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Pharmacoepidemiology of Antibiotics: An Investigation of Current Practices in Goat Farming in Mamou, Guinea

Lanan Wassy SOROMOU^{1,2}, Mamadou Saïdou BAH^{2,3}, Mama Agnès TEA²,
Hamani MARICHATOU³, Cé 2 ZOTOMY², Mamadou Fodé CAMARA²

¹Département de Biologie Appliquée, Université de Labé, Labé, Guinée

²Département de Médecine Vétérinaire, Institut Supérieur des Sciences et de Médecine Vétérinaire de Dalaba, Dalaba, Guinée

³Centre d'Excellence Régional sur les Productions Pastorales : Viande, lait, Cuir et Peaux (CERPP), Université Abdou Moumouni de Niamey, Niamey, Niger

*Corresponding Author, Lanan Wassy SOROMOU, Email: lanan-wassy.soromou@univ-labe.edu.gn

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Abstract :

The management of animal health and the use of antibiotics in farming is a critically important issue. The aim of the research is to evaluate current antibiotic usage practices in goat farming in Guinea, in order to understand their impact on antimicrobial resistance and animal health management.

Interviews were conducted with veterinarians and local farmers, and field observations were made. The study collected data on common diseases, veterinary practices, antibiotic usage, and the challenges faced by farmers in managing animal health.

The results show that the main diseases affecting goats are Peste des Petits Ruminants (PPR) and anthrax. Veterinarians primarily prescribe oxytetracycline and penicillin-streptomycin prophylactically. However, the treatments are often ineffective due to inappropriate practices, self-medication by farmers, and a lack of laboratory testing. Furthermore, non-compliance with prescribed treatments by farmers exacerbates the situation. Farmers also express an urgent need for quality veterinary medicines and solutions to eliminate stray dogs, which pose a threat to their livestock.

In conclusion, this study has enabled us to identify current antibiotic usage practices in goat farming in Mamou and understand their implications for antimicrobial resistance. This would help reduce antimicrobial resistance and improve animal health in the region, thereby contributing to the sustainability and productivity of goat farming in Mamou

Introduction

Antibiotics are essential drugs for the treatment of bacterial infections. Their use has become a common practice in both human and veterinary medicine ^{1,2}. In animal health, and particularly in the livestock sector, this issue is even more concerning due to the often poorly regulated antimicrobial practices, with easy access to veterinary medicines, including by non-professionals ^{3, 4, 5}.

In goat farming systems, bacterial infections represent major health and economic challenges that must be effectively addressed to ensure herd productivity and the sanitary safety of animal-derived products ^{6,7}. These pathogenic agents are increasingly associated with resistance to standard antibiotics, thereby compromising treatment success and increasing the risk of resistance transmission to humans through the food chain or the environment. Moreover, these risks are exacerbated by inappropriate practices such as self-medication, underdosing, failure to observe withdrawal periods, and the unjustified use of broad-spectrum antibiotics ^{8,9}.

In Africa, and more specifically in many countries, the monitoring of veterinary antibiotic use remains a public health priority and should not be overlooked ¹⁰. In the urban municipality of Mamou, a region characterized by a high goat population density and intensive farming practices, antibiotics are frequently used for preventive or curative purposes in goats. However, the practices related to the use of these drugs remain poorly understood, and cases of therapeutic failure are increasingly being reported by users.

In light of this situation, there is an urgent need for reliable data on sanitary practices and antibiotic use in goat farms in Mamou, in order to better understand the constraints and risks, and to guide preventive and regulatory interventions.

This study adopts a pharmacoepidemiological approach, aiming to provide an overview of sanitary practices, antibiotic usage, and bacterial resistance profiles in goat farming systems in Mamou. Its objective is to contribute to a better understanding of local antimicrobial resistance dynamics and to propose context-specific recommendations.

2. Materials and Methods :

2.1. Materials

2.1. Presentation of the study area

The urban municipality of Mamou is located approximately 275 kilometers from Conakry, the capital of Guinea. It lies at a latitude of 10°22'31" North, a longitude of 12°05'29" West, and an altitude of approximately 720 meters above sea level. It is bordered to the north by the rural municipalities of Bouliwel and Tolo, to the northeast by Dounet, to the southeast by Soya, and to the west by Konkouré. Strategically positioned in the heart of Guinea, Mamou lies along the national and international corridor connecting Conakry to major cities such as Kindia, Faranah, Kankan, Siguiri, N'Zérékoré, as well as Dalaba, Pita, Labé, Koundara, and Senegal. This central location has earned it the nickname "crossroads city." According to records from the Urban Municipality of Mamou (2018), the town has a population of 14,416 inhabitants, with a density of 64 inhabitants per square kilometer. Administratively, the municipality comprises 23 neighborhoods and 5 districts ¹¹.

2.2. Methods :

2.2.1. Livestock Authorities :

A sampling strategy was used to select farms of different sizes (small, medium, and large) in different locations within the municipality. The selection criteria included accessibility, readiness to participate, and the presence of goat farming activities. The sample was designed to reflect the diversity of agricultural practices and patterns of antibiotic use.

In order to ensure a comprehensive and reliable data collection process, we first met with municipal veterinary and livestock service officials. The main objectives of these meetings were to obtain the necessary administrative authorizations to conduct the study in the targeted areas; to gather contextual information on goat farming practices specific to the municipality; to understand the local availability and distribution channels for veterinary drugs; to identify the antibiotics most commonly used by farmers and animal health workers; and finally, to assess the prevalence of major goat diseases, cases of treatment failure, and existing measures, if any, implemented locally to control antimicrobial resistance.

2.2.2. Practicing Veterinarians

Recognizing their central role in animal health management, seven veterinarians practicing in the urban commune of Mamou were selected for in-depth semi-structured interviews. These interviews explored several key topics, including the most frequently diagnosed diseases in goats, the types of antibiotics commonly prescribed, their frequency of use and the clinical indications for their use, the reported cases of treatment failure and the suspected contributing factors, the nature of interactions with farmers as well as the operational challenges encountered in their daily practice.

2.2.3. Farmers' Cooperatives and Associations

In order to gather the collective experiences and practices of goat farmers, several cooperatives and associations of farmers operating were contacted. The objective was to understand their organizational structures, production systems, and animal health management strategies; to assess their level of awareness and knowledge of the responsible use of antibiotics and antimicrobial resistance; to record their perceptions of veterinary care, treatment outcomes, and barriers to accessing professional animal health services ; and to identify their main sources of veterinary medicines and assess the quality and level of regulation of these channels. Data collection was based on a combination of group discussions, which facilitated a free exchange of ideas among members

2.2.4. Veterinary Diagnostic Laboratories

We contacted regional and local veterinary laboratories to obtain data on diagnostic tests performed on goats, particularly bacteriological tests and antibiotic susceptibility profiles. In addition, this collaboration made it possible to identify local capacities in terms of diagnostic services and antimicrobial resistance surveillance. The information gathered from these laboratories complemented the clinical and epidemiological data collected in the field.

2.2.5. Veterinary Drug Sellers

The surveys also targeted official veterinary pharmacies and informal drug sellers to find out which drugs were most commonly sold to goat farmers, to understand how drugs were distributed and what kind of advice was given to users, if any, and to assess the level of compliance with existing regulations governing the sale of antibiotics.

2.2.6. Data Analysis Methods

Data was collected using a combination of semi-structured interviews and standardized questionnaires. Prior to the main survey, these tools were pre-tested

and refined with a small sample of farms to ensure clarity, contextual relevance, and reliability. The pre-testing phase also allowed for adjustments to improve the accuracy and consistency of responses. The collected data were coded, organized, and analyzed using qualitative and quantitative approaches to identify emerging trends. Microsoft Excel was used for initial data entry and cleaning, while SPSS was used to perform statistical analyses. Associations between variables were examined using chi-square tests.

3. Results :

3.1. Data from the Livestock Authorities

During our discussions with officials from the Prefectural Directorate of Agriculture and Livestock, we found that no data were available concerning the use and sale of antibiotics in the municipality. According to them, veterinarians and farmers obtain these products through informal and unreliable channels. Furthermore, no control measures are currently in place regarding veterinary practices. It was reported that the main diseases affecting goats in this area are Peste des Petits Ruminants and anthrax. Officials also mentioned having recorded several cases of therapeutic failure in farms. The identified challenges included farmers' reluctance, lack of collaboration, self-medication, illegal drug sales, and free-roaming animals.

3.2. Common Diseases

Veterinarians in the region reported that the most common diseases affecting goat herds include sheep and goat plague, internal and external parasitoses, respiratory infections, pasteurellosis, blackleg, and mastitis.

3.3. Health Personnel Profile

In Mamou, although several youths are graduates of the Livestock Technician Training Center, only a relatively small proportion (14.28%) are actively practicing their profession. This is partly due to the predominance of veterinary doctors (85.71%), who are most frequently consulted by farmers. Additionally, many farmers tend to neglect animal health, preferring self-medication, which contributes to this trend. It is also worth noting that the Mamou region hosts an Institute of Sciences and Veterinary

Medicine. Overall, farmers' reluctance and the practice of self-medication contribute to treatment failures and the emergence of microbial resistance.

3.4. Veterinary Intervention Patterns

Animal health workers in the municipality do not always follow a comprehensive intervention protocol. While history-taking (anamnesis) is crucial for diagnosis, it is performed by only 57.14% of respondents. Observation is also rarely conducted. Professionals rely mainly on clinical examinations before administering treatment. Advice to farmers is scarcely given (only 14.28% of health personnel provide it), and follow-up after treatment is often lacking. This approach may lead to the recurrence of diseases in livestock.

Relying solely on clinical examinations may not accurately identify the causative agent or effectively guide antibiotic therapy, potentially contributing to the increase in antimicrobial resistance. Many diseases exhibit similar clinical signs, making laboratory analyses followed by antibiograms essential for determining pathogen sensitivity.

However, none of the veterinarians interviewed reported performing any laboratory tests. Under ideal conditions, clinical signs alone are not always sufficient for establishing a definitive diagnosis. Laboratory analysis is essential to identify the exact cause of disease and implement appropriate curative and preventive measures. Knowing the type of causative pathogen is critical.

3.5. Preventive Use of Antibiotics

All animal health professionals in our study area practice antibiotic prophylaxis. This practice may significantly contribute to microbial resistance, as the necessity of prophylactic antibiotic use is not always evident and should not be systematic. In many cases, prophylaxis is used on animals that are neither stressed nor symptomatic, purely as a precaution, resulting in the treatment of entire herds.

3.6. Frequency of Antibiotic Use

The frequency of antibiotic use was assessed in order to better understand treatment methods among farmers and identify potential risks associated with the emergence of antimicrobial resistance. The results are presented in the figure 1.

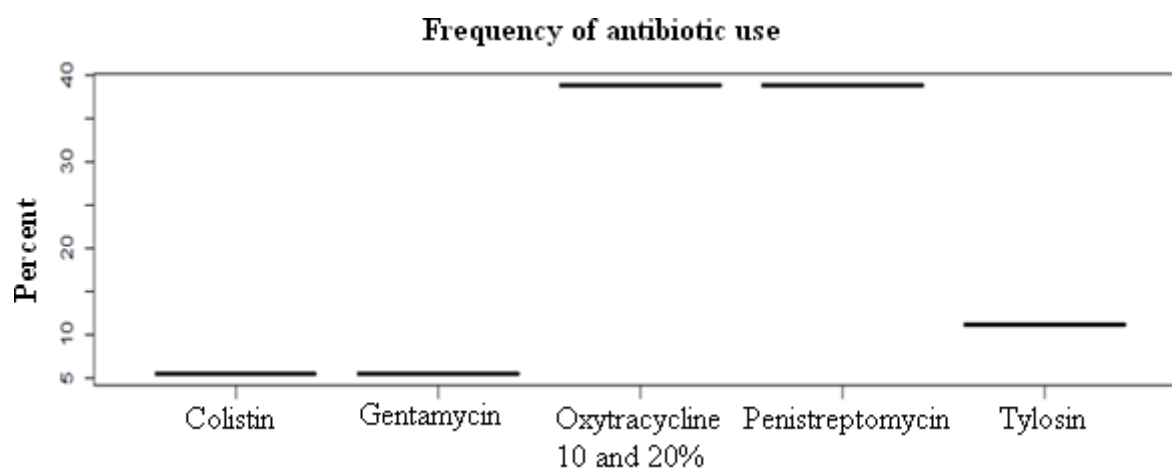


Figure 1 : Frequency of Antibiotic Use

We observed a concerning and excessive use of oxytetracycline and penicillinstreptomycin in goat farming. These two antibiotics are perceived by professionals as nearly universal solutions, used to treat the majority of the conditions encountered, while other classes of antibiotics are rarely utilized. Such untargeted use promotes the rapid emergence of resistance in many bacterial strains, leading to therapeutic failures and an increase in animal mortality. The choice of administered molecules seems to be dictated by their availability on the local market, the prescribing habits of veterinarians, and the financial capacity of farmers to afford treatment. According to the European Medicines Agency, goats are considered minor species among those intended for human consumption, which may explain the still limited development of specific veterinary products for this species. ^{12,13}

3.7. Duration of Treatment

The duration of treatment was evaluated in order to better understand the impact of the health and therapeutic practices implemented on the progression of diseases within goat farms. The results obtained are presented in the figure 2.

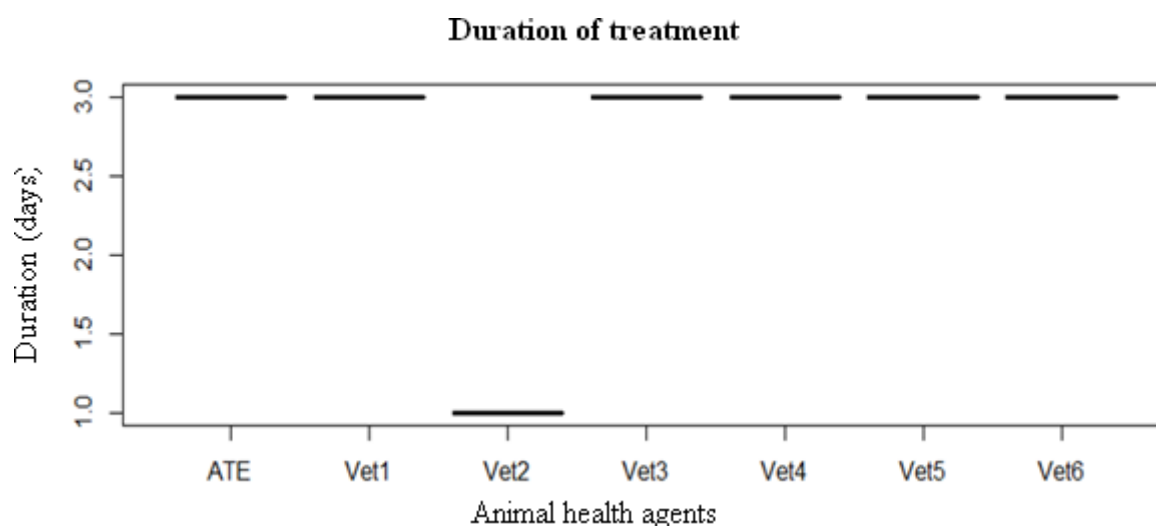


Figure 2 : Duration of Treatment

The analysis of veterinary practices reveals that the majority of veterinarians administer oxytetracycline, a bacteriostatic antibiotic, for approximately 72 hours. However, dosing recommendations suggest administration over a period of 3 to 5 days, with doses ranging from 5 to 10 mg/kg of body weight per day. This shortened duration could promote the development of bacterial resistance. Regarding penicillin-streptomycin, a bactericidal antibiotic, veterinarians generally adhere to a minimum treatment duration of 3 days. Furthermore, veterinarians reported treatment failures, which could be attributed to inappropriate practices and the quality of the available medications.

3.8. Medical Measures in Case of Failure

After treatment failure, veterinary practitioners adopt options for the next steps (figure 3).

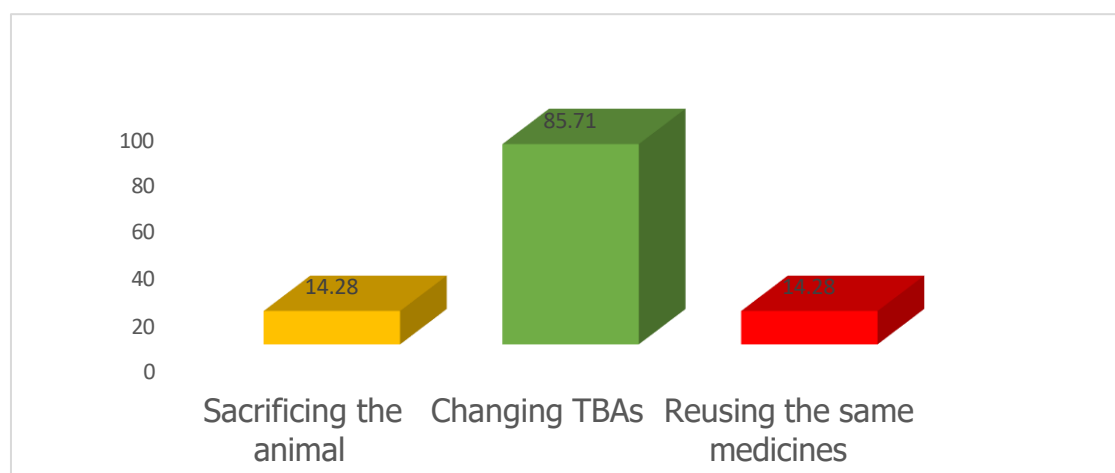


Figure 3 : Measures Taken in Case of Treatment Failure

The veterinarians contacted reported having encountered treatment failures during their sessions. These failures could be attributed to various practices, such as the systematic use of the same molecules to treat all diseases over a long period, poor diagnostics, inappropriate antibiotic choices based on the disease cause, a limited number of antibiotics available on the market, a treatment duration that is too short, as well as non-compliance with the treatment program by the farmers. All these factors indicate a significant presence of antimicrobial resistance. According to Dognon et al., 2018, it appears that many veterinary medicines marketed on the West African market are of poor quality. Among the medications identified in 2005, 61% in Mali and 48% in Togo were counterfeit drugs¹⁴.

3.9. Compliance with Treatment Instructions by the Farmer

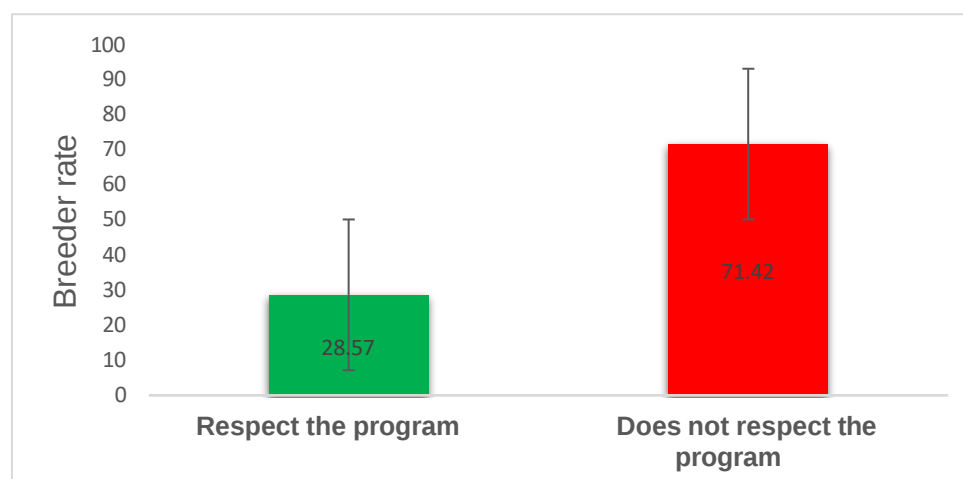


Figure 4 : Rate of Compliance with Treatment Instructions by Farmers

According to the figure 4, it appears that most farmers generally do not adhere to the instructions provided by the veterinarian. This observation is significant, as the success of a treatment largely depends on the farmer's willingness to follow the prescribed regimen. Indeed, as the primary caretaker of the animals, the farmer represents the first link in the chain of traceability and documentation of drug treatments.

3.10. Measures Taken by Veterinarians in Case of Non-Compliance with the Treatment Regimen

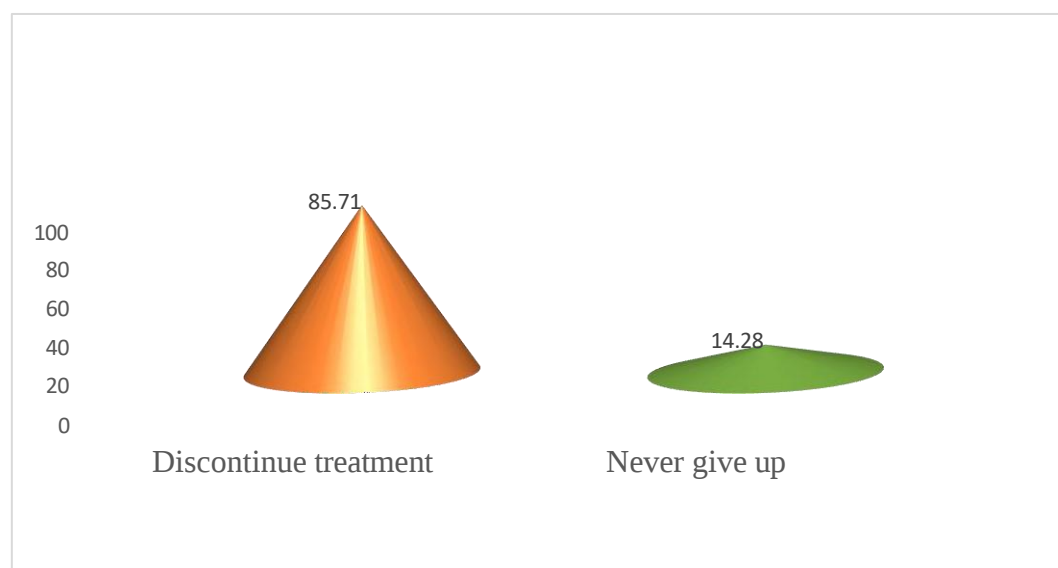


Figure 5 : Measures Taken by the Treating Veterinarian in Case of Farmer Reluctance

It was observed that 85.71% of veterinarians discontinue the treatment when the animal owner fails to comply with the prescribed treatment regimen (Figure 5).

3.11. Management of Waste from Veterinary Treatments

During the study, we observed that waste generated from veterinary care is managed with varying degrees of responsibility by the involved stakeholders. Most veterinarians take care to dispose of waste from medications and treatment materials, either by discarding it into septic pits, incinerating it, or, regrettably, sometimes abandoning it in the environment. Among these methods, incineration appears to be the most appropriate. It not only helps protect the environment particularly aquatic ecosystems and water resources but also safeguards public health. Most veterinarians take care to dispose of waste from medications and treatment materials, either by discarding it into septic pits, incinerating it, or, regrettably, sometimes abandoning it in the environment.

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3.12. Challenges Faced by Veterinarians

Veterinarians report a range of challenges, primarily concerning the collection of health-related data directly associated with the administration of treatments, monitoring disease progression, and the time required for effective follow-up. These challenges are compounded by the frequent reluctance of livestock owners to adhere to the principles and recommendations provided by veterinary professionals. Such resistance can negatively impact the veterinarian's decision-making process and compromise the expected outcomes of treatments.

3.13. Findings from Farmers

Field visits and interviews were conducted at livestock sites to gain deeper insight into farmers' management strategies and practices. The results of these observations and discussions are presented below.

3.13.1. Goat Farming Methods and Objectives

All surveyed farmers engage in extensive goat farming systems. Some occasionally provide supplementary feed such as bread or salt. Regarding the main objectives of their farming activities, 3.33% of the farmers cited an economic motivation, viewing goat farming as an investment often through breeding and fattening systems intended to generate income. Approximately 36.66% reported practicing animal husbandry as part of a family tradition, while 60% stated that their primary goal was to meet daily household needs (e.g., baptisms, weddings, healthcare, funerals, food expenses, etc.). Overall, these observations suggest that livestock farming is predominantly perceived as a means of progressively fulfilling various social and economic needs of households, with objectives varying according to individual and familial contexts.

3.13.2. Experience of the farmers

The experience level of livestock farmers varies considerably across the surveyed population.

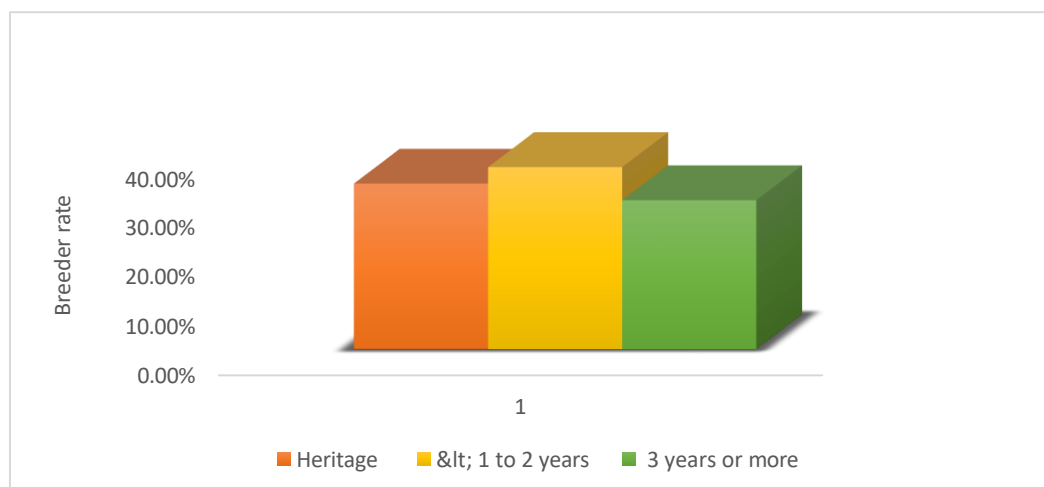


Figure 6 : Experience Related to Livestock Duration

From the figure 6, it appears that the majority of the farmers surveyed are at an early stage in their farming careers, with between 1 and 2 years of experience. This situation could be explained by several factors, including the limited availability of pasture areas and climatic constraints—particularly during the rainy season, when animals are often tethered to prevent roaming and minimize sanitary risks.

3.14. Livestock Characteristics

3.14.1. Animals breeds

All surveyed farmers raise the Guinea dwarf goat breed. This choice is largely due to its resistance and excellent adaptation to local climatic conditions. In West Africa, two major indigenous goat groups are generally identified: the Sahelian goat and the West African Dwarf goat, also known as the Djallonké. The Guinea dwarf goat is particularly recommended for areas with high rainfall, where disease risk is elevated¹⁵.

3.14.2. Livestock housing

According to the survey results, 90% of the farmers have proper housing facilities for their animals, while 10% shelter them in unfinished buildings. These housing systems can improve livestock welfare and health by protecting animals from heat stress¹⁶.

3.14.3. Livestock population

The animals were categorised according to the approximate number held per farmer (Figure 7).

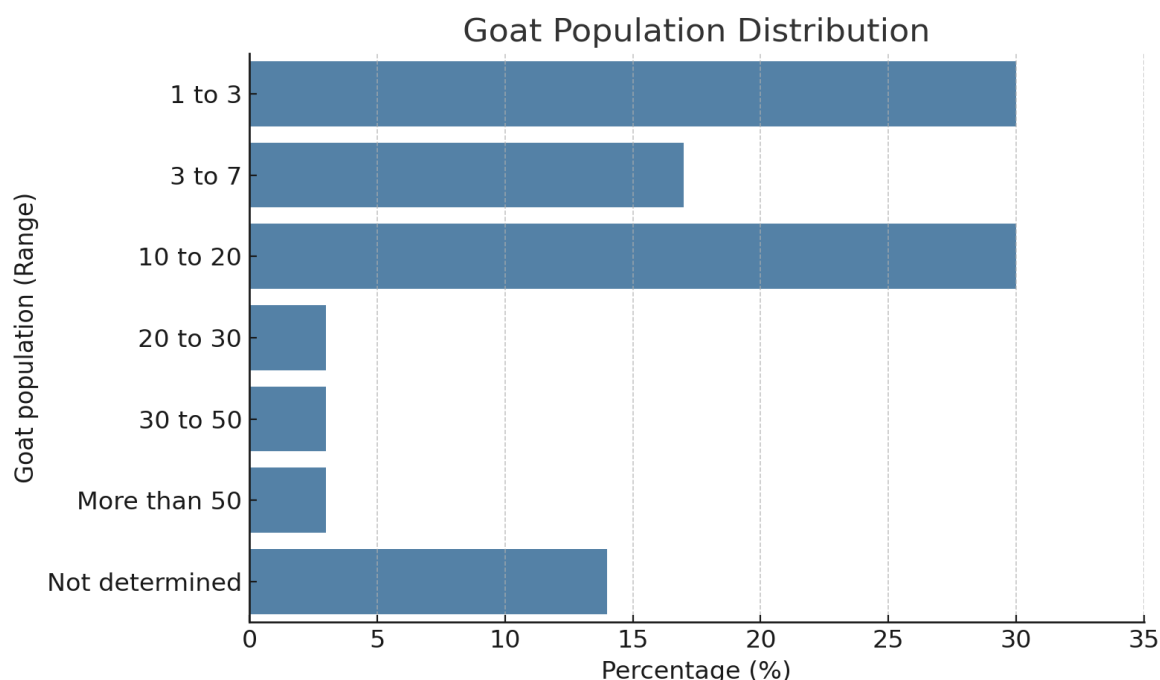


Figure 7 : Situation of Goat Populations by Farm

Animal populations vary considerably from one farmer to another. During the survey, 30% of farmers reported owning between 1 and 3 animals (Figure 7). The small size of herds is mainly due to their status as amateur farmers, the lack of space dedicated to this activity, difficulties related to feeding, and the emergence of seasonal diseases such as small ruminant pest (PPR).

3.14.4. Animal Feeding

Animal feeding is a crucial factor in livestock management. It represents the primary and most challenging activity to manage, as demonstrated by the following figures 8 and 9.

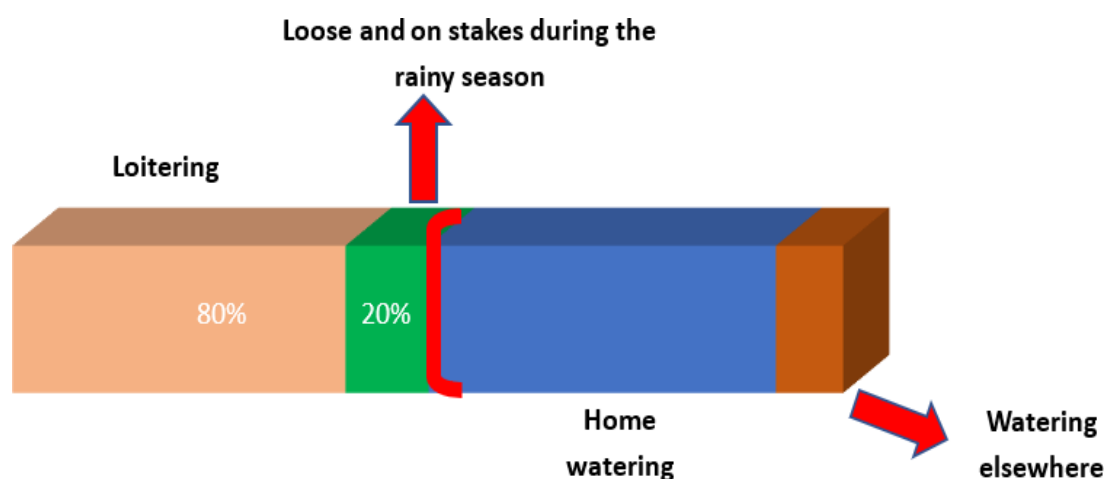


Figure 8: Animal Feeding Practices

3.14.5. Health Management in Case of Disease

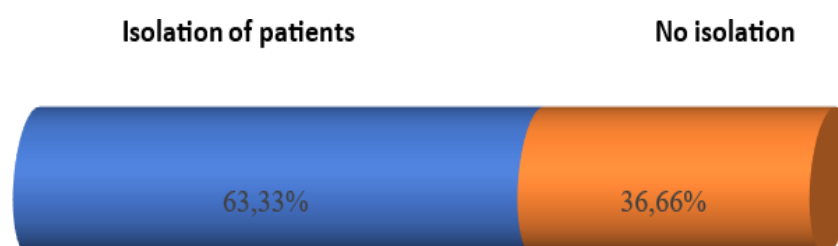


Figure 9: Management of Sick Animals

According to the figure 8 and 9, 63.33% of farmers report isolating their sick animals in order to prevent contamination of the rest of the herd. On the other hand, those who do not practice isolation cite the main difficulty as the lack or inadequacy of suitable facilities for this essential health measure.

3.15. Problems encountered in ensuring the health and safety of goat farms

Goat farmers face numerous challenges related to animal health security, including attacks by predators (stray carnivores), as well as various diseases such as bronchitis, plague of small ruminants, and symptomatic anthrax. They are also confronted with issues such as coughing, diarrhea, mortality in young animals, stomatitis, conjunctivitis, as well as plastic ingestion and skin diseases. Furthermore, accidents and thefts result in significant losses. Additionally, managing animal nutrition during the rainy season remains a major challenge for the farmers.

According to goat farmers in the commune of Mamou, predation, particularly by stray dogs, is reported as the main concern affecting their livestock. These farmers view dogs as one of the major obstacles to the development of their herds.

In the course of this study, we collected the needs expressed by livestock farmers in relation to the difficulties they encounter. Their main concern is access to high- quality veterinary drugs, with the aim of continuing, for some, the practice of self- medication. However, other farmers expressed greater concern about the need to eliminate stray dogs, to effectively control animal diseases, and to import improved goat breeds in order to increase meat and milk production.

4. Discussion :

This study conducted in Mamou reveals a source for concern regarding veterinary practices in goat farming, with significant implications for both animal and public health. Due to the lack of clear and effective regulatory frameworks, herd health management often relies on empirical and non-standardized practices. The most frequently reported diseases, namely small ruminant pest, anthrax, parasitic infestations, respiratory infections, pasteurellosis, anthrax fever, and mastitis, reflect common health problems in extensive farming systems in sub-Saharan Africa. These results are consistent with those of previous studies conducted in Benin, confirming similar epidemiological patterns across all regions due to similar ecological and production conditions¹⁷. It is essential to note that the frequent treatment failures observed in livestock farms in Mamou indicate deeper systemic challenges. These include the inappropriate use of antibiotics, self-medication by farmers, the purchase of veterinary drugs on unregulated markets, and limited diagnostic capacity. These practices are well recognized as major contributing factors to antimicrobial resistance, which poses a serious threat to global public health. Our findings are consistent with those of Kingsley (2015), who noted that the prevalence of low-quality and counterfeit veterinary drugs compromises treatment outcomes and promotes bacterial resistance¹⁸.

Our analysis of veterinary interventions shows a big difference between local practices and international standards. According to global action plans against antimicrobial resistance, like the Global Action Plan on Antimicrobial Resistance¹⁹, antibiotics used in veterinary medicine should follow strict clinical protocols based on risk. However, our study highlights the frequent use of antibiotics for prophylactic purposes in healthy

animals, a practice strongly discouraged by international guidelines due to its contribution to the selection and spread of resistant strains^{20,21}. Without remedial action, this could have consequences for human health, particularly in communities where the risks of zoonotic transmission and drug residues in animal products are not monitored. In Guinea, the insufficient number of veterinary laboratories, essential reagents, and diagnostic equipment significantly hinders rational prescribing. These factors contribute to a high level of empirical treatment and diagnostic errors, creating a favorable environment for resistance. As points out by authors, the limitation of inappropriate antimicrobial prescriptions is a fundamental responsibility of veterinary professionals in the global fight against antimicrobial resistance²¹.

Furthermore, this study reveals that farmers rarely observe prescriptions, unlike in Madagascar, where veterinary recommendations are followed more consistently²². These differences in practices highlight the need to strengthen farmer education, enhance relations between veterinarians and farmers, and increase institutional support. However, it is encouraging to observe that a number of modern farmers in Mamou is actively pursuing quality services and developing better health management skills, demonstrating that positive transformation is possible with a strengthened support system. Another issue that is neglected despite its crucial importance is medical waste management. The inadequate disposal of antibiotics, syringes, and used equipments, often in the environment, poses a risk to the environment and public health. A similar study conducted in Dakar revealed that only 5% of veterinary establishments incinerated waste, while 38% disposed of it in landfills²³, illustrating a regional trend toward poor pharmaceutical waste management.

The socio-economic profile of livestock farming in Mamou should also be taken into consideration. Although 60% of farmers breed goats for their own consumption, only 3.33% do so for economic reasons. These factors limit opportunities for implementing high-quality health interventions and reinforce unconventional treatment strategies. The unregulated nature of animal feeding and watering practices, combined with extensive farming systems, further complicates disease control efforts and may promote the circulation of resistant pathogens.^{24,17} Furthermore, access to high-quality veterinary medicines is a major concern. As in Cameroon, where 53% of farmers reported difficulties in obtaining veterinary medicines (Tchouamo, 2005), our research indicates that the unregulated distribution channels used in Mamou expose farmers to poor-quality or counterfeit products, which directly harms animal welfare and indirectly

increases the risk of antimicrobial resistance.

In conclusion, this study highlights significant gaps in veterinary governance and practices in Guinea. The consequences for public health, particularly in terms of antimicrobial resistance, are alarming. In order to align national efforts with international strategies to combat antibiotic resistance, it is imperative to strengthen diagnostic capabilities through appropriate infrastructure and targeted training, promote the rational and evidence-based use of antibiotics, strengthen regulations governing the distribution of veterinary drugs, and raise awareness among livestock farmers while encouraging their collaboration with animal health professionals. These measures are essential not only to improve animal health and productivity, but also to protect public health and contribute to global efforts to combat antimicrobial resistance.

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Conflict of Interest

All authors declare that there is no conflict of interest.

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