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Health Management in Livestock Production in Sub Saharan Countries

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Abstract

Purpose: The general objective of this study was to explore health management in livestock production in Sub Saharan countries.

Methodology: The study adopted a desktop research methodology. Desk research refers to secondary data or that which can be collected without fieldwork. Desk research is basically involved in collecting data from existing resources hence it is often considered a low cost technique as compared to field research, as the main cost is involved in executive's time, telephone charges and directories. Thus, the study relied on already published studies, reports and statistics. This secondary data was easily accessed through the online journals and library.

Findings: The findings revealed that there exists a contextual and methodological gap relating to health management in livestock production in Sub Saharan countries. Preliminary empirical review revealed that the health management of livestock in Sub-Saharan Africa is a complex and multifaceted endeavor, influenced by a range of factors including limited access to veterinary services, inadequate nutrition management, and the effectiveness of disease control measures.

Unique Contribution to Theory, Practice and Policy: The One Health theory, Theory of Planned Behaviour and the Diffusion of Innovations theory may be used to anchor future studies relating to livestock production. The study recommends for enhancing access to veterinary services, promoting knowledge, scaling up vaccination efforts, improving nutrition management, strengthening biosecurity measures, using gender sensitive approaches and investing in disease surveillance and rapid response.

Keywords: *Livestock Health, Health Management Practices, Sub-Saharan Countries, Livestock Disease Control, Agricultural Livelihoods*

1.0 INTRODUCTION

Livestock health is a crucial aspect of animal agriculture in the USA, as it directly impacts the well-being of animals and the economic viability of the livestock industry. The health of livestock refers to the overall condition and disease status of animals raised for various purposes, including meat, milk, and fiber production. It encompasses a range of factors, such as physical health, reproductive health, and freedom from diseases and injuries. Ensuring livestock health is not only essential for animal welfare but also for maintaining food safety and security (Smith & Johnson, 2019)

In the USA, livestock health is closely monitored and managed to meet high production standards. According to data from the United States Department of Agriculture (USDA), the prevalence of certain livestock diseases has been decreasing over the years due to effective health management practices. For example, the incidence of bovine tuberculosis (TB) in cattle has significantly decreased, with less than 1% of cattle testing positive for TB in recent years (USDA, 2020). This reflects the success of disease surveillance and control programs.

Another example is the reduction in the prevalence of brucellosis in cattle herds. Brucellosis is a contagious disease that can impact cattle reproductive health and human health. The USDA reports that the number of brucellosis-infected cattle herds has declined over the past few decades, with the disease being nearly eradicated from commercial cattle herds (USDA, 2021). These statistics highlight the effectiveness of health management practices in the USA's livestock industry in reducing the prevalence of significant diseases. Continued efforts in disease surveillance, vaccination, biosecurity measures, and nutrition management contribute to maintaining and improving livestock health. Furthermore, ongoing research and innovation in veterinary medicine and animal science play a pivotal role in safeguarding the health of livestock, promoting animal welfare, and ensuring a sustainable and resilient livestock industry.

Livestock health in the United Kingdom (UK) is a critical aspect of agriculture and food production. It encompasses the physical, mental, and social well-being of animals raised for various purposes, including meat and dairy production, as well as other livestock-related industries. Ensuring livestock health is essential not only for animal welfare but also for maintaining food security and the sustainability of the agricultural sector. According to Smith, Jones & Brown (2019), the UK has witnessed several trends in livestock health over the past decade. One notable trend is the significant reduction in the prevalence of specific diseases through rigorous disease control programs. For example, the incidence of bovine tuberculosis (bTB) has been a major concern in the UK, with efforts to control the disease showing positive results. Between 2013 and 2018, there was a decrease in the number of new bTB incidents in cattle by approximately 45%, reflecting the success of measures such as cattle testing and movement restrictions.

Furthermore, the implementation of improved biosecurity measures on livestock farms has been associated with a reduction in the incidence of contagious diseases. For instance, the introduction of stricter biosecurity protocols has led to a decline in the occurrence of foot-and-mouth disease (FMD). Statistics from the Department for Environment, Food & Rural Affairs (DEFRA) indicate that there have been no reported cases of FMD in the UK since the outbreak in 2007, highlighting the effectiveness of biosecurity measures in safeguarding livestock health. Despite these positive trends, challenges persist in livestock health. The UK faces issues related to antimicrobial resistance (AMR), with the overuse of antibiotics in livestock farming being a concern. According to Russo & Scholes (2018) an increase in antibiotic prescriptions for livestock between 2013 and 2017. This underscores the need for continued efforts to promote responsible antibiotic use and develop alternative disease management strategies that reduce the reliance on antibiotics. In conclusion, livestock health in the UK has seen notable improvements in disease control and biosecurity practices, resulting in a decrease

in the prevalence of diseases such as bTB and FMD. However, challenges like antimicrobial resistance persist, emphasizing the importance of responsible antibiotic use and ongoing research to address these issues. Livestock health remains a critical component of the UK's agricultural sector, impacting animal welfare, food production, and public health.

Livestock health is a critical component of agricultural systems worldwide, encompassing the well-being and disease management of various domesticated animals, including cattle, poultry, swine, and more. In Japan, livestock health plays a pivotal role in sustaining the country's agricultural industry, which contributes significantly to its economy. According to Tanaka, Goto, Kamata, Ito, Ishige, Nakamura, M., & Otsu (2018, Japan has been actively monitoring and improving livestock health, with a focus on disease prevention and biosecurity measures. One prominent example of this commitment to livestock health is Japan's efforts in addressing avian influenza (AI) outbreaks.

Japan has experienced several avian influenza outbreaks in the past decade, leading to significant economic losses and posing a risk to both poultry and human health. The Japanese government, in collaboration with the poultry industry, has implemented stringent biosecurity measures, including quarantine protocols and vaccination campaigns. These measures have been effective in controlling AI outbreaks. Statistics from the Ministry of Agriculture, Forestry, and Fisheries (MAFF) of Japan indicate a decline in the number of AI outbreaks over the years, highlighting the success of these interventions. In 2015, Japan reported 278 AI outbreaks, while in 2019, this number reduced to just 32 outbreaks (MAFF, 2019).

Another critical aspect of livestock health in Japan is the management of livestock diseases such as foot-and-mouth disease (FMD). According to Hayama, Muroga, Nishida, & Tsutsui (2017).published in the Journal of Veterinary Medical Science, highlights Japan's proactive vaccination strategy to control FMD. The research reports that Japan has maintained a high vaccination coverage rate among cattle, contributing to the absence of FMD outbreaks in the country since 2010. This demonstrates the effectiveness of vaccination as a preventive measure for livestock diseases in Japan.

In conclusion, livestock health in Japan is a multifaceted area of concern, with a strong emphasis on disease prevention and biosecurity measures. Statistics from sources like the Ministry of Agriculture, Forestry, and Fisheries highlight positive trends in disease control, such as the reduction in avian influenza outbreaks. Additionally, research studies, including the one by Tanaka et al. (2018) and Hayama et al. (2017), illustrate the importance of proactive health management practices, including vaccination campaigns, in maintaining the well-being of livestock populations in Japan.

Livestock health is a critical component of agricultural systems in Sub-Saharan Africa, where millions of people rely on livestock for their livelihoods and food security. Livestock play a pivotal role in the region's economy, providing income through sales of meat, milk, and other animal products. However, the health of these animals is often threatened by various factors, including infectious diseases, malnutrition, and inadequate veterinary services. According to a study by Mariner et al. (2016), Sub-Saharan Africa faces significant challenges in maintaining livestock health due to limited resources and infrastructure.

One of the major concerns in Sub-Saharan Africa is the prevalence of infectious diseases that affect livestock. For instance, East Coast fever, a tick-borne disease, is a significant threat to cattle in the region. In Tanzania, approximately 9 million cattle were at risk of contracting East Coast fever, leading to significant economic losses (Chema, Komba, Shirima & Mantip, 2019). Moreover, trypanosomiasis, a parasitic disease transmitted by tsetse flies, has a devastating impact on livestock in countries like Uganda and Kenya, with millions of cattle and other livestock at risk (Shaw, Torr, Waiswa, Cecchi, Wint, Mattioli & Robinson, 2017).

Nutrition plays a critical role in livestock health. In Sub-Saharan Africa, inadequate access to nutritious forage and supplements can lead to malnutrition among animals. According to Phiri, Phiri & Ziela (2015), in Malawi, a lack of proper nutrition resulted in high mortality rates among young goats and sheep. Malnourished livestock are more susceptible to diseases, and their overall productivity is compromised. Access to veterinary services is another crucial factor in livestock health. In many Sub-Saharan African countries, there is a shortage of trained veterinarians and limited access to veterinary clinics and medications. According to Garine-Wichatitsky, Caron, Kock, Tschopp, Munyeme, Hofmeyr & Michel (2018) in Zimbabwe found that only a small percentage of cattle owners sought veterinary care for their animals, often due to financial constraints and limited availability of veterinary services.

Livestock health in Sub-Saharan Africa is influenced by a complex interplay of factors, including disease prevalence, nutrition, and access to veterinary services. These challenges have significant economic and food security implications for the region. Addressing livestock health issues in Sub-Saharan Africa requires holistic strategies that include improved disease control measures, better nutrition management, and increased access to veterinary care. Policymakers, researchers, and international organizations need to collaborate to develop and implement effective interventions to enhance livestock health and, by extension, the well-being of the communities that depend on these animals for their livelihoods.

Health management practices encompass a range of strategies and actions aimed at preserving and improving the well-being of individuals or populations. In the context of livestock health, health management practices refer to the systematic approaches and interventions implemented to maintain the health of animals in agricultural systems. These practices are crucial for ensuring the productivity, sustainability, and welfare of livestock populations (Girard and McEwen, 2018).

One essential aspect of health management practices in livestock production is vaccination protocols. Vaccinations are administered to animals to protect them against specific diseases. For example, in poultry farming, routine vaccinations against diseases like Newcastle disease and avian influenza are critical (Dorea, Cole, Hofacre, Zamperini, Mathis & Doyle (2019). Proper vaccination schedules and coverage can significantly reduce disease incidence and prevent outbreaks, contributing to overall livestock health.

Biosecurity measures are another vital component of health management in livestock. These measures involve practices to prevent the introduction and spread of diseases within and between farms. In the case of livestock, implementing strict biosecurity protocols, such as controlling the movement of animals, disinfection, and quarantine measures, can help mitigate the risk of disease transmission (Bjornsdottir, Gudmundsdotti & Kristinsson, 2018). Effective biosecurity practices are essential in safeguarding livestock health and minimizing economic losses.

Nutrition management plays a pivotal role in maintaining livestock health. Providing animals with balanced diets that meet their nutritional requirements is essential. Malnutrition can weaken animals' immune systems, making them more susceptible to diseases. For example, in ruminant production, ensuring proper forage quality and supplementation can prevent nutritional deficiencies and related health issues (Hassanpour, Torshizi & Boldaji, 2019). Nutrition management practices are integral to enhancing the overall health and productivity of livestock.

Regular monitoring of livestock health is a fundamental health management practice. Veterinarians and livestock producers routinely assess the health status of animals through clinical examinations and diagnostic tests. Early detection of diseases allows for timely intervention, reducing the severity of outbreaks. For instance, in dairy farming, routine health checks and monitoring of milk quality help

identify issues like mastitis early on (Laven & Lawrence, 2018). Monitoring and early detection are essential components of proactive health management strategies.

Access to veterinary services and knowledge transfer is crucial in implementing effective health management practices in livestock. Veterinarians provide expertise in disease diagnosis, treatment, and prevention. Additionally, knowledge transfer programs and extension services facilitate the dissemination of best practices among livestock producers. Ensuring that farmers have access to veterinary care and knowledge resources is essential for the successful implementation of health management practices (Muma, Samui, Siamudaala, Oloya, Matope, Omer & Munyeme, 2019).

1.1 Statement Problem

The health management of livestock in Sub-Saharan countries is a critical issue, given the region's heavy reliance on livestock for livelihoods and food security. According to recent statistics from the Food and Agriculture Organization (FAO), livestock production contributes significantly to the agricultural GDP of Sub-Saharan Africa, with millions of households depending on livestock for their income and nutrition (FAO, 2021). However, there is a notable gap in our understanding of the specific challenges and strategies related to health management in this context. This study aims to fill this gap by investigating the current state of health management practices in Sub-Saharan African countries and identifying the key factors affecting livestock health, including disease prevalence, nutrition, access to veterinary services, and the effectiveness of disease control measures. The target audience for this study includes policymakers, veterinary professionals, livestock producers, and researchers interested in improving livestock health and the overall well-being of communities dependent on livestock. The study intends to provide evidence-based recommendations and strategies to enhance health management practices in Sub-Saharan countries, ultimately contributing to increased livestock productivity, reduced disease burdens, and improved food security in the region.

2.0 LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 One Health Theory

One Health is a concept that recognizes the interconnectedness of human, animal, and environmental health. It emphasizes the interdependence of these three domains and the need for a collaborative and holistic approach to health management. The One Health concept has evolved over time, but it has been championed by various organizations, including the World Health Organization (WHO), the Food and Agriculture Organization (FAO), and the World Organisation for Animal Health (OIE). One Health is highly relevant to the study of health management in livestock production in Sub-Saharan countries because it underscores the importance of considering not only the health of the animals themselves but also the potential impacts on human health and the environment. Livestock-related diseases can have zoonotic potential, meaning they can be transmitted from animals to humans, making a One Health approach crucial for disease control and overall health management in livestock populations (FAO, OIE, & WHO, 2018).

2.1.2 Theory of Planned Behavior

The Theory of Planned Behavior, developed by Icek Ajzen, focuses on the role of individual attitudes, subjective norms, and perceived behavioral control in influencing intentions and behaviors. It suggests that individuals are more likely to engage in a behavior if they have a positive attitude toward it, perceive that others expect them to do it, and believe they have control over it. The Theory of Planned Behavior was proposed by Icek Ajzen in 1985. This theory is relevant to the study of health management in livestock production in Sub-Saharan countries as it can help explain the motivations and intentions of livestock producers and veterinarians regarding health management practices.

Understanding the factors that influence their attitudes and perceptions toward practices like vaccination, biosecurity, and nutrition can inform interventions aimed at improving livestock health management (Ajzen, 1985).

2.1.3 Diffusion of Innovations Theory

The Diffusion of Innovations Theory, developed by Everett Rogers, explores how new ideas, practices, or innovations spread through a population over time. It identifies different categories of adopters (innovators, early adopters, early majority, late majority, and laggards) and factors influencing the adoption and diffusion of innovations. The Diffusion of Innovations Theory was developed by Everett Rogers in 1962. In the context of health management in livestock production in Sub-Saharan countries, this theory can help analyze the adoption and dissemination of innovative health management practices, such as new vaccination techniques, disease control strategies, or nutritional interventions. By understanding the factors that influence the acceptance and adoption of these innovations within the livestock industry, researchers and policymakers can tailor their efforts to promote more effective and widespread implementation (Rogers, 1962).

2.2 Empirical Review

Dwomoh, Amegbor & Nutsugah (2017) evaluated the exiting health management practices in smallholder farms in Ghana. A cross-sectional survey was conducted among 300 smallholder farmers. Data were collected through structured interviews and observations. The study found that a lack of access to veterinary services, limited knowledge about disease prevention, and inadequate nutrition management were significant challenges. Many farmers relied on traditional remedies due to limited resources. The study recommended improving access to veterinary services, providing training on modern health management practices, and promoting the use of vaccines and improved nutrition

Oluwayelu, Omowunmi & Jegede (2016) investigated the implementation of biodiversity measures and their impact on disease control in commercial poultry farms in Nigeria. A mixed-methods approach, including surveys and on-farm assessments, was used to collect data from 50 poultry farms. The study found that while some biosecurity measures were in place, there were gaps in implementation. Farms with better biosecurity practices had lower disease incidence. Challenges included inadequate biosecurity knowledge and resource constraints. The study recommended training programs for poultry farmers on biosecurity, improved farm infrastructure, and access to veterinary support

Makungu, Sallu & Ndossi (2019) evaluated the effectiveness of vaccination programs in reducing the prevalence of common livestock diseases in Tanzania. A longitudinal study was conducted in three regions of Tanzania, tracking disease prevalence and vaccination coverage over a three-year period. The study demonstrated a significant reduction in disease prevalence in areas with higher vaccination coverage. Vaccination programs were found to be a cost-effective way to improve livestock health. The study recommended scaling up vaccination efforts, especially in remote areas, and strengthening monitoring and evaluation systems

Njau, Kaima & Mbugua (2017) examined the nutritional management practices and their influence on the health and productivity of dairy cattle in Kenya. Data were collected through surveys and on-farm assessments of 100 dairy farms in different regions of Kenya. The study revealed that many farms lacked proper nutrition management practices, leading to suboptimal milk production and increased disease susceptibility. Inadequate knowledge of nutritional requirements was a key challenge. The study recommended farmer training on nutrition management, access to balanced feed, and improved record-keeping.

Alemu, Yigzaw & Mengistie (2018) assessed the accessibility of veterinary services and their impact on the health and productivity of livestock in Ethiopia. A combination of surveys, interviews, and focus group discussions were conducted with livestock farmers in different regions of Ethiopia. The study found that limited access to veterinary services hindered timely disease diagnosis and treatment. Farmers in remote areas faced the most significant challenges. The study recommended expanding the coverage of veterinary services, especially in rural and underserved areas, and training community animal health workers

Nakirya, Mogoa & Nalule (2018) explored the involvement of women in livestock health management and their contributions to the wellbeing of livestock in Uganda. Qualitative data were collected through interviews and focus group discussions with women in various livestock-keeping communities. The study highlighted the significant role of women in daily animal care, disease detection, and treatment. However, women often faced challenges in accessing veterinary services and resources. The study recommended gender-sensitive interventions, training programs, and increased support for women's participation in livestock health management.

Perry, Randolph, McDermott, Sones & Thornton (2017) assessed the economic consequences of disease ouybreaks on livestovk production in West African countries. A combination of economic modeling and data collection from affected regions was used to estimate the costs of disease outbreaks. The study demonstrated that disease outbreaks had substantial economic impacts, including reduced livestock productivity, increased veterinary costs, and trade restrictions. Smallholder farmers were particularly vulnerable. The study recommended investments in disease surveillance, emergency response plans, and capacity building for rapid outbreak containment.

3.0 METHODOLOGY

The study adopted a desktop research methodology. Desk research refers to secondary data or that which can be collected without fieldwork. Desk research is basically involved in collecting data from existing resources hence it is often considered a low cost technique as compared to field research, as the main cost is involved in executive's time, telephone charges and directories. Thus, the study relied on already published studies, reports and statistics. This secondary data was easily accessed through the online journals and library.

4.0 FINDINGS

This study presented both a contextual and methodological gap. A contextual gap occurs when desired research findings provide a different perspective on the topic of discussion. For instance, Perry, Randolph, McDermott, Sones & Thornton (2017) assessed the economic consequences of disease outbreaks on livestock production in West African countries. A combination of economic modeling and data collection from affected regions was used to estimate the costs of disease outbreaks. The study demonstrated that disease outbreaks had substantial economic impacts, including reduced livestock productivity, increased veterinary costs, and trade restrictions. Smallholder farmers were particularly vulnerable. The study recommended investments in disease surveillance, emergency response plans, and capacity building for rapid outbreak containment. Our current study on the other hand is on health management in livestock production in sub Saharan countries.

Secondly, a methodological gap also presents itself, for example, in their study on the economic consequences of disease outbreaks on livestock production in West African countries; Perry, Randolph, McDermott, Sones & Thornton (2017) used a combination of economic modelling and data collection from affected areas to estimate the costs of disease outbreaks. Whereas, our study adopted a desktop research method in exploring health management in livestock production in Sub Saharan countries.

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In conclusion, the study on health management in livestock production in Sub-Saharan countries sheds light on critical issues and challenges that have significant implications for the well-being of livestock populations, food security, and the livelihoods of communities dependent on animal agriculture. Through the examination of various empirical studies conducted in the region, it becomes evident that the health management of livestock in Sub-Saharan Africa is a complex and multifaceted endeavor, influenced by a range of factors including limited access to veterinary services, inadequate nutrition management, and the effectiveness of disease control measures.

These studies have highlighted the importance of adopting a holistic approach to livestock health management that encompasses not only the treatment of diseases but also proactive measures such as vaccination, biosecurity practices, and proper nutrition. The role of women in livestock health management has also been recognized, emphasizing the need for gender-sensitive interventions and support. Furthermore, the economic consequences of disease outbreaks in livestock have been made evident, underlining the urgency of investing in disease surveillance, rapid response strategies, and capacity building in the region. This is particularly crucial for smallholder farmers who are often the most vulnerable to the impacts of livestock diseases.

To address these challenges and enhance the health management of livestock in Sub-Saharan countries, a collaborative effort among governments, international organizations, researchers, and local communities is imperative. Implementing evidence-based recommendations such as improving access to veterinary services, providing training programs, and promoting biosecurity measures will contribute to the overall health and productivity of livestock, thus benefiting both the agricultural sector and the well-being of the broader population.

In the face of the dynamic and evolving nature of livestock health challenges, continued research, monitoring, and adaptation of strategies will be essential to ensure sustainable and resilient livestock production systems in Sub-Saharan Africa. By addressing these issues comprehensively and proactively, there is an opportunity to not only improve the health and welfare of livestock but also contribute to food security, poverty reduction, and the economic development of the region.

5.2 Recommendations

Enhance access to veterinary services: Governments and relevant stakeholders should prioritize efforts to increase the accessibility of veterinary services, particularly in rural and remote areas where smallholder farmers often face the greatest challenges. This includes establishing mobile veterinary clinics, training community animal health workers, and providing incentives to veterinarians to work in underserved regions.

Promote knowledge transfer and training: Comprehensive training programs should be developed and implemented to educate livestock producers on modern health management practices. These programs should cover topics such as vaccination protocols, biosecurity measures, nutrition management, and disease prevention strategies. Extension services, farmer field schools, and information campaigns can play a crucial role in disseminating knowledge.

Scale up vaccination efforts: Vaccination programs have been shown to be effective in reducing the prevalence of livestock diseases. Governments and organizations should scale up vaccination efforts, especially in areas prone to disease outbreaks. Ensuring the availability of vaccines and conducting regular vaccination campaigns can significantly improve disease control.

Improve nutrition management: Livestock nutrition is essential for health and productivity. Livestock farmers should be encouraged to provide balanced diets that meet the nutritional requirements of their animals. This may involve promoting the cultivation of nutritious forage crops and the use of appropriate supplements. Training and guidance on nutrition management should be widely available.

Strengthen biosecurity measures: Effective biosecurity measures can prevent the introduction and spread of diseases on farms. Livestock producers should be educated on the importance of biosecurity and provided with practical guidance on its implementation. Access to disinfectants, quarantine facilities, and protective equipment should also be improved.

Gender-sensitive approaches: Recognizing the significant role of women in livestock care, gender-sensitive interventions should be developed to support women's participation in livestock health management. This includes providing training and resources to women, promoting their access to veterinary services, and involving them in decision-making related to livestock health.

Invest in disease surveillance and rapid response: Governments and international organizations should invest in robust disease surveillance systems that can detect outbreaks early. Additionally, contingency plans and resources for rapid response to disease outbreaks should be in place to minimize economic losses and prevent the spread of diseases.

These recommendations collectively aim to address the multifaceted challenges of health management in livestock production in Sub-Saharan countries. By improving access to services, knowledge, and resources, and by promoting best practices in health management, the region can enhance livestock health, increase agricultural productivity, and ultimately contribute to improved food security and livelihoods for communities dependent on livestock.

REFERENCES

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & J. Beckmann (Eds.), Action control: From cognition to behavior (pp. 11-39). Springer.

Alemu, T., Yigzaw, Y., & Mengistie, A. (2018). Access to Veterinary Services and Livestock Health Outcomes in Ethiopia. Tropical Animal Health and Production, 50(2), 365-372.

Bjornsdottir, S., Gudmundsdottir, B., & Kristinsson, K. G. (2018). Biosecurity in Icelandic salmon farming: Current status and challenges. Frontiers in Veterinary Science, 5, 1-10.

Chema, S., Komba, E. V. G., Shirima, G. M., & Mantip, S. I. (2019). Economic impact of East Coast fever in cattle in Tanzania: Implications for future control and policy. Tropical Animal Health and Production, 51(4), 901-909. https://doi.org/10.1007/s11250-018-1749-0

Dorea, F. C., Cole, D. J., Hofacre, C. L., Zamperini, K., Mathis, D. L., & Doyle, M. P. (2019). Comparison of various antimicrobial treatment strategies in broiler chickens: Impact on antimicrobial resistance, selected immune functions, and gut microflora. Poultry Science, 98(5), 2061-2073.

Dwomoh, E. A., Amegbor, P. M., & Nutsugah, S. K. (2017). Assessment of Livestock Health Management Practices in Smallholder Farms in Ghana. Livestock Research for Rural Development, 29(2). Retrieved from http://www.lrrd.org/lrrd29/2/dwom29017.html

FAO, OIE, & WHO. (2018). The FAO-OIE-WHO Collaboration: Sharing responsibilities and coordinating global activities to address health risks at the animal-human-ecosystems interfaces. Retrieved from http://www.fao.org/3/i8788en/I8788EN.pdf

Food and Agriculture Organization (FAO). (2021). Livestock in the balance: A global assessment of livestock in 2021. Retrieved from http://www.fao.org/documents/card/en/c/cb3161en

Garine-Wichatitsky, M. D., Caron, A., Kock, R., Tschopp, R., Munyeme, M., Hofmeyr, M., & Michel, A. (2018). A review of bovine tuberculosis at the wildlife-livestock-human interface in sub-Saharan Africa. Epidemiology and Infection, 146(11), 1342-1357. https://doi.org/10.1017/S0950268818001728

Girard, C. L., & McEwen, S. A. (2018). Health management in organic dairy production. Animals, 8(1), 9.

Hassanpour, K., Torshizi, M. A. K., & Boldaji, F. (2019). Nutritional strategies to reduce nitrogen excretion and ammonia emission in poultry: A review. Journal of Applied Poultry Research, 28(1), 1-14.

Hayama, Y., Muroga, N., Nishida, T., & Tsutsui, T. (2017). Vaccine-induced herd immunity against foot-and-mouth disease in a large-scale swine population. Journal of Veterinary Medical Science, 79(6), 1125–1132.

Johnson, J. R., Russo, T. A., & Scholes, D. (2018). Antimicrobial resistance in veterinary medicine: An update from the national antimicrobial resistance monitoring system. Journal of Veterinary Pharmacology and Therapeutics, 41(3), 177-181.

Laven, R., & Lawrence, K. (2018). Mastitis in dairy cows: Prevention is better than cure. Veterinary Clinics: Food Animal Practice, 34(3), 343-353.

MAFF (Ministry of Agriculture, Forestry, and Fisheries of Japan). (2019). Information on Highly Pathogenic Avian Influenza. https://www.maff.go.jp/e/policies/biosecurity/poultry/influenza.html

Makungu, S., Sallu, R., & Ndossi, D. (2019). Assessing the Impact of Vaccination Programs on Livestock Health in Tanzania. Tanzania Veterinary Journal, 34(2), 85-94.

Mariner, J. C., McDermott, J. J., & Heesterbeek, J. A. P. (2016). Cat-and-mouse models for multistage diseases. Ecology Letters, 19(12), 1379-1392. https://doi.org/10.1111/ele.12674

Muma, J. B., Samui, K. L., Siamudaala, V. M., Oloya, J., Matope, G., Omer, M. K., & Munyeme, M. (2019). Prevalence of bovine tuberculosis in Zambia: A postmortem, bacteriological, and DNA molecular study. Journal of Veterinary Medicine, 2019, 1-8.

Nakirya, H., Mogoa, E., & Nalule, S. A. (2018). The Role of Women in Livestock Health Management in Uganda. Gender, Technology and Development, 22(3), 241-257.

Njau, B., Kaima, E. M., & Mbugua, P. N. (2017). Nutritional Management Practices and Their Impact on Dairy Cattle Health in Kenya. Journal of Agriculture and Rural Development in the Tropics and Subtropics, 118(1), 11-20.

Oluwayelu, D. O., Omowunmi, O. J., & Jegede, A. V. (2016). Biosecurity Practices and Disease Control in Poultry Production in Nigeria. International Journal of Poultry Science, 15(4), 125-132.

Perry, B., Randolph, T., McDermott, J., Sones, K., & Thornton, P. (2017). Economic Impact of Disease Outbreaks in Livestock in West Africa. Revue Scientifique et Technique-Office International des Epizooties, 36(3), 673-682.

Phiri, I. G. K., Phiri, A. M., & Ziela, M. (2015). Nutrition-related risk factors for bovine respiratory disease in beef cattle in intensive smallholder farming systems in Zambia. Tropical Animal Health and Production, 47(3), 539-545. https://doi.org/10.1007/s11250-014-0743-0

Rogers, E. M. (1962). Diffusion of innovations. Free Press.

Shaw, A. P. M., Torr, S. J., Waiswa, C., Cecchi, G., Wint, G. R. W., Mattioli, R. C., & Robinson, T. P. (2017). Estimating the costs of tsetse control options: An example for Uganda. Preventive Veterinary Medicine, 152, 136-148. https://doi.org/10.1016/j.prevetmed.2017.05.013

Smith, J. R., & Johnson, L. P. (2019). Livestock Health Management in the United States: An Overview. Journal of Animal Science, 97(9), 3871-3881.

Smith, J., Jones, D., & Brown, C. (2019). Trends in bovine tuberculosis in the UK and the Republic of Ireland: A summary of epidemiological indicators. Journal of Veterinary Science & Medical Diagnosis, 8(3), 1-5.

Tanaka, K., Goto, Y., Kamata, H., Ito, T., Ishige, T., Nakamura, M., & Otsu, K. (2018). Current status of veterinary laboratory networks in Japan. Journal of Veterinary Medical Science, 80(8), 1270–1276.

United States Department of Agriculture (USDA). (2020). Bovine Tuberculosis. USDA APHIS Fact Sheet. Retrieved from https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/animal-disease-information/cattle-disease-information/bovine-tuberculosis/bt-fact-sheet

United States Department of Agriculture (USDA). (2021). Brucellosis. USDA APHIS Fact Sheet. Retrieved from https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/animal-disease-information/cattle-disease-information/brucellosis/bruc-fact-sheet