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PREVALENCE OF ANTIMICROBIAL RESISTANCE AND CONTROL METHODS USED BY LIVESTOCK FARMERS AND VETERINARY SERVICE PROVIDERS IN KAYONZA DISTRICT TO IMPROVE ONE HEALTH IN RWANDA

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Abstract

Globally regionally and in Rwanda, the prevalence of antimicrobial resistance and the control strategies used by livestock farmers and veterinary service providers remain a big challenge to achieve in one health by population health on the health population, similar to Farmers in Kayonza District, it was this reasons led to study the prevalence of antimicrobial resistance and control methods used by livestock farmers and veterinary service providers in Kayonza district to improve one health in Rwanda, methods used were mixed of survey and interviews livestock farmers, veterinary doctors, community veterinary doctors as the target population utilizing descriptive, cross-sectional. Sampling techniques of purposive census, quota, and snowball sampling on the respective respondents. A sample size of 207 respondents was used. Data collection tools and instruments were key informant interviews KII, and focus group discussions, FGDs a mixed-method approach, incorporating both quantitative and qualitative research methods. Quantitative data was gathered using semi-structured questionnaires, while qualitative data was collected through Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs). Data was managed, using SPSS Version 25 and, analyzed by tabulation of descriptive and inferential statistics, and presented in the form of pie charts and bar graphs. The results opined that in the prevalence of antimicrobials, 170 (82%), with RR of (0.643, 0. 233), signifying government protective strategies are active among the affected livestock farmers. While (37), 17.8%, opined that they are main cohorts of new antimicrobial resistance and in one health and death. And the

majority of livestock farmers sell their livestock to butcher men in the community, before they die, thus evading mortalities of sick animals at home to control farmers' loss of burying carcasses. Thus sell butchers who meet with residues of antibiotics of higher concentration to humans to consume so when they are administered drugs of low dosages they become resistant, has discussed in several KII with key stakeholders in Kayonza District. Therefore study on Antimicrobial resistance in Kayonza District looks forward to improving capacity building among population health through various integrated strategies of appropriate technologies to improve One Health outcomes.

Keywords: Antimicrobial Resistance, Livestock Farmers, Veterinary Service Providers, One Health, prevalence, appropriate technology

2.0. Material and Methodology

2.1.1 Material

2.1 Introduction and Background information

Antimicrobial resistance (AMR) is a global public health concern that has escalated in recent years due to the misuse and overuse of antibiotics in both human and animal health sectors. The World Health Organization (WHO) estimates that by 2050, drug-resistant infections could result in 10 million deaths annually if no effective measures are implemented (WHO, 2020). AMR not only affects human health but also poses significant challenges to livestock production and food security. In the context of the One Health framework, which recognizes the interconnection between human, animal, and environmental health, addressing AMR requires integrated solutions across all sectors (Roca et al., 2015). This study focuses on the prevalence of AMR in livestock in Kayonza District, Rwanda, and examines the control methods employed by farmers and veterinary service providers to mitigate its spread.

Globally, the increasing prevalence of antimicrobial-resistant bacteria in livestock has been a pressing issue, particularly in countries with intensive livestock farming practices. Studies have shown that the use of antibiotics in animal farming contributes significantly to the rise of AMR (Van Boeckel et al., 2017). The indiscriminate use of antibiotics, such as administering them as growth promoters or for disease prevention in healthy animals, accelerates resistance development (O'Neill, 2016). In response, international organizations like the WHO, the Food and Agriculture Organization (FAO), and the World Organisation for Animal Health (OIE) have been advocating for stricter regulations on antibiotic use in animal farming, promoting the prudent use of these drugs to safeguard public health (WHO, 2020).

In Sub-Saharan Africa, the challenges of AMR are exacerbated by weak regulatory frameworks, limited access to veterinary services, and inadequate public awareness of the dangers of antibiotic misuse (Kimera et al., 2020). The livestock sector in this region plays a vital role in rural livelihoods and food security. However, the uncontrolled use of antibiotics in animal farming has led to an increased prevalence of resistant pathogens, which threaten both animal and human health. Studies from countries like Kenya, Uganda, and Tanzania have reported high levels of AMR in livestock, particularly in bacteria such as Escherichia coli and Salmonella (Caudell et al.,

2017). Addressing this issue requires a coordinated regional approach, focusing on better surveillance, policy implementation, and farmer education.

Rwanda, like many other developing countries, faces significant challenges in combating AMR in the livestock sector. The government of Rwanda, through its One Health strategic framework, has recognized the need for coordinated efforts to address the AMR threat across human, animal, and environmental health sectors (Rwanda Ministry of Health, 2021). In the livestock industry, there is widespread use of antibiotics for both therapeutic and prophylactic purposes, which has contributed to the emergence of resistant bacterial strains (Ntaganda et al., 2018). The Rwanda Agriculture and Animal Resources Development Board (RAB) has been working with local farmers and veterinary service providers to promote the responsible use of antimicrobials, yet more efforts are needed to enforce regulations and monitor antibiotic usage patterns.

Kayonza District, located in the Eastern Province of Rwanda, is one of the key agricultural regions in the country, with a significant portion of its population relying on livestock farming for their livelihoods. Livestock farmers in Kayonza, like many others in rural Rwanda, often have limited access to formal veterinary services and rely heavily on over-the-counter antibiotics, which are frequently misused (Ntaganda et al., 2018). As a result, cases of antimicrobial resistance in livestock have been rising, posing risks to both animal and public health. This study aims to assess the prevalence of AMR in livestock in Kayonza District and explore the control methods employed by local farmers and veterinary service providers to manage this growing threat.

The One Health approach, which promotes interdisciplinary collaboration across human, animal, and environmental health, is crucial for addressing AMR (Roca et al., 2015). In Rwanda, this approach has been integrated into national policies to enhance the control of zoonotic diseases and AMR (Rwanda Ministry of Health, 2021). By investigating AMR in livestock and the practices of both farmers and veterinarians in Kayonza District, this study will contribute to understanding how local-level practices affect broader public health outcomes. Moreover, the study will highlight the importance of strengthening regulatory frameworks, providing education on antibiotic stewardship, and enhancing access to veterinary services to control AMR in rural areas.

2.1.2 Prevalence of Antimicrobial Resistance and Strategies Used In Control among Livestock Farmers and Veterinary Service Providers

Numerous empirical studies have examined the frequency of antimicrobial resistance (AMR) and the effectiveness of control strategies among veterinarians and livestock producers around the world. Multiple studies have shown that antimicrobial resistance (AMR) is common in cattle populations, and different levels of management have been implemented to deal with this increasing problem (O'Neill, 2016). The frequency of AMR in Escherichia coli bacteria found in pig poop from industrial pig farms was examined in a 2020 Chinese study by Tang et al. There is an immediate need for better antimicrobial stewardship methods and stronger control mechanisms, as the results showed high levels of resistance to numerous antibiotics frequently used in cattle production.

The causes of antibiotic resistance and the methods used to combat it by livestock producers and veterinarians have been the subject of multiple empirical investigations. Research conducted in Nigeria by Alhaji *et al*. (2018) examined the beliefs, practices, and levels of knowledge held by livestock farmers about the usage and resistance of antibiotics. It is clear from the results that farmers have inadequate understanding and use antibiotics inappropriately; therefore, educational interventions and regulatory enforcement are necessary to improve antimicrobial management.

Various empirical studies have used different methodologies to examine the prevalence of antimicrobial resistance (AMR) and control methods among veterinary care providers and livestock producers. These methodologies include microbiological analysis, longitudinal monitoring programs, and cross-sectional surveys. Take, for instance, the three-year South African by Duse *et al.* (2018), which tracked the incidence of AMR in bacteria found in cattle and food items. To determine the extent of resistance and track any changes over time, the research used microbiological methods, such as antimicrobial susceptibility testing.

The significance of utilizing comprehensive strategies for antimicrobial control in cattle production has been highlighted by empirical study findings. Some have argued that antimicrobial stewardship programs are a viable strategy for fighting antimicrobial resistance, with legislative actions and educational efforts aimed at livestock farmers and veterinary service providers. European researchers Chantziaras *et al.* (2014) examined the results of antimicrobial stewardship programs in the veterinary field and found that interdisciplinary teams, evidence-based recommendations, and constant surveillance of antibiotic usage and resistance patterns were critical to their effective execution.

2.2 One Health Concept for the Health Ecosystems and Population Health

The idea of "One Health" is an interdisciplinary strategy that takes into account the interdependence of human, animal, and environmental well-being. Because the well-being of one area has a significant bearing on the other areas, this all-encompassing model emphasizes the interconnections among people, animals, and their common habitats. Antimicrobial resistance (AMR) is one of many complicated health issues that must be addressed through the combined efforts of human and veterinary healthcare providers, environmental scientists, legislators, and others (Kahn *et al.,* 2017).

To tackle antimicrobial resistance (AMR) head-on, the One Health paradigm stresses the importance of multidisciplinary and integrated research methods (Grace et al., 2018). To better understand the intricate drivers and dynamics of antimicrobial resistance (AMR), researchers should collaborate with specialists from a wide range of disciplines, such as microbiology, ecology, social science, human and veterinary medicine, epidemiology, and human and veterinary medicine. Rüegg *et al.* (2018) emphasized the need of interdisciplinary collaboration in discovering effective interventions and methods to address antimicrobial resistance (AMR) while reducing trade-offs and unintended consequences across sectors.

To further address antimicrobial resistance (AMR), the One Health strategy encourages collaboration across sectors and participation from all relevant stakeholders in order to put policies

and treatments backed by evidence into action. Research in Kayonza District, Rwanda, by Zinsstag *et al.* (2020) found that responsible use of antimicrobials, improved monitoring and surveillance systems, and behavior change among livestock farmers and veterinary service providers could only be achieved through collaboration between government agencies, agricultural extension services, veterinary associations, healthcare providers, and community organizations.

When it comes to the complicated problems caused by antibiotic usage and resistance, the One Health philosophy offers a thorough framework for comprehension and resolution. To effectively tackle antimicrobial resistance (AMR), the One Health approach highlights the significance of interdisciplinary collaboration, integrated research, and multi-sectoral collaborations by acknowledging the interconnection of human, animal, and environmental health. In the context of the study in Kayonza District, Rwanda, implementing the principles of One Health can guide interventions and strategies based on evidence to encourage responsible use of antibiotics, protect the health of both humans and animals and ensure that these agents remain effective for generations to come.

2.3 KAP Influence on Antimicrobial Resistance and Control Methods by Livestock Farmers and Veterinary Service Providers to Prevent Drug Resistance

Tang et al. (2018) investigated the KAP of pig farmers in China regarding antimicrobial use and resistance. The findings revealed gaps in knowledge regarding appropriate antibiotic use practices, with a significant proportion of farmers lacking awareness of withdrawal periods and dosage regimens. Attitudes toward antimicrobial use were found to be influenced by economic factors, with farmers prioritizing cost-effectiveness over antimicrobial stewardship principles. Practices such as over-the-counter antibiotic purchasing and prophylactic antibiotic use were prevalent, contributing to the emergence of AMR in pig populations (Van Boeckel *et al.,* 2019)

Similarly, a survey conducted by Visschers *et al.* (2015) among Swiss livestock farmers and veterinarians highlighted the influence of KAP on antimicrobial use behaviors. The study found that farmers' attitudes toward antibiotic use was influenced by perceptions of disease severity and efficacy of antibiotics, with concerns about animal welfare and economic considerations also shaping decision-making. Limited knowledge about antibiotic resistance mechanisms and the role of prudent antibiotic use in mitigating AMR was identified among both farmers and veterinarians, underscoring the need for targeted educational interventions (Magar *et al.,* 2022)

Contrastingly, a study by Nhung *et al.* (2016) in Vietnam found that while knowledge levels regarding AMR were relatively high among poultry farmers, attitudes and practices often did not align with recommended antimicrobial stewardship principles. Despite awareness of the risks associated with antimicrobial misuse, farmers reported continued reliance on antibiotics for disease prevention and growth promotion purposes. Factors such as accessibility of veterinary services and economic pressures were cited as barriers to implementing alternative disease control strategies, highlighting the complex interplay between KAP and antimicrobial resistance in livestock farming contexts.

2.3 Conceptual Framework

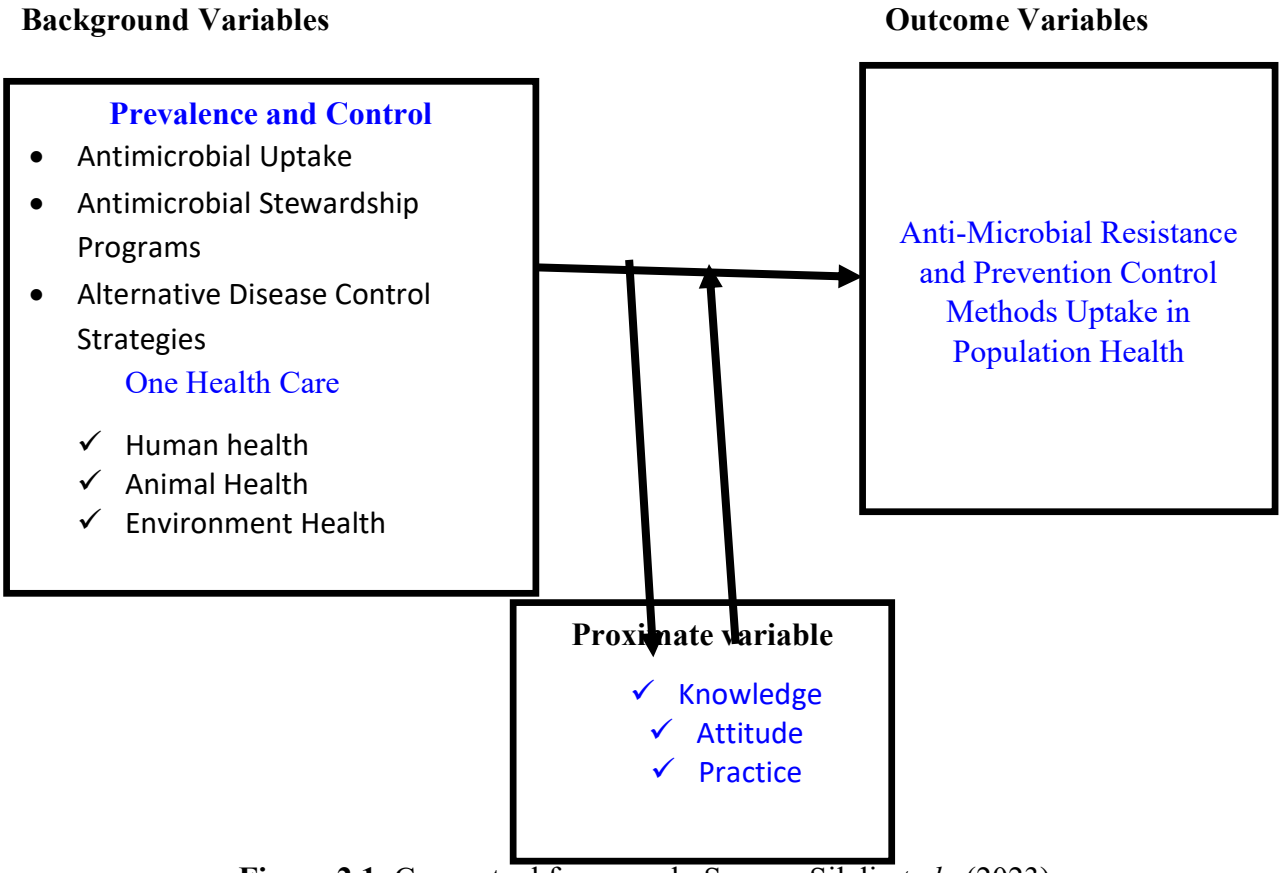

Figure 2.1: Conceptual framework**,** Source: Silali *et al.,* (2023)

3.0 METHODOLOGY AND METHODS

The research methods used were mixed of surveys and interviews with livestock farmers, veterinary doctors, and community veterinary doctors as the target population utilizing descriptive, cross-sectional. Sampling techniques of purposive census, quota, and snowball sampling on the respective respondents. A sample size of 207 respondents was used. Data collection tools and instruments were key informant interviews KII, and focus group discussions, FGDs a mixed-method approach, incorporating both quantitative and qualitative research methods. Quantitative data was gathered using semi-structured questionnaires, while qualitative data was collected through Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs). Data was managed, using SPSS Version 25 and, analyzed by tabulation of descriptive and inferential statistics, and presented in the form of pie charts and bar graphs using Fisher's formula (Fisher's, 1998), we may determine the sample size. For those working in the cattle industry and in veterinary medicine, this tool is invaluable for gauging the current and future health of a population and identifying potential problem areas. There are less than 10,000 households in the Kayonza district, so the formula was adjusted using a finite population adjustment formula to acquire the correct

study sample size. The target population is 600, while the study population is less than 10,000. Fisher's formula states:

$$n = \frac{Z^2 pq}{d^2}$$

Where

n = target population greater than 10,000

Z = degree of confidence (1.96)

p = Population of estimated study / target population (0.50)

q = proportion of the acceptance proportion significance of respondents estimated to be traced. (0 .50)

d = level of statistical test, 0.05

$$n = \frac{(1.96)2\ (0.5)\ (.05)}{(0.05)2} \qquad \frac{9604}{25}$$

n = 384

The sample size was adjusted using Fisher's (1998) finite population correction procedure since the projected number of responders from livestock farmers and veterinary service providers was less than 10,000. Hence corrected sample size:

$$nf = \frac{n}{1+\left(\frac{n}{N}\right)}$$

Where

nf= desired sample size of respondents was less than 10,000.

n= desired sample size of respondents was more than 10,000

N = total estimated study/target population size (600)

Hence:

$$nf \qquad \frac{384}{1+\ \frac{\{384\}}{600}}$$

= 235 respondents

4.0 Results and Findings

4.1 Findings on Prevalence of Antimicrobial Resistance in Kayonza District

The use of antimicrobials, such as antibiotics, in livestock farming is an essential practice for managing animal health and preventing diseases. However, improper use can lead to antimicrobial resistance, a significant public health concern. Figure 3 illustrates the extent to which respondents (N = 235) in Kayonza District utilize antimicrobials in their livestock farming practices, highlighting key patterns and trends.

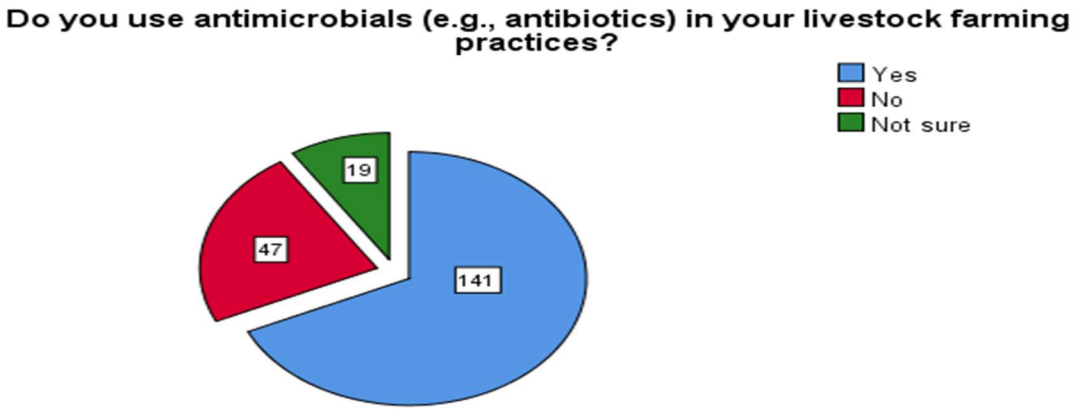

Figure 2: Uptake of various antimicrobials during livestock Husbandry

The results indicated that the majority of respondents 160 (68.1%) in Kayonza District report using antimicrobials, including antibiotics, in their livestock farming practices with a significance of 0.67 and CI 95 % transmission in the one health ecosystem.

The results opined that in the prevalence of antimicrobials, 170 (82%), with RR of (0.643, 0. 233), signifying government protective strategies are active among the affected livestock farmers. While (37), 17.8%, opined that they are main cohorts of new antimicrobial resistance and in one health and death. And the majority of livestock farmers sell their livestock to butcher men in the community, before they die, thus evading mortalities of sick animals at home to control farmers' loss of burying carcasses. Thus sell butchers who meet with residues of antibiotics of higher concentration to humans to consume so when they are administered drugs of low dosages they become resistant, has discussed in several KII with key stake holders in Kayonza District

4.1.1 Types of antimicrobials commonly used in One Health Ecosystem

The use of different types of antimicrobials is a common practice among livestock farmers to manage animal health and prevent infections. Identifying the specific types of antimicrobials used is crucial in understanding their role in the development of antimicrobial resistance. Figure 4 outlines the various antimicrobials commonly utilized by respondents in Kayonza District, shedding light on their preferences and potential risks associated with improper use.

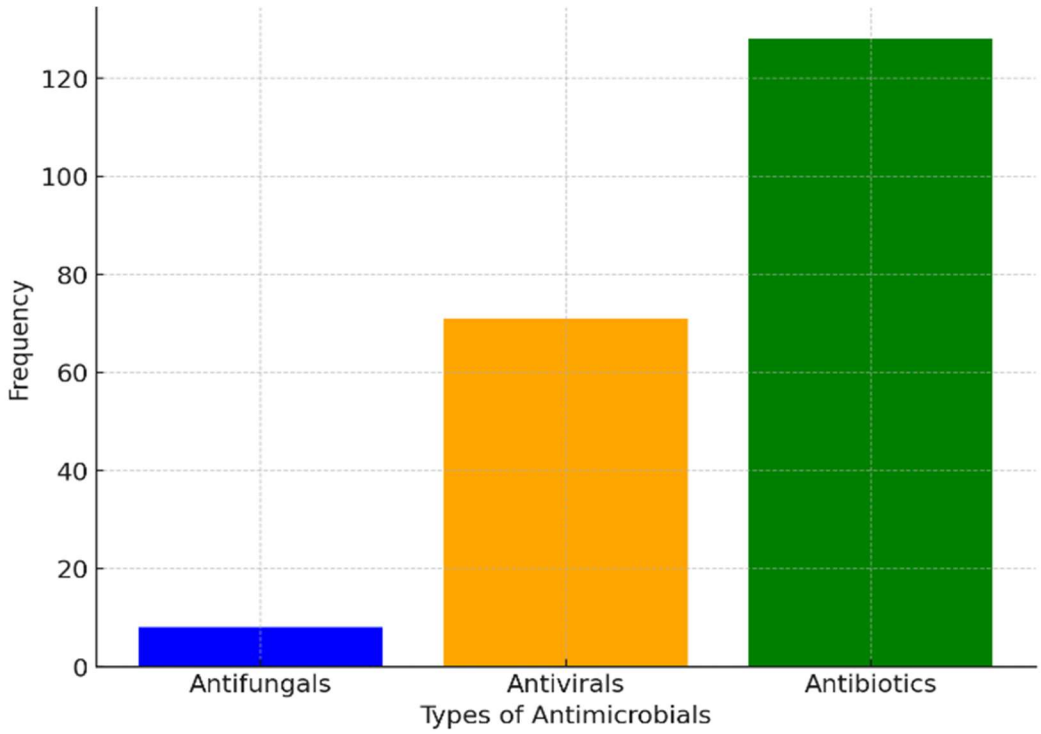

Figure 3: Types of antimicrobials commonly used

The findings revealed the types of antimicrobials commonly used by livestock farmers in Kayonza District. And this was also discussed on KII

"(*The medicines used to treat bacterial infection in men and animals are the same but the concentration in animals is high compared to man medicine, thus if a man consumes meat inoculated with drugs when comes sick and takes similar drugs they will not work because man drug, has less concentration*)". KII guide in Kayonza District on 28 /8/2024.

("*Here in Kayonza, the most common antimicrobial drugs we use are antibiotics, antifungals and antivirals due to environmental factors of the district; example of antibiotics include broad-spectrum agents, such as tetracycline, penicillin, and sulfonamides, which are frequently used in both human and animal medicine due to similar organic formula*". A KII discussed on 12/09/2024 in Kayonza District).

4.1.2 Duration of Administering Antimicrobials Ill Health Livestock

The duration of antimicrobial administration in livestock farming varies among the farmers in Kayonza District, as illustrated in Figure 5 below. The data shows different frequencies of antimicrobial use, ranging from daily to occasional, reflecting diverse management practices. Understanding these patterns is essential for assessing the potential impact on antimicrobial resistance and optimizing treatment strategies for livestock health.

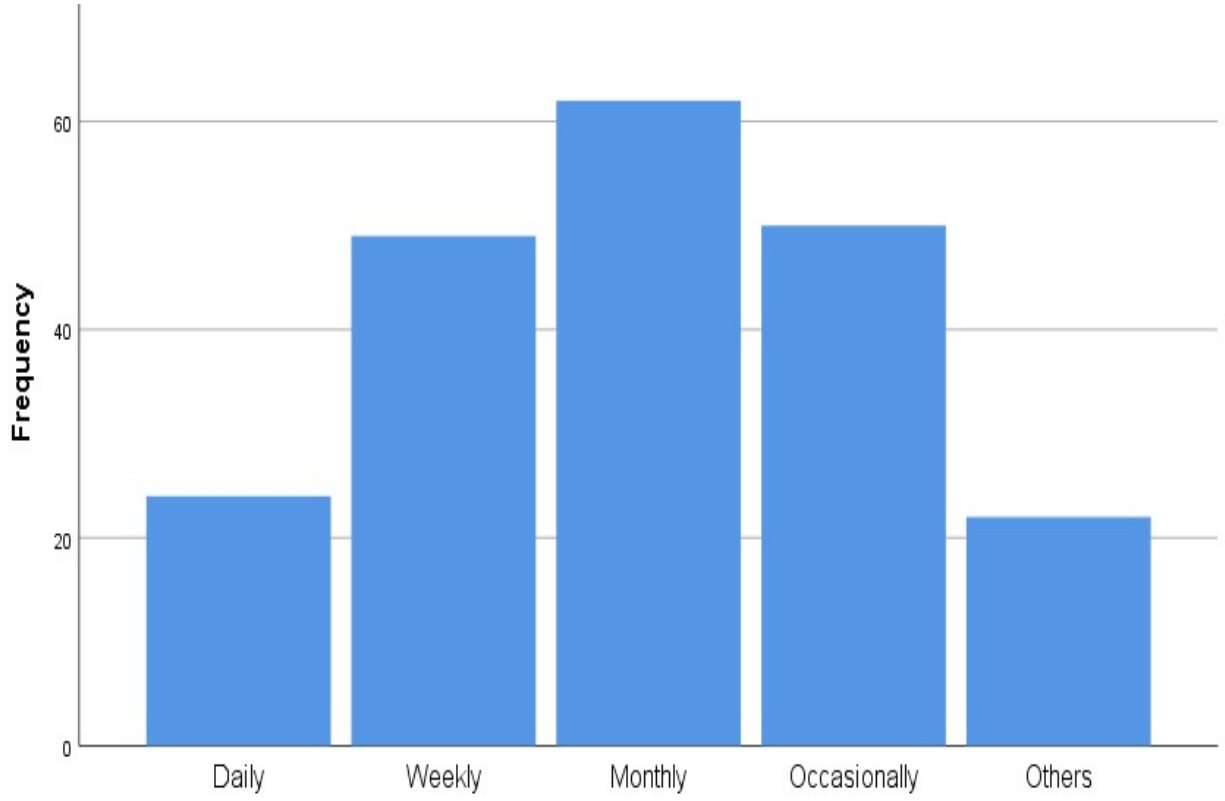

Figure 4: Duration of administering antimicrobials to your livestock

The results opined that the most common practice is monthly administration, reported by 30.0% of respondents. However, the relatively high percentage of occasional use (24.2%) suggests that some farmers may only administer antimicrobials when there are visible signs of disease, which could lead to improper dosing and incomplete treatment, contributing to antimicrobial resistance (AMR).

Weekly administration, practiced by 23.7% of respondents, may indicate a more aggressive approach to disease prevention, potentially reflecting concerns about livestock health or past disease outbreaks. Daily administration, reported by 11.6% of respondents, is more common in intensive farming systems where livestock are housed in close quarters, increasing the likelihood of disease spread. Finally, 10.6% of respondents reported using antimicrobials under other unspecified circumstances, which may include emergency treatments or the use of antibiotics in response to advice from informal sources.

4.1.3 Factors Influencing Your Decision to Use Antimicrobials in Livestock Farming

Figure 4.7 explores the various factors that influence the decision to use antimicrobials in livestock farming. The data reveals key motivations such as disease treatment, prevention, and economic considerations, highlighting the complex decision-making process faced by livestock farmers.

Understanding these factors is essential for developing strategies to optimize antimicrobial use and address issues related to antimicrobial resistance.

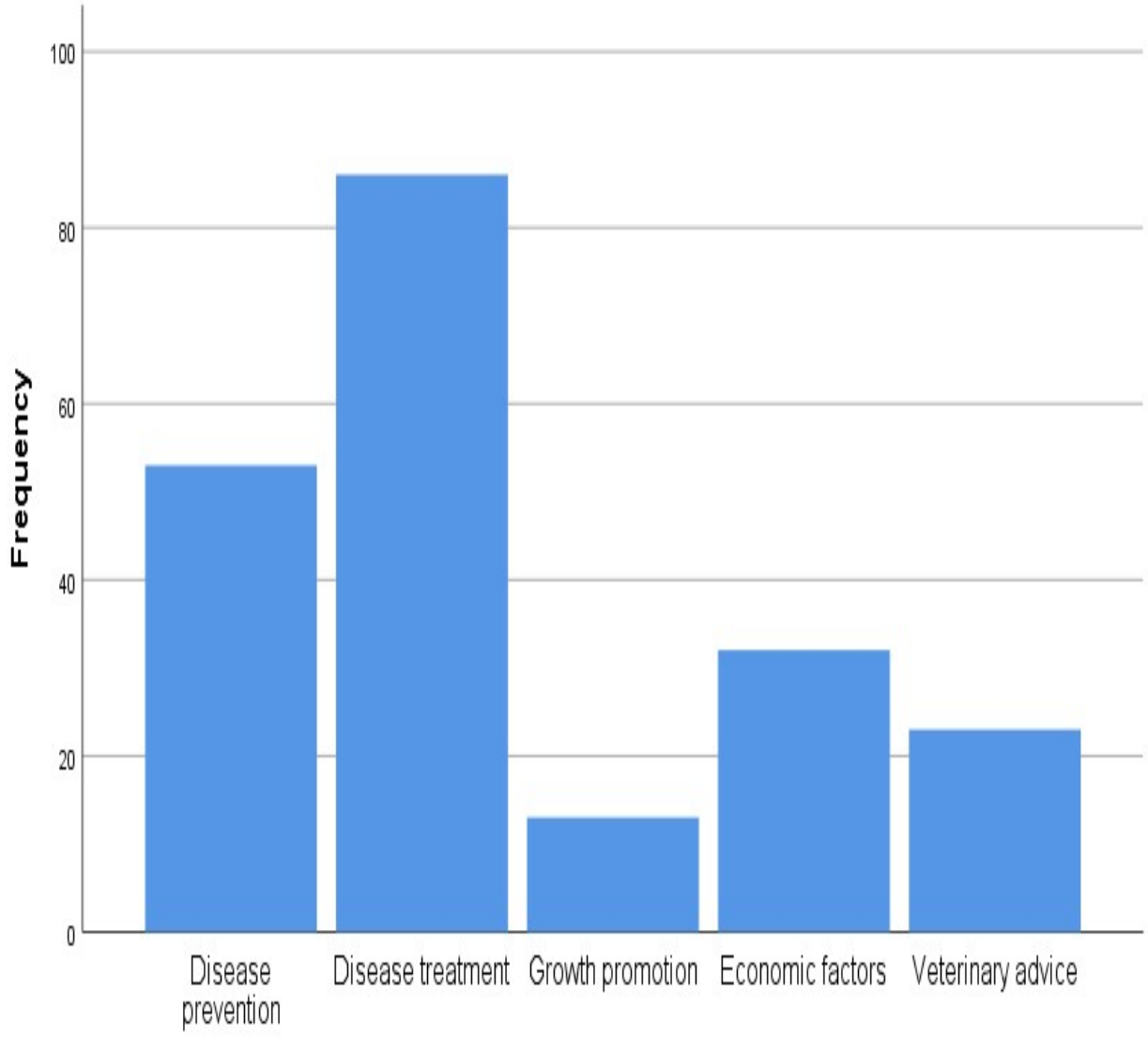

Figure 5: Factors Influencing Reached Diagnosis to Use Antimicrobials in Livestock Farming

The findings opined that the primary reason reported for using antimicrobials is disease treatment, with 41.5% of respondents indicating this as their main motivation.

Disease prevention is another significant factor, cited by 25.6% of respondents. However, the use of antimicrobials for growth promotion, reported by only 6.3% of respondents, is notably lower.

Economic factors are also a notable consideration for 15.5% of respondents, suggesting that cost considerations and the economic benefits of using antimicrobials influence their decision-making.

Additionally, veterinary advice plays a role for 11.1% of respondents, highlighting the importance of professional guidance in shaping antimicrobial use practices.

This was also opined during the FGD discussion:

("Disease prevention in our community is hard to achieve because some of our farmers when a cow dies due to a certain disease which is not zoonotic, they will eat the carcass because they think is a loss to farmers as a result, they induce antimicrobial resistance from animal drug residues"), FGD held on 10/09/2024.

4.1.4 Acquiring of Antimicrobials for Use in Livestock Farming

Figure 4.8 examines how respondents acquire antimicrobials for use in livestock farming. The data shows a significant reliance on over-the-counter purchases, with p value of 0.588 and CI 95 %, with fewer respondents obtaining antimicrobials through veterinary prescriptions. Understanding these acquisition patterns is essential for addressing antimicrobial resistance and promoting responsible use in livestock management.

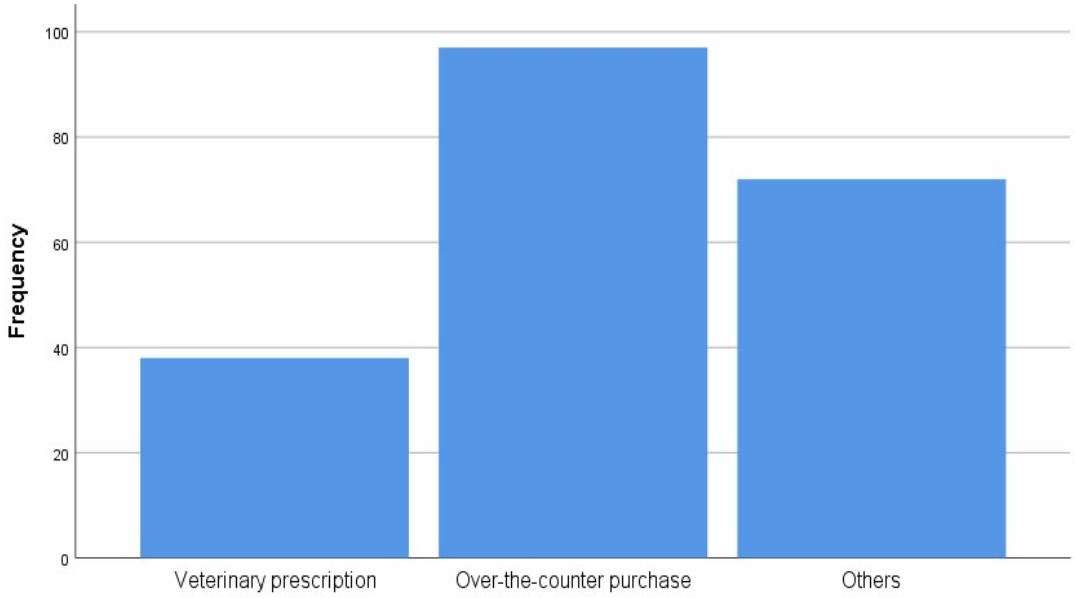

Figure 6: Main Sources Acquiring of antimicrobials Uptake in livestock farming

The results show that the majority, 46.9%, (97), obtain antimicrobials through over-the-counter purchases, due to easy accessibility of these drugs without veterinary consultations. Only 18.4% (38) respondents acknowledged to acquire antimicrobials through veterinary prescription, highlighting the limited role of veterinarians in guiding antimicrobial use and had significant limited of drug resistance. Also, 34.8% of respondents reported acquiring antimicrobials through other means, which could include informal channels such as purchasing from local markets or using leftover drugs. This unregulated access reflects gaps in the formal veterinary system and underscores the need for stronger regulatory frameworks to control antimicrobial distribution and mitigate the spread of AMR.

A significant portion of respondents, 56.5%, with p value of 0.78 and CI 95%, reported encountering cases where antimicrobials failed or showed reduced effectiveness. Approximately 30.9% of respondents indicated they had not encountered such issues, which may suggest that

some livestock farmers either adhere to better antimicrobial practices or have not yet experienced resistance-related problems. Interestingly, 12.6% of respondents were unsure if they had experienced treatment failure or reduced antimicrobial effectiveness. This was also opined during FGD discussion:
("In our community, affordability of veterinary services is still a challenge. Hence, we just buy medicines from pharmacies and treat our animals,"), FGD held on 10/09/2024.

5.0 Conclusions of the study

The study on antimicrobial resistance (AMR) in Kayonza District underscores several critical conclusions regarding the factors influencing AMR and the effectiveness of control methods among livestock farmers and veterinary service providers. The findings indicate a notable gap in knowledge about AMR among the community. Many farmers and veterinary practitioners lack sufficient understanding of AMR, which directly impacts their antimicrobial usage practices. Without proper knowledge, individuals are more likely to misuse or overuse antimicrobials, exacerbating the problem of resistance. This highlights the urgent need for comprehensive educational programs to improve awareness and understanding of AMR among all stakeholders.

5.1 Recommendations of the study

5.1.1 The 3 Ministries of Respective (One Health, Health. Vertinary, and Environment)

Kayonza District should prioritize raising awareness on antimicrobial resistance (AMR) at the community level. This can be achieved through consistent community awareness campaigns that highlight the dangers of antimicrobial misuse and the importance of seeking professional medical advice. Given the prevalent cultural beliefs that may influence the misuse of antimicrobials, it is essential to involve local leaders and traditional healers to harmonize traditional practices with modern healthcare approaches. This could foster trust in medical treatments while addressing culturally rooted stigmas. Additionally, the district should encourage livestock farmers to adopt alternative practices, such as vaccination, hygiene improvements, and biosecurity measures, to reduce dependence on antimicrobials

5.1.2 Regulatory Bodies: Rwanda Food and Drugs Authority (Rwanda FDA) and Rwanda Council of Veterinary Doctors (RCVD):

Initiate integrated Onehealth prevention control programs to reduce antimicrobial resistance

5.2 Public-Private Engagement on AMR

Public engagement is vital for raising awareness through capacity building and empowerment to livestock farmers, about the dangers of antimicrobial resistance. AMR stewardship programs should work with local governments, healthcare providers, and media outlets to develop public engagement strategies. These could include media campaigns that educate the public on the risks of antimicrobial misuse and how to prevent it. Furthermore, community dialogues and stakeholder meetings should be organized to foster conversations about AMR, allowing for feedback from the

community. By engaging the public directly, AMR programs can promote a deeper understanding of the issue and encourage more responsible antimicrobial use among both individuals and livestock farmers.

5.3. Further Studies

Further studies should explore the long-term impact of antimicrobial resistance (AMR) education and awareness programs on behavior change among livestock farmers and veterinary service providers. Research could focus on assessing whether training and awareness initiatives lead to sustained improvements in antimicrobial use practices and a reduction in resistance cases over time. Additionally, future studies should examine the effectiveness of integrating traditional cultural beliefs with modern healthcare strategies in addressing AMR, as cultural taboos and stigmas play a significant role in healthcare-seeking behavior. Understanding the balance between cultural practices and scientific methods could provide valuable insights for developing more culturally sensitive AMR control strategies.

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Appendix Distribution Boundaries of Kayonza District, Rwanda

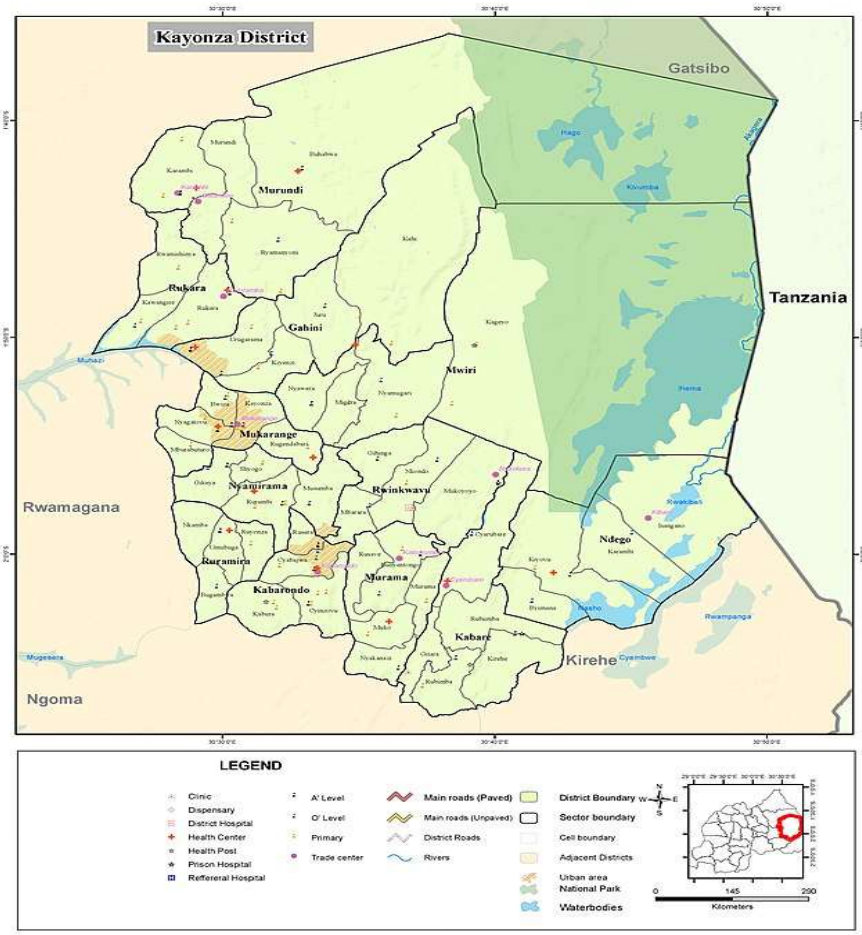

Figure 7: Map of Kayonza District source MINAGRI, 2018