar *et al.*, 2023). In order to optimize livestock products and optimally overcome the shortage of production supplies, especially in Aceh Province. The government is trying to maximize the performance of cattle farming businesses by taking firm steps to improve and supervise them. These steps include improving policies and draft regulations, in order to improve livestock quality and increase human resource (HR) capacity. The main need in improving maintenance management is to estimate what will happen in livestock management in the future, so that healthy and productive, efficient and optimal livestock can be created (Ermiwati, 2018).

Through an integrated management model involving all supporting elements, livestock can be created including ensuring overall livestock health, so that appropriate and sustainable livestock resources can be realized in order to

meet needs and achieve national food security. Long-term livestock management models are very important, especially for handling strategic diseases that attack livestock and disrupt production, including the high risk of the spread of worms (Anantal *et al.*, 2014; Fox *et al.*, 2012; Pinilla *et al.*, 2018). This strategy includes environmental management of cattle farms from worm attacks in order to maintain sustainable production and productivity. The aim of this research was to analyze the level of gastrointestinal nematode worm infestation in cattle in different environments, specifically between the lowlands and the highlands.

MATERIAL AND METHODS

Materials and Tools

The materials used were cattle feces, soil samples, standing water around the pen, laboratory materials (physiological NaCl, 0.4% formalin), cattle farmer respondents, district maps, provincial maps. The tools used are a set of environmental survey tools (GPS, thermometer, hygrometer (humidity meter), ombrometer (rainfall analysis), pH soil (pH meter). stationery, paperboard, questionnaire sheets, plastic, ice box, plastic basin, laboratory equipment (test tube, petri dishes, measuring cup, scissors, glass objects, glass cover), refrigerator, digital scale, mask, becker glass, chamber Withlok counts, electron microscopes, cameras, markers, pens, computers.

Methodology

This research uses observation methods, field surveys and laboratory examinations. Field observations were carried out to determine environmental conditions at the research location such as topography, temperature, humidity, soil pH and rainfall. Also carried out in terms of maintenance management such as cages, feed, age group and gender. This is done to ensure that the area under study can be considered to influence the development of gastrointestinal nematode worms in cattle. The field survey was conducted to determine problems in the field and then the researcher gave a questionnaire in the form of questions to cattle breeders and animal health workers related to the research objectives. The research was conducted between February 2018 and August 2018 in three lowland districts (< 400 masl) with a sample 307 tail and three highland districts (>400 masl) with a sample 205 tail (Table 1 and Figure 1). Then the cattle feces, muddy soil, puddles around the pen are taken to

the laboratory for inspection in order to determine the level of gastrointestinal nematode presence in the environment.

Data Analysis

To determine the environmental factors that play a role and risk in increasing the prevalence of gastrointestinal nematodes in cattle, it is calculated mathematically using the multilinear regression test (multiple linear regression) as follows:

$$Y = a + b_1X_1 + b_2X_2 + \dots + b_nX_n$$

Information:

Y: Gastrointestinal Nematode Prevalence (Defenden)

a : Constant (Y value if $X_1, X_2..X_n = 0$),

b_1 : Regression coefficient (value increases or decreases)

X_1 : Factor X_1 (Independent)

Furthermore, the measurement of environmental factors associated with the level of risk from the prevalence of gastrointestinal nematodes was analyzed using estimated odds ratios (OR) and continued with the chi-square test.

RESULTS AND DISCUSSION

Identification of Environmental Factors in the Lowland and Highlands Regions of Aceh Province

This research was conducted on cattle farms in the lowlands and highlands of Aceh Province. The lowland region consists of the districts of Aceh Utara, Aceh Timur and Pidie Jaya, while the highlands consist of the districts of Bener Meriah, Aceh Tengah and Gayo Lues. The research location is shown on the map in Figure 1.

The location selection was based on the large number of farms in each district. In addition, the selected area makes it easier for researchers to take samples. Overall data collected from lowland and highland areas is shown in Table 1. The topography of the lowlands is between 19.6-35 meters with an average of 25.1 meters above sea level (masl). The temperature in the plains and upland areas does not differ, namely between 28°C-35°C. Humidity is seen in the lowlands with a higher average percentage (63.6%-71.6%) compared to the upland areas (56%-63.3%). Furthermore, for pH there is no difference between lowland and highland areas ranging from 5.6 to 6. Then for the average rainy day in the lowlands it varies from 137 days per year, and in the highlands the average is around 148 days per

year. The rainfall seen in the lowlands is 1696.7 mm/year and in the highlands it is around 1682 mm per year. Except in Gayo Lues Regency, the

level of rainfall is low in the range of 759 mm/year, even though it is in the highlands.



Figure 1. Map of the research area (■) lowland and (■) the highlands of Aceh Province

Environmental factors are very influential in increasing the prevalence of gastrointestinal nematodes in cattle in the lowlands and highlands. Environmental conditions (topography, temperature, humidity, soil pH, rainy days, rainfall) and samples in the study are shown in

Table 2. These cattle fecal samples were taken and examined at the parasitology laboratory for 307 lowland areas and 205 upland areas. Y= prevalence, X₁= topography X₂= temperature, X₃= humidity, X₄= soil pH, X₅= rainy day, X₆= rainfall as in Table 2.

Table 1. Environmental conditions in the lowlands and highlands

No	Condition	Lowland Region				Highlands Region			
		Aceh Utara	Aceh Timur	Pidie Jaya	Average	Bener Meriah	Aceh Tengah	Gayo Lues	Average
1	Topografi (mdpl)	19.6	20.6	35	25.1	914	1374	865	1051
2	Temperatur (C°)	32	35.3	27.9	31.7	28.4	28.6	31.5	29.5
3	Humidity (%)	68.1	73.6	71.6	71.1	62	56	63.3	60.4
4	soil pH	5.9	5.5	5.6	5.7	5.9	6	5.8	5.9
5	Rainy day (year)	181	111	119	137	141	188	109	146
6	Rainfall (mm/year)	1495	1488	2107	1696.7	1399	2891	757	1682

Table 2. Environmental factors and the prevalence of gastrointestinal nematodes in cattle in the lowlands and highlands

Condition	Sampel	N	Y	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆
Lowland	307	101	32.9	0.321 ^{*)}	0.798	0.880	0.299 ^{*)}	0.090 ^{*)}	0.303 ^{*)}
Highland	205	27	13.2	0.551	0.619	0.714	0.681	0.570	0.766 ^{**)}

Notes: ^{*)}sig (P<0.05) and ^{**)} non sig. (P>0.05), Y= Prevalence, X₁= Topography X₂= Temperature, X₃= Humidity, X₄= Soil pH, X₅= Rainy Day, X₆= Rainfall

Based on the results of observations and data collection, it is known that the prevalence rate of gastrointestinal nematodes in cattle in the lowlands is around 32.9%, while the prevalence compared to the highlands is around 13,2 %. From the data obtained after being linked with environmental factors that affect prevalence a multiple regression analysis was then performed. In the lowlands with a prevalence rate of 32.9%, topographic factors (sig 0.321), rainy days (sig

0.090) and rainfall (sig 0.303) have a significant effect (P <0.05) on the increase in gastrointestinal nematodes in cattle, while other environments such as temperature, humidity and soil pH did not affect the increase in gastrointestinal nematodes in cattle (P> 0.05). While for the highlands, it seems that none of the environmental factors have an effect on the increase in gastrointestinal nematodes in cattle.

Previous research based on region was carried out, where the highest prevalence rate was in the lowlands (July District, Bireuen Regency) at 66% and the lowest was in the highlands (Pintu Rime Gayo District, Bener Meriah Regency) at 22% (Zulfikar *et al.*, 2018). Changes in environmental conditions can result in and influence the high incidence of disease animals, humans and plants throughout the world, including in Indonesia. The increase and spread of disease, especially gastrointestinal nematode parasites in cattle in recent years is closely related to climate change, including the height of the area and the process of survival and the freedom of gastrointestinal nematodes in the environment is strongly influenced by temperature and humidity, topography and other climates (Bautista *et al.*, 2022; Tibebu *et al.*, 2018). The development of gastrointestinal nematode larvae in cattle pastures during seasonal changes will not occur if temperature, humidity, soil pH and rainfall are not suitable.

Subsequent analyses were carried out to calculate the prevalence rate by determining the confidence interval (CI) and the level of risk (Odd Ratio-OR) of gastrointestinal nematodes between the lowlands and the highlands. in lowland areas, 101 samples were positive with a prevalence of 32.9% (CI 27.68-38.34). Whereas in the

highlands, 27 samples were positive with a prevalence of 13.2% (CI: 9.21-18.48). The mean prevalence results showed that the lowlands were higher than the highlands, indicating that there was a significant difference ($P < 0.01$) between these regions.

Meanwhile, for the CI and OR of gastrointestinal nematodes on farms in each region, in the lowlands such as North Aceh District there were 33 positives with a prevalence of 24.63% (CI: 18.11-32.56), in Pidie Jaya District there were 80 samples. There were 33 positive samples with a prevalence of 41.3%; (CI: 31.11-52.2) and in East Aceh District, from the 93 samples there were 35 positive samples with a prevalence of 37.23% (CI: 28.14-47.33). These results show that the cattle- raising model in Pidie Jaya is more risky than in North Aceh and East Aceh. Whereas for the highland area of Bener Meriah Regency, out of 72 samples of faeces, 8 samples were positive with a prevalence of 11.11% (CI: 1.11-52.2). 3.13-15.87). While in Gayo Lues District, out of 64 fecal samples, 14 samples were positive with a prevalence of around 23.4% (CI 13.5-33.43) based on prevalence figures indicating that cattle raising in Gayo Lues is more risky than maintenance in Central Aceh and Bener Meriah. These results can be seen in Figure 2.

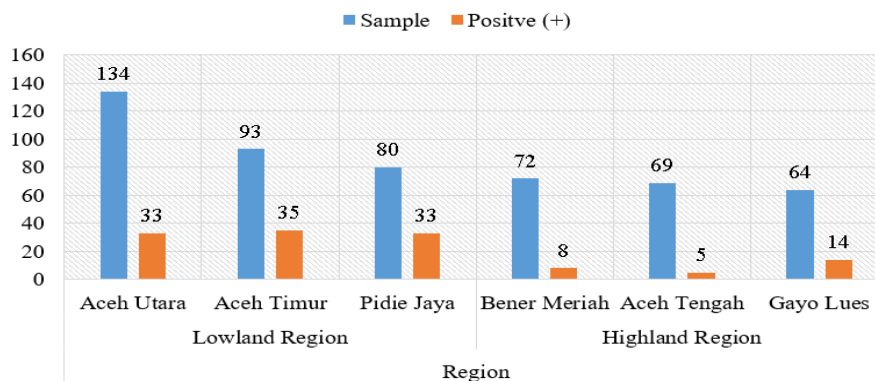


Figure 2. Samples by region

The results of the prevalence between regions are then continued with the complexity of the formulation of the Odds Ratio (OR) test to see the level of risk for gastrointestinal nematodes by region. The comparison of the risk level for gastrointestinal nematodes based on the regional odds ratio (OR) test showed that the management of cattle rising in the lowlands was more risky than in the highlands with a range of 3.38 (CI: 2.1-5.43). So livestock raising is associated with poorer health management in the lowlands than in

the highlands. This result is based on a significant level showing a very significant difference ($P < 0.01$) in the management of livestock especially in health management.

Various types of nematodes that infect ruminants and their cosmopolitan distribution occur in various geographic locations and in the appropriate climates and seasons throughout the year. However, there are certain types that are only found in certain environments (Kitagami *et al.*, 2017). Previous research has explained that

parasitic worm infestations in livestock can be caused by various factors, including geographical location, environmental conditions, cage quality, sanitation and hygiene, cage density, temperature, humidity and vegetation (Weingartz, 2017; Zvinorova *et al.*, 2016).

CONCLUSION

The study's findings, the prevalence of gastrointestinal nematodes in the lowlands at 32.9% and the highlands 13.2%. Environmental factors such as topography (sig 0.321), rainy days (sig 0.090), and rainfall (sig 0.303) have a significant effect on the increase in the prevalence of gastrointestinal nematodes in cattle, especially for rearing in lowland areas and have a significant ($P < 0.05$). The odds ratio (OR) test revealed that managing cattle in the lowlands was risky than managing cattle in the highlands, with a range of 3.38 (CI: 2.1-5.43) and a very significant difference ($P < 0.01$), and maintenance management elements had a big influence on animal health services and insufficient nourishment.

REFERENCES

- Anantal, S. M., Suharno, Hidayat, A., & Matsubayashi, M. (2014). Survey on gastrointestinal parasites and detection of *Cryptosporidium* spp. on cattle in West Java, Indonesia. *Asian Pacific Journal of Tropical Medicine*, 7(3), 197–201. [https://doi.org/10.1016/S1995-7645\(14\)60020-1](https://doi.org/10.1016/S1995-7645(14)60020-1).
- Aryal, J. P., Sapkota, T. B., Khurana, R., Khatri-Chhetri, A., Rahut, D. B., & Jat, M. L. (2020). Climate change and agriculture in South Asia: adaptation options in smallholder production systems. In *Environment, Development and Sustainability* (Vol. 22, Issue 6). Springer Netherlands. <https://doi.org/10.1007/s10668-019-00414-4>.
- Bautista-Garfias, C. R., Castañeda-Ramírez, G. S., Estrada-Reyes, Z. M., Soares, F. E. de F., Ventura-Cordero, J., González-Pech, P. G., Morgan, E. R., Soria-Ruiz, J., López-Guillén, G., & Aguilar-Marcelino, L. (2022). A Review of the Impact of Climate Change on the Epidemiology of Gastrointestinal Nematode Infections in Small Ruminants and Wildlife in Tropical Conditions. *Pathogens*, 11(2). <https://doi.org/10.3390/pathogens11020148>.
- BPS Provinsi Aceh. 2015. *Aceh Dalam Angka 2015*.
- Cable, J., Barber, I., Boag, B., Ellison, A. R., Morgan, E. R., Murray, K., Pascoe, E. L., Sait, S. M., Wilson, A. J., & Booth, M. (2017). Global change, parasite transmission and disease control: Lessons from ecology. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 372(1719). <https://doi.org/10.1098/rstb.2016.0088>.
- Ermiwati. (2018). *Efektivitas closantel Dan Albendazole Terhadap Parasit Gastrointestinal Dengan Dosis Standar Pada Sapi Balidi Lombok Barat*.
- Fadli, M., Oka, I. B. M., & Suratna, N. A. (2014). Prevalensi Nematoda Gastrointestinal pada Sapi Bali yang Dipelihara. *Indonesia Medicus Veterinus*, 3(5), 411–422.
- Fox, N. J., Marion, G., Davidson, R. S., White, P. C. L., & Hutchings, M. R. (2012). Livestock helminths in a changing climate: Approaches and restrictions to meaningful predic. *Animals*, 2(1), 93–107. <https://doi.org/10.3390/ani2010093>.
- Hamid, P. H., Kristianingrum, Y. P., Prastowo, J., & Da Silva, L. M. R. (2016). Gastrointestinal parasites of cattle in central Java. *American Journal of Animal and Veterinary Sciences*, 11(3), 119–124. <https://doi.org/10.3844/ajavsp.2016.119.12>.
- Handayani, P., Santosa, P. E., & Siswanto. (2015). Tingkat Infestasi Cacing Saluran Pencernaan Pada Sapi Bali Di Kecamatan Sukoharjo Kabupaten Pringsewu Provinsi (Lampung Infestation Rate of The Digestive Fluke on Bali Cattle in Sukoharjo Sub-district Pringsewu District Lampung Province). *Jurnal Ilmiah Peternakan Terpadu*, 3(3), 127–133.
- Huang, C. C., Wang, L. C., Pan, C. H., Yang, C. H., & Lai, C. H. (2014). Investigation of gastrointestinal parasites of dairy cattle around Taiwan. *Journal of Microbiology, Immunology and Infection*, 47(1), 70–74. <https://doi.org/10.1016/j.jmii.2012.10.004>.
- Jones, K. R., & Garcia, G. W. (2018). Gastrointestinal Parasites Found in

- Domesticated Animals Introduced Into the Neo-Tropics (New World Tropics). *Concepts of Dairy & Veterinary Sciences*, 1(2), 51–67. <https://doi.org/10.32474/cdvs.2018.01.000110>.
- Kitagami, Y., Kanzaki, N., & Matsuda, Y. (2017). Distribution and community structure of soil nematodes in coastal Japanese pine forests were shaped by harsh environmental conditions. *Applied Soil Ecology*, 119(May), 91–98. <https://doi.org/10.1016/j.apsoil.2017.05.03>.
- Marskole, P., Verma, Y., Dixit, A. K., & Swamy, M. (2016). Prevalence and burden of gastrointestinal parasites in cattle and buffaloes in Jabalpur, India. *Veterinary World*, 9(11), 1214–1217. <https://doi.org/10.14202/vetworld.2016.1214-1217>.
- Navarro-Gonzalez, N., Fernández-Llario, P., Pérez-Martín, J. E., Mentaberre, G., López-Martín, J. M., Lavín, S., & Serrano, E. (2013). Supplemental feeding drives endoparasite infection in wild boar in Western Spain. *Veterinary Parasitology*, 196(1–2), 114–123. <https://doi.org/10.1016/j.vetpar.2013.02.01>.
- Nejash, A. (2019). Impact of Climate Change on Livestock- A Review. *International Journal of Current Microbiology and Applied Sciences*, 8(05), 1710–1719. <https://doi.org/10.20546/ijcmas.2019.805.198>.
- Nugraheni, Y. R., Priyowidodo, D., Prastowo, J., Rohayati, E. S., Sahara, A., & Awaludin, A. (2018). Parasit Gastrointestinal pada Sapi di Daerah Aliran Sungai Progo Yogyakarta. *Jurnal Ilmu Peternakan Terapan*, 1(2), 46–50. <https://doi.org/10.25047/jipt.v1i2.889>.
- Pinilla, J. C., Flórez, P., Sierra, M. T., Morales, E., Sierra, R., Vásquez, M. C., Tobon, J. C., Sánchez, A., & Ortiz, D. (2018). Point prevalence of gastrointestinal parasites in double purpose cattle of Rio de Oro and Aguachica municipalities, Cesar state, Colombia. *Veterinary Parasitology: Regional Studies and Reports*, 12(December 2017), 26–30. <https://doi.org/10.1016/j.vprsr.2018.01.003>.
- Putra, H., & Nasir, M. (2015). Analisis Faktor-Faktor Yang Mempengaruhi Produksi Sektor Pertanian di Propinsi Aceh. *Jurnal Ilmu Ekonomi*, 16(1), 53–60.
- Tibebu, A., Tamiru, Y., & Abdeta, D. (2018). Prevalence of Major Gastrointestinal Nematode and Degree of Parasite Infestation in Sheep of Bako Agricultural Research Center Community Based Breeding Program Project Small Holder Farms at Horro District. *Journal of Dairy & Veterinary Sciences*, 8(3). <https://doi.org/10.19080/jdvs.2018.08.555740>
- Underwood, W. J., Ruth Blauwiekel, Delano, Gillesby, M. L., Scott A. Mischler, & Schoell, A. (2020). Biology and Diseases of Ruminants (Sheep, Goats, and Cattle). In *Sustainability (Switzerland)* (pp. 623–692). <http://www.unpcdc.org/media/15782/sustainable-practice.pdf> <https://europa.eu/capacity4dev/unep/document/briefing-note-sustainable-public-procurement%0Ahttps://europa.eu/capacity4dev/unep/document/briefing-note-sustainable-public-procurement%0Ahttp://www.hpw.qld.gov.au/SiteCollectionDocuments/ProcurementGuideIntegratingSustainability>
- Weingartz, C. R. (2017). *ScholarWorks @ UARK A Study of the Prevalence of Gastrointestinal Nematodes in Goats Obtained from Northwest Arkansas*.
- Zulfikar, Umar, S., Ferasyi, T. R., & Tafsir, M. (2018). Association of Infestation of Gastrointestinal Nematode With Altitudes of Location of Cattle Raising in Two Different Districts in Aceh Province. *IJTVBR*, 03(01), 30–34.
- Zulfikar, Z., Umar, S., Ferasyi, T. R., & Tafsir, M. (2023). Developing a model for predicting the dynamics of cattle infestation by gastrointestinal nematodes in Aceh Province, Indonesia. *Asia-Pacific Journal of Science and Technology*, 28(1), 1–9.
- Zvinorova, P. I., Halimani, T. E., Muchadeyi, F. C., Matika, O., Riggio, V., & Dzama, K. (2016). Prevalence and risk factors of gastrointestinal parasitic infections in goats in low-input low-output farming systems in Zimbabwe. *Small Ruminant Research*, 143, 75–83. <https://doi.org/10.1016/j.smallrumres.2016.09.005>