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Antibiotic use practices in food systems in Senegal: a cross-sectional survey of pastoral livestock farming in Kaffrine

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Antibiotic resistance (ABR) is recognised as a critical One Health challenge globally, threatening human, animal, and environmental health. In Senegal, pastoral livestock systems provide the bulk of animal-source foods, yet little evidence exists on antibiotic use practices that may foster ABR. This study aimed to investigate antibiotic use in pastoral farming in Kaffrine, Senegal, and its implication for ABR transmission across the food system. A cross-sectional survey was conducted between March and April 2023 among 220 pastoralists in Kaffrine. Participants were selected using Schwartz' formula, and data were collected through face-to-face interviews using an adapted CGIAR AMUSE Livestock questionnaire, translated into local languages. Data were analysed descriptively with R Studio (version 4.3.2.). Respondents were predominantly men (86.8%), with limited formal education (81%). Common animal diseases included Plague of small ruminants (52.7%), Lumpy skin disease (39%), and Pasteurellosis (28.1%). Antibiotic use was extensive, dominated by tetracyclines (88.6%), followed by penicillins (10.4%). Usage was mainly for treatment (94%), prevention (42.7%), and growth promotion (33%). Administration was carried out by para-veterinarians (50.9%) and untrained auxiliaries (45.9%), while 40.5% of pastoralists practiced self-medication for their animals. Although 65.5% recognised ABR as a public health issue, only 5.5% adopted reduction strategies, primarily vaccination. Notably, 65.5% administered antibiotics to lactating animals, and only 55% observed withdrawal periods before slaughter, averaging 4 days. Non-compliance, inadequate dosages, and treatment interruptions were frequent. Despite awareness of ABR, misuse of antibiotic remains generalized in pastoral systems in Kaffrine, posing significant food safety and public health risks. Expanding access to veterinary services, strengthening vaccination programmes, and enhancing antibiotic stewardship through an increased number of veterinary drug inspectors and adequate financial resources for effective monitoring and regulatory oversight are critical to mitigating ABR and safeguarding sustainable food systems.

KEYWORDS

antibiotic resistance, antibiotic use, food systems, one health, pastoralism, Senegal

Introduction

Antibiotic resistance is on the World Health Organisation's (WHO) list of ten health emergencies facing the world (Dix menaces pour la santé, 2019). It was responsible for 1 million deaths worldwide in 2021 (Naghavi et al., 2024) and is expected to have serious health, social and economic repercussions if it is not given the appropriate political priority (Accueil, 2025). Resistant bacteria exist in humans, animals, food and the environment, and there are limited barriers to the transmission of resistance genes across bacterial species and compartments (Founou et al., 2016). Bacteria can be naturally resistant; however, exposure to antibiotics is one of the main factors in the emergence and spread of resistance genes (Bordier et al., 2018).

The use of antibiotics in livestock farming has been used to support animal production, especially in developing countries (Grace, 2015), but the inappropriate use of antibiotics in food-producing animals is one of the factors contributing to the emergence of antibiotic resistance. Furthermore, this resistance can spread throughout the food chain, contributing to infections in humans (Lambraki et al., 2022). Antibiotic resistance is essentially a One Health issue involving various sectors and stakeholders, and requiring cross-sectoral policies and interventions (Robinson et al., 2016).

In Senegal, animal-source food needs are mainly met through pastoral livestock farming, especially for populations in large cities (Orou Seko et al., 2019). More than 80% of meat and milk production and sale is informal. In addition, nearly 80% of the urban population, including schoolchildren, students, employees, the unemployed, street children and traders, eat at informal food markets that are affordable and easily accessible outside their homes (Yougbaré, 2014). Thus, the practices of actors within this food system can contribute to the emergence and spread of antibiotic resistance. The informal food system, and poor practices across it, therefore has the potential to mediate individual and community health at all points along the farm-to-fork food chain, especially at the human-animal-environment interface (Orou Seko et al., 2022; Leone et al., 2022). However, studies on antibiotic use practices in pastoral settings are very limited in Senegal compared to the

literature available in other countries such as Ethiopia (Tufa et al., 2023) and Nigeria (Alhaji et al., 2019). It remains relatively unexplored compared to research carried out in modern poultry farming (Emes et al., 2023).

In a context marked by strong interest in the development of healthy and sustainable food systems, this study aims to analyse the various practices involving the use of antibiotics that may contribute to the emergence and spread of antibiotic resistance through the food chain in pastoral areas in Senegal.

Materials and methods

Study area and sample

This cross-sectional study was conducted between March and April 2023 among livestock farmers in various departments of the Kaffrine region, a pastoral region in central Senegal (14° 07' north, 15° 42' west) (Figure 1).

Kaffrine remains one of the largest pastoral areas supplying meat and milk to major cities. Furthermore, during the dry season between February and June, when fodder becomes scarce, the area remains a place of refuge and transit for large-scale pastoralists and their herds (Ciss et al., 2023). It is therefore the ideal location for conducting this study on the use of antibiotics in pastoral livestock farming.

The minimum sample size was calculated using Schwartz formula:

$$N = (Z^2 \times \sigma^2) / L^2$$

applying the following parameters: (Z) a confidence level of 95%, (L) a margin of error of 7% and (σ) an expected proportion of 50% as the actual proportion is unknown.

$$N = (1.95^2 \times 0.5^2) / 0.07^2$$

$$N = 196$$

Thus, the minimum sample size is 196 participants. This number was increased to 236 to account for missing data.

Data collection, management and analysis

We targeted livestock farmers (both men and women) in collaboration with the Kaffrine region animal health service. The CGIAR AMUSE Livestock questionnaire, developed to collect data on antimicrobial use practices in livestock farming, we made minor adaptations by adding variables related to compliance with withdrawal periods for milk and meat, the diversity of animal species reared, and the economic costs associated with antibiotic use. These adaptations were necessary to ensure that the questionnaire was better suited to the pastoral livestock systems that constituted the focus of this study (AMUSE Livestock, 2019). Other adapted versions have previously been used in Ethiopia (Gemedo et al., 2020) and Uganda (Nohrborg et al., 2022). The questionnaire was implemented on Kobotoolbox with the Open Data Kit (ODK) interface to facilitate real-time data entry and generate an Excel database. The questionnaire was administered face-to-face by four project researchers between 24 March and 1 April 2023. The questionnaire was administered in the local

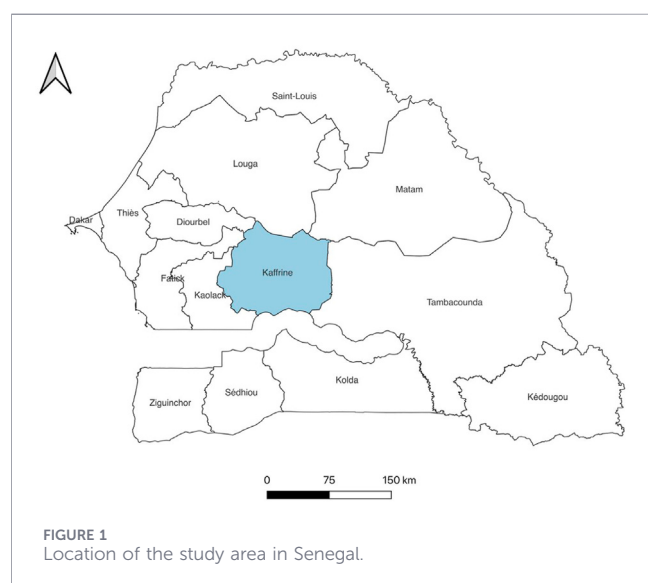


TABLE 1 Sociodemographic characteristics of participants.

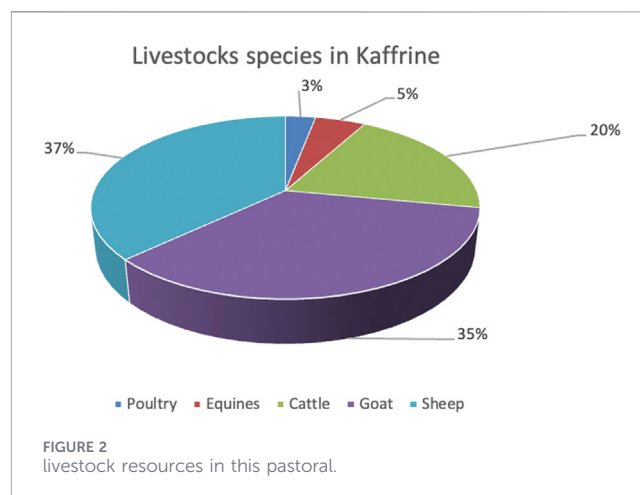
Characteristics	N (%)	95% CI
Gender		
Female	29 (13.2%)	8.7, 17.7
Male	191 (86.8%)	82.3, 91.3
Age (years)		
18–32	18 (13%)	7.4, 18.7
32–50	36 (26%)	18.9, 33.6
>50	83 (61%)	52.4, 68.8
Educational level		
None	178 (81%)	75.7, 86.1
Literacy	11 (5%)	2.1, 7.9
Primary	17 (8%)	4.2, 11.3
Secondary	13 (6%)	2.8, 9.0
University	1 (<1%)	0.0, 1.3
Work experience (years)		
<5	12 (5%)	2.5, 8.5
5–10	24 (11%)	6.8, 15.0
10–20	30 (14%)	9.1, 18.2
15–20	21 (10%)	5.7, 13.4
>20	133 (60%)	54.0, 66.9

language (Wolof and Pular) according to participants' preference after a pilot testing in local languages. A snowball sampling method was used to select farms. This method was chosen because a national database of pastoralist farmers has not yet been compiled, making other sampling methods prohibitively difficult. Four people in total were responsible for data collection, divided into two pairs, each composed of a researcher and a member of the Regional Veterinary Service Division (RDSV) of Kaffrine. Data were collected electronically on smartphones using the Open Data Kit (ODK) platform.

The collected data were cleaned and analysed using R Studio software version (4.3.2). During the data cleaning phase, only complete responses were retained for analysis. During the data cleaning phase, only complete responses were retained for analysis. Questionnaires with a completion rate of less than 90%, as well as those that were abandoned before completion, were excluded from the database used in this study. A total of 16 respondents were thus removed, bringing the final sample analysed to 220 participants. Primarily, a descriptive analysis was conducted to better characterise the study population and antibiotic use practices in pastoral livestock farming.

Ethical approval and informed consent

This study involved human participants who completed an interviewer-administered questionnaire. Although the study did



not involve patients, biological samples, or clinical interventions, ethical approval was obtained from the National Ethics Committee for Health Research (Comité National d'Éthique pour la Recherche en Santé, CNERS), Senegal, in January 2023, prior to data collection. All participants were informed about the objectives of the study, the voluntary nature of their participation, and the confidentiality of the information collected. Written informed consent was obtained from all participants before participation in the survey.

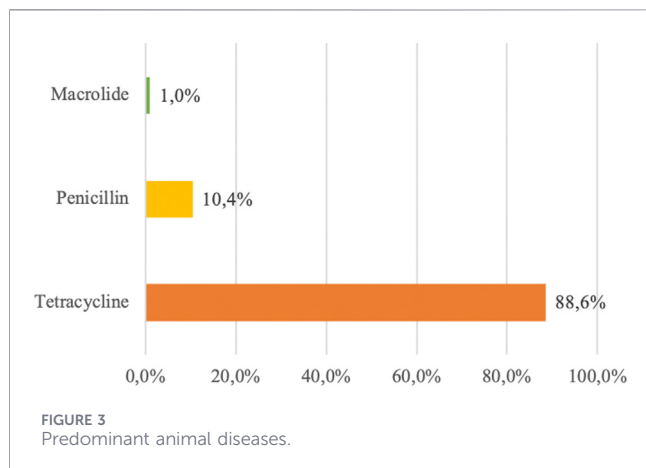
Results

Sociodemographic characteristics and study participants

In this study, there were 220 respondents, of whom 86.8% (191/220) were men and 13.2% (29/220) were women (Table 1). This low participation rate among women reflects gender roles in rural areas. Women are more likely to be involved in household tasks and sometimes in the management of small ruminants. Another characteristic of the pastoral environment is low school enrolment, as shown by the results of this study. The majority (81%) of livestock farmers had not attended the formal government school system but had received education through Koranic schools, an informal system of religious instruction. Regarding age, only 62% (n = 137) of respondents answered this question, reflecting the sensitive nature of age in rural areas. More than half (60%) of the livestock farmers surveyed had over 20 years of experience in pastoral livestock farming in Senegal.

Livestock resources

The survey results highlight the strong dependence of households on livestock resources in this pastoral area. In total, the surveyed households own a herd of 13,856 animals (Figure 2). The dominant species are sheep (37%) and goats (35%), which together account for more than two-thirds of the total livestock population. This predominance can be attributed primarily to their greater adaptability to the mobility requirements of pastoral systems, as well as to their role as a readily accessible form of economic capital that households can mobilize when needed. Cattle account for 20%



of the livestock population and play an important role in household livestock management strategies. Local poultry remains marginal, representing only 3% of the total livestock population. Equines account for 5% of the animals surveyed and fulfil essential functions within pastoral systems, supporting household mobility and facilitating water extraction from wells.

Predominant animal diseases

Respondents reported several major livestock health challenges in the Kaffrine region. Among the diseases identified, Plague of small ruminants was the most frequently reported (52.7%), followed by Lumpy skin disease (39%), Pasteurellosis (28.1%), Botulism (24%), and Foot-and-mouth disease (3.1%). This disease profile reflects the epidemiological conditions typical of Sahelian pastoral systems, where both infectious and production-limiting diseases remain prevalent. The predominance of highly transmissible viral diseases may be associated with high animal densities and frequent herd movements, which facilitate disease spread. Although antibiotics are ineffective against viral infections, their occurrence may indirectly contribute to increased antibiotic use for the prevention or treatment of secondary bacterial infections and disease-related complications (Figure 3).

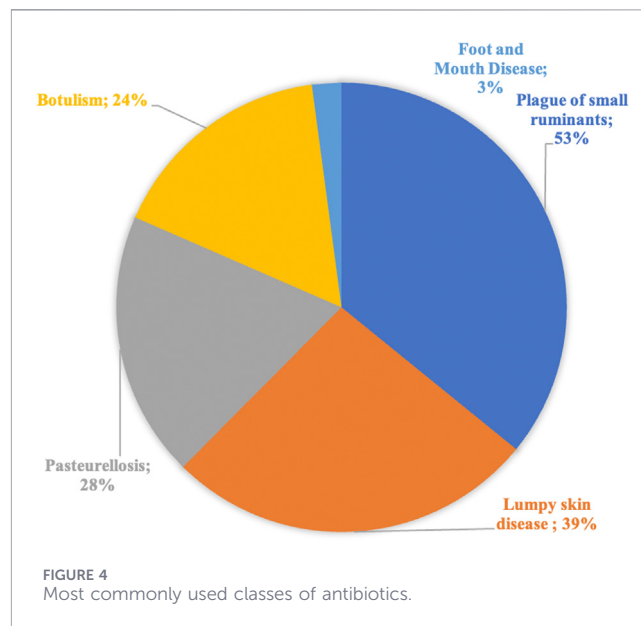
Antibiotic usage practices

Antibiotics used

A generalized antibiotic use was observed in the study area, with all surveyed livestock farmers (100%) reporting antibiotic use in their herds. Thus, 88.6% of the farmers surveyed used tetracyclines, 10.4% used penicillin, and less than 1% in the area used macrolides (Figure 4).

Factors influencing antibiotic use

The farmers surveyed in this area used antibiotics for several reasons. The vast majority (94%) used antibiotics to treat sick animals, while 42.7% reported using them prophylactically to prevent the occurrence of disease. Antibiotics are also used as growth promoters by 33% of farmers in Kaffrine. In addition, when disease breaks out in a herd, 15.4% of owners administer



antibiotics to prevent other symptoms from appearing and other animals from getting sick.

Administration of antibiotics

In most cases (50.9%), antibiotics were administered by veterinary assistants, who are professionals with an intermediate level of training in animal health. In contrast, 45.9% of antibiotic treatments were administered by animal health auxiliaries with no formal academic training. Only 26.8% of farmers reported consulting a veterinary surgeon for antibiotic administration.

Self-medication remains a widespread practice in pastoral areas. Antibiotics were administered directly by livestock owners in 40.5% of cases and by a family member in 4.5% of cases. The practice of self-medication with substandard antibiotics is facilitated by the limited availability of animal health professionals and the unregulated circulation of antibiotics. These products are commonly sold in the two largest weekly markets of Birkilane and Missira.

Our findings further indicate that livestock keepers in the study area are primarily confronted with viral diseases. Nevertheless, antibiotics are frequently used for treatment purposes. This practice is of particular concern, as it promotes inappropriate antibiotic use and constitutes a significant risk factor for the emergence and spread of antimicrobial resistance.

Only 5.5% of respondents reported implementing strategies aimed at reducing antibiotic use. These strategies mainly consisted of improving vaccination coverage to reduce animal exposure to disease, primarily through annual vaccination campaigns organised by government veterinary services for priority diseases. Farmers (19%) also reported the use of traditional remedies available locally as a means of limiting antibiotic use. However, they often lacked knowledge regarding the appropriate dosage of these remedies, which may result in unintended consequences. Notably, none of the livestock farmers surveyed reported implementing biosecurity improvement

measures as a strategy to reduce the need for antibiotic use. The survey further revealed that improved hygiene practices are generally not implemented on farms as a means of preventing disease and reducing reliance on antibiotics.

Knowledge about antibiotic resistance

Antibiotics are medicines familiar to livestock farmers. Overall, 63.6% of respondents reported being able to identify antibiotics available in the study area by their generic names. This level of knowledge is likely to stem from training courses and animal health initiatives carried out as part of livestock farming projects in the region. In addition, 65.5% of livestock farmers recognised antibiotic resistance as an issue that could have an impact on public health and the economy through loss of productivity, mortality due to bacterial diseases, and food safety. However, 28.2% of stakeholders remain sceptical about the harmful effects of the emergence and spread of resistant bacteria.

Risky antibiotic use practices exposing the food system

The farmers surveyed recognised antibiotics and were aware of the negative impacts of antibiotic resistance in livestock farming and on public health. However, this knowledge did not necessarily translate into more judicious antibiotic use. In fact, only 5.5% of farmers are developing strategies to reduce antibiotic use.

Attitudes also show that antibiotics were administered to lactating females whose milk is intended for human consumption by 65.5% of the farmers surveyed. The practice of observing withdrawal periods was applied by 75% of our respondents, with an average duration of 5 days. Antibiotics are also administered to animals destined for slaughter, with an estimated average withdrawal period of 4 days among 55% of farmers. The average treatment period for animals is estimated at 3 days. The majority of farmers (61%) systematically stop administering antibiotics to their animals when no improvement is observed. Conversely, 31% increase the dose, whilst 30% continue treatment with the same antibiotic. Farmers' reasons for stopping treatment were the ineffectiveness of antibiotics (38%), the recovery of sick animals (35%) and the high cost of antibiotics (27%).

Discussion

This study on antibiotic use practices in the pastoralist livestock farming system in Senegal, an essential link in the food system, shows widespread use of antibiotics, mainly from the tetracycline class. The Kaffrine region is an area with high potential for livestock farming and the sale of animal products. The lack of access to animal health services and the circulation of counterfeit medicines encourage self-medication and, in some cases, the discontinuation of treatment. Farmers are aware of antibiotics and antibiotic resistance as a result of awareness campaigns conducted by technical services and various projects operating in this strategic area for livestock farming in the country. However, failure to comply with withdrawal periods for milk and meat, interruption of treatment and over- or under-

dosing are factors contributing to the emergence and spread of antibiotic resistance in the food chain.

Pastoral farming is characterised by the mobility of herds and populations. Animals move from one area to another throughout the year to find the most favourable conditions, which also facilitates the spread of disease. As a result, certain diseases remain endemic in pastoral or semi-pastoral areas such as the Kaffrine region. Our results show that Peste des petits ruminants, Lumpy skin disease, Pasteurellosis, Botulism, and Foot-and-mouth disease are the most common in this area. Observations made in other studies on pastoral livestock farming in Senegal show considerable economic impacts (Jahel et al., 2020; Meyer et al., 2025). This type of farming contributes to the food system by supplying large urban areas with animal products, especially during religious festivals such as Tabaski, Magal de Touba and Gamous (Ciss et al., 2023). On these occasions, large quantities of meat are consumed, sometimes exposing consumers to the risk of zoonotic diseases (Sow et al., 2016; Ndiaye et al., 2021).

Pastoral farmers often have limited access to animal healthcare due to their mobility. As a result, they resort to self-medication for their livestock, sometimes using low-quality antibiotics. Our findings indicate that treatment is administered and discontinued voluntarily, without supervision by animal health professionals. This is not unique to pastoral farming, but has also been observed in much more modern poultry farming, where stakeholders are aware of the importance of having access to health professionals given the significant investments made in Uganda and Senegal (Emes et al., 2023; Nohrborg et al., 2022). Self-medication is also found in similar farming systems in Ethiopia (Gemedo et al., 2020), Nigeria (Alhaji and Isola, 2018) and Malawi (Kainga et al., 2023).

For years, Senegal has focused on raising awareness and training stakeholders in the various livestock sectors, with the support of technical and financial partners such as the Food and Agriculture Organization of the United Nations (FAO). The implementation of the 2018–2022 national action plan for (NAP) antimicrobial resistance has improved knowledge of the issue among the general population and livestock farmers (Keïta et al., 2025). Our results align with this observation: the livestock farmers surveyed were well informed about antibiotic resistance. However, this knowledge was not often translated into practice. Failure to comply with withdrawal periods for meat and milk are practices that compromise the food system and pose a major public health hazard. Studies conducted in Senegal show products containing antibiotic residues are being sold in Dakar, including milk and meat (Niang et al., 2017) and poultry products (Python Ndekou et al., 2023; Vounba et al., 2019; Cissé et al., 2024). This confirms the risks posed by inappropriate antibiotic use practices in African food systems (Nguyen-Viet et al., 2025). However, studies in Africa clearly show that communication and awareness-raising initiatives alone are not sufficient to reduce the inappropriate use of antibiotics. These efforts must be accompanied by the implementation of antibiotic stewardship programmes, a monitoring system and improved access to veterinary services (Sow et al., 2025).

This study used questionnaire tool designed in English and administrated to Wolof and Pular languages since majority of the participants do not possessed formal education to sufficiently answer questions satisfactorily, which is a major limitation. In

this case, the questionnaire was pilot tested in local languages to make sure that no information was lost in the process and the questions are interpreted in the same way as in the original questionnaire.

The results of this study show that pastoral farmers have knowledge of antibiotics and the phenomenon of antibiotic resistance. However, this knowledge needs to be translated into appropriate use and compliance with withdrawal periods in order to ensure food safety. Although the awareness campaigns included in the National Action Plan to combat AMR have substantially improved understanding of antimicrobial resistance, interventions aimed at improving access to animal health services and providing alternatives to antibiotics remain essential to reduce inappropriate antibiotic use. These findings provide evidence to inform One Health policies and interventions aimed at reducing antimicrobial resistance while promoting healthy and sustainable food systems.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

This study involved human participants who completed an interviewer-administered questionnaire. Although the study did not involve patients, biological samples, or clinical interventions, ethical approval was obtained from the National Ethics Committee for Health Research (Comité National d'Éthique pour la Recherche en Santé, CNERs), Senegal, in January 2023, prior to data collection. All participants were informed about the objectives of the study, the voluntary nature of their participation, and the confidentiality of the information collected. Written informed consent was obtained from all participants before participation in the survey.

Author contributions

MS: conceptualization, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft preparation.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was not used in the creation of this manuscript.

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