Plagiarism Checker X - Report

Originality Assessment

5%

Overall Similarity

Date: Mar 4, 2026 (12:48 PM)
Matches: 345 / 6572 words
Sources: 11

Remarks: Low similarity detected, consider making necessary changes if needed.

Verify Report:
Scan this QR Code

v 9.0.7 - WML 4
FILE - IJAR-56435.DOCX

KNOWLEDGE, ATTITUDES, AND PRACTICES (KAP) ON ANTIMICROBIAL USE AND RESISTANCE AMONG POULTRY FARMERS IN SOUTHERN SENEGAL

Saboury Ndiaye1, Michel Dione2, Landing Diedhiou1,3,*, Charles L. Tumuhe4, Fatima Guissé1, Khalifa Keïta1, Abdou Mané1, , Yaye Aminata Gueye4

1. Université Assane Seck de Ziguinchor (UASZ), BP 523, Ziguinchor, Senegal

2. International Livestock Research Institute, BP 24265, Dakar, Senegal

3. ECO-IMPACT Sénégal, Ziguinchor, Senegal

4. Uganda Martyrs University, Faculty of Agriculture, Kampala, Uganda

5. Département de Productions Animales et Élevage, UFR S2ATA, Université Gaston Berger, Sénégal

Correspondence Author’s email: E-mail: l.d7@zig.univ.sn

Abstract

This paper assesses knowledge, attitudes, and practices towards antimicrobial use and antibiotic resistance (AMR) among 135 poultry farmers in the urban and peri-urban areas of Ziguinchor, Senegal, to assess their antimicrobial use practices and their knowledge and attitudes towards antibiotic resistance (AMR). Exploratory and multivariate logistic regression models were used to describe the relationship between knowledge, attitudes, and practices of antibiotic use and the AMR and demographic characteristics of poultry farmers. Key findings reveal that 67% of poultry farmers employed inappropriate antibiotic use, including increasing doses, treating both healthy and sick birds, and administering antibiotics on the eve of slaughter. In addition, poultry farmers under 20 years old ($p=0.033$), with university education ($p=0.078$), trained in poultry farming ($p=0.084$), and with a flock of over 300 chickens ($p=0.07$), were more likely to be familiar with AMR. Additionally, poultry farmers under 20 years old ($p = 0.06$) and those who had reached the university level ($p = 0.035$) were more likely to have a positive attitude toward antimicrobials. However, those with technical training in poultry farming ($p = 0.072$) and those with a flock of over 300 ($p = 0.06$) were less likely to adopt a positive attitude towards antimicrobials. The study recommends strengthening awareness campaigns, promoting

best practices in antimicrobial use, and improving biosecurity measures to reduce misuse and mitigate the risk of antibiotic resistance.
Keywords: Knowledge, Attitude, Practices, antibiotics, antimicrobial resistance, Poultry Farmers

Introduction

In Senegal, the poultry value chain has been expanding since the government suspended imports of chicken meat and table eggs in November 2005 [1]. In addition to supplying animal proteins, poultry farming offers opportunities for job creation and income generation for young people and women. Chicken meat is the most widely consumed meat in Senegal, with production increasing from 115,857 tons in 2017 to 150,000 tons in 2021, accounting for 41% of the country's total meat production [2]. Over the same period, egg production grew at an average annual rate of 17%, from 719 million to 1,300 million units [2]. However, national demand for chicken meat and eggs remains strong in Senegal, due to urbanization, population growth, and the relative evolution of income [1]. This growing demand has triggered the rapid expansion of poultry farms in urban and peri-urban areas, but also and above all the increased use of antimicrobial drugs [3,4]. The inappropriate use of antibiotics and antimicrobial drugs increases the risk of antimicrobial resistance (AMR) and the transmission of zoonotic diseases [5,6]. AMR is considered one of the greatest threats to human and animal health [7]. Recent data indicate that AMR-associated deaths affected nearly 5 million people worldwide in 2019, of which 1.27 million were directly attributable to it [3]. To reduce AMR, the Government of Senegal drew up a national action plan on antimicrobial resistance in 2017 [2]. This action plan aims to strike a balance between the rational use of antibiotics and raising awareness of AMR and infection control as part of the "One Health" approach. In Senegal, studies of AMR on poultry farms are mainly concentrated in the urban and peri-urban areas of Dakar (capital) and Thiès regions, where industrial and intensive poultry farming systems are practiced [8–10]. Currently, there are no AMR studies on semi-intensive poultry systems in Senegal. However, this type of farming, which is expanding rapidly in urban, peri-urban, and rural areas, is still marked by a high prevalence of viral and bacterial diseases and a low to minimal level of application of biosecurity measures [11–13].

In this context, low-income individuals involved in semi-intensive poultry farming face a dilemma between using antibiotics to prevent and treat infections while stimulating flock growth to maximize profits, and reducing antibiotic use with the risk of increased mortality and reduced income. It is therefore important to understand the perceptions and practices of poultry farmers 1 in relation to antimicrobial use and AMR, and to identify the socio-economic and demographic factors that influence them. This is the background to this study, which assesses the knowledge, attitudes, and practices of semi-intensive poultry farming systems in the urban and peri-urban areas of the city of Ziguinchor in southern Senegal. In this area, semi-intensive poultry farming, the subject of this study, is a commercial activity that took off in the 1980s, before gaining new impetus in 2005 following the cessation of chicken meat imports [1]. Since then, new techniques have been introduced, including the use of exotic and improved strains, closed housing, and industrial feed rations [11]. The results of this study will contribute to the improvement of knowledge on AMR to guide political decision-makers in the territorialization of the "One Health" policy on a national scale.

Materials and methods

Study area: The study area is the urban zone of Ziguinchor, the regional capital of southwestern Senegal. It is located between 16° and 17° West, and 12° and 13° North, in a basin bounded by the Casamance River to the north and, respectively, marshy areas to the east and west. The climate is of the southern coastal Sudano type (with an average annual rainfall of 1310.54 mm [14]. The city’s economy is essentially based on agriculture, livestock, fishing, and cross-border trade. Currently, Ziguinchor has an estimated population of 281,915. Rapid urbanization and population growth, combined with the opening of the university, have contributed to an unprecedented increase in demand for meat products, particularly poultry meat [11]. The rising demand for poultry, the low level of farmer training, limited biosecurity, and the heavy use of antibiotics in poultry farming in the urban and peri-urban areas of Ziguinchor justified the choice of this zone.

Figure 4: Geographic location of the study area

Sampling: To select the neighborhoods, the non-probability value judgment sampling method [15,16] and field surveys were used. The 29 neighborhoods selected are in the city of Ziguinchor, located in southern Senegal. These neighborhoods were chosen because they are home to the largest number of chicken coops in the city [11]. For the sample size, Cochran's formula was used to calculate the required sample size for the specified level of precision, confidence level, and the estimated proportion of poultry farmers present in the population. Indeed, at that time, there was no database of poultry farmers in the study area. According to [17], the Cochran's formula is most suitable for a large population. The formula in question is described below (1):

No = sample size; Z = confidence level according to the centered reduced normal distribution (for a 95% confidence level, z = 1.96, for a 99% confidence level, z = 2.575); p = estimated proportion of the population exhibiting the characteristic (when unknown, we use p = 0.1, which corresponds to the worst case, i.e., the widest dispersion); m= tolerated margin of error (for example, we want to know the true proportion to within 5%). With a confidence level of 95% and a margin of error of 5%.

The value of p=0.1 was chosen based on preliminary information and expert knowledge indicating that only a small share of the population was expected to present the characteristic of interest. Using this estimate rather than the conservative p=0.5 prevented an unrealistically large sample size while remaining consistent with local expectations.
The resulting sample size is as follows:

Although the initial target was 138 respondents, the survey successfully covered 135 poultry farmers who agreed to answer our questions, representing a robust and diverse sample despite the limited availability of some participants during the data collection phase.

Data collection: Data collection was based on a questionnaire drawn up on the basis of an in-depth review of the scientific literature. To ensure the relevance of the questions and the methodological appropriateness to the local context, a pilot survey was carried out in the study area. The questionnaire was administered over the period between December and January 2024 by two Bachelor’s-level agronomy students with extensive knowledge of data collection. The KoboToolbox platform (version 2.024.05) 2 was used to develop the questionnaire, which was then deployed on the KoboCollect application (version 2023.2.4) to ensure effective data collection.

Data processing: The data were cleaned and processed in an Excel spreadsheet. In this study, we focus on antibiotics among the various antimicrobials. Antibiotic use practices were assessed by asking a list of 7 questions. The responses of poultry farmers to the given questions were coded in binary format so that a correct response corresponds to 1 (Yes =1) and an incorrect response to 0 (No or Don't know =0). The overall score ranges from 0 to 7 points for each poultry farmer. If the score is greater than or equal to four (4), the poultry farmer is classified as making good use of antibiotics. The poultry farmer is classified as making poor use of them, otherwise (score between 0 and 3). So, this approach permitted the generation of a binary variable, used to define two groups of poultry farmers according to their antibiotic use score. This variable takes the value 1 if the poultry farmer makes appropriate use of antibiotics (i.e., a score greater than or equal to 4) or takes the value 0 if he makes inappropriate use of antibiotics (i.e., a score between 0 and 3). This binary variable (1 or 0) on antibiotic use was used to estimate the logistic regression.

Regarding the assessment of poultry farmers' attitudes towards AMR, a list of 4 questions was asked, including only positive affirmations. A 4-modality Likert scale was used 6 (strongly disagree, disagree, agree, and strongly agree) [18]. For each positive statement, "agree" or "strongly agree" = 1, and "strongly disagree" and "disagree" = 0. The total score was calculated by adding up the scores for each statement and ranged from 0 to 4. If the score is greater than or equal to three (3), the poultry farmer is classified as having a positive attitude towards antibiotic resistance. The poultry farmer is classified as having a negative attitude toward them, otherwise (score between 0 and 2). A binary variable was used to define groups of poultry farmers according to their attitude towards antibiotic resistance. This variable 9 takes the value 1 if the poultry farmer has a positive attitude towards antibiotic resistance (i.e., a score greater than or equal to 3) or takes the value 0 if he has a negative attitude towards antibiotic resistance (i.e., between 0 and 2).

Data analysis: STATA/SE-17.0 software (StataCorp, 4905 Lake Way Drive, College Station, TX 77845, USA) was used for data analysis. Cronbach's alpha test was used to measure internal consistency between themes. With an overall value of 0.71 (>0.50), the questions on knowledge, attitudes, and practices are sufficiently consistent to explain the obtained results. A multicollinearity test was carried out on the socio-demographic and economic variables, yielding a Variance Inflation Factor (VIF) of 1.21, which is less than 10. This means that there are no problems of multicollinearity between the socio-demographic and economic variables in our model. 7 Descriptive statistics such as frequencies and percentages were also used. Also, relationships between socio-economic variables and the level of knowledge, practices, and attitudes were explored using the Pearson Chi-square test. Finally, logistic regression was used to identify and determine the socio-demographic and economic variables influencing poultry farmers' knowledge, attitudes, and practices in relation to antibiotic use practices and attitudes towards AMR. Results are presented as Odds Ratios (OR), with 95% confidence intervals (CI) as the criterion for statistical significance. Equations 1 and 2 present the logistic regression model (Logit):

Where,   is the probability of a poultry farmer applying appropriate antibiotic use practices and having a positive attitude towards AMR ;   Représente les variables dépendantes (pratique appropriée ou non appropriée d'usage des antibiotiques : 1 ou 0 ; attitude positive ou négative par rapport aux antibiotiques : 1 ou 0 ;   est l'ordonnée à l'origine ;   est le coefficient des variables explicatives ;   représente les variables explicatives (âge, sexe, statut matrimonial, éducation, taille cheptel, formation, etc.) ; est le nombre de variables explicatives.

Results

Socio-economic characteristics: The results in Table 1 indicate that men (77%) play a more important role in poultry production than women (23%). In terms of age, more than half of poultry farmers are young people (67%), with a majority having a secondary education (High school) (53%). Among poultry farmers, the majority belong to the Diola ethnic group (40%), 20% to the Mandingo ethnic group, and 39% to other ethnic groups. Just over half (52%) are married, while a significant proportion are single (46%).

The results also show that the majority of farmers (96%) devote themselves solely to broiler production, while a minority (4%) combine this with egg production. Poultry farming is a secondary activity for most of them (61%), whose main activity is trading. The majority of the surveyed farmers are new to poultry production, with nearly half (40%) having less than 5 years' experience in poultry farming, compared with 32% who have between 5 and 10 years' experience, and only 28% who have more than 10 years' experience. Notably, it is surprising to observe that more than half of farmers (66%) report never having received any technical training in poultry farming. In addition to poultry production, farmers are also active in goat breeding.

Table 1. Demographic and socioeconomic information of the respondents

Variables

Modalities

Proportions

Gender

Male

77,04%

Female

22,96%

Age range

<20

67%

21-35

21%

>35

12%

Education level

Primary

21,48%

High School

52,59%

Other

26,92%

Ethnic groups

Diola

40,74%

Mandingo

20,19%

Other ethnic groups

39,07%

Marital status

Married

53,33%

Single

45,93%

Types of poultry production

Only broiler chickens

96%

Broiler chickens and eggs

4%

Poultry training

No

65,93%

Yes

34,07%

Poultry farming experience (years)

0-4

40%

5-10

31,85%

> 10

28,15%

3 Poultry farming is the main activity

Yes

38,52%

No

61,48%

Animal species raised

Poultry

69,64%

Goats

20,74%

Pigs

4,44%

Sheep

2,96%

Cattle

2,22%

Poultry species raised

Chickens

74,82%

Ducks

21,48%

Guinea fowl

2,22%

Turkeys

1,48%

Zootechnical parameters: The data in Table 2 show that the average broiler flock size is 331 birds per farm. By category, 43% of farms have a flock size of 100 birds or fewer, while 44% have a flock size between 100 and 300 birds. Only 13% of farms have more than 300 birds. The average age of a broiler chicken per production cycle is 44.22 days, with a minimum of 33 days [3] and a maximum of 60 days. According to the respondents, the average slaughter weight is 2.53kg, with a minimum of 1kg and a maximum of 5kg. The average number of laying hens is 3,292, with a maximum of 8,000. The average age of a laying hen is 196.5 days, with a maximum of 365 days. The average mortality rate, estimated from the data provided by the farmers for each species, is 6.5%. Finally, a farm creates an average of 3 casual jobs and 1 permanent job.

Table 2. Some zootechnical parameters of the poultry flock

Variables	Average	Standard deviation	Min	Max
Number of broilers (no.)	331	1 106	8	10 000
Number of laying hens (no.)	3 292	3 358	105	8 000
Broiler age (days)	44.22			

4.74

33

60

Age of laying hen (days)

196.5

125.59

4

365

Number of eggs produced per day

1 658.33

3 598.48

40

9 000

Broiler sales weight (kg)

2.53

0.64

1

5

Broiler mortality rate (%)

6.75

10.37

0

87

Layer mortality rate (%)

6.5

5.64

0

14

Casual employees (no.)

2.64

1.5

0

15

Permanent employees (no.)

1.01

3.61

0

27

Disease management: Analysis of Figure 1 shows that the main diseases suspected by poultry farmers are coccidiosis (24%) and Gomboro (24%) (Figure 1a). Poultry farmers rarely apply preventive measures to combat disease. For disease management, poultry farmers make greater use of antibiotics (98% frequency of quotation). Figure (1d) shows that poultry farmers use a variety of antibiotics, the most frequently cited being Norfloxacin (31%), Tetracolivit (17%), and Trisylmicin (12%). In addition, very few poultry farmers (11% frequency of quotation) vaccinate their flocks.

Figure 1: Suspected diseases (a); Drugs used (b); Types of antibiotics (c); Biosafety level (d)

Antibiotic use practices: The results in table 3 show that the majority of poultry farmers use antibiotics to both prevent and treat sick and healthy birds, increase the dosage or change antibiotics when they are not effective; treat birds with antibiotics throughout the production cycle and at all ages; continue to treat birds with antibiotics until they are slaughtered and sold; and often use antibiotics intended for human use to treat sick birds. Additionally, some poultry farmers fail to consult a veterinarian regarding antibiotic use and usually do not adhere to the recommended dosage. Very few poultry farmers apply good practices in the use of antibiotics, particularly by following veterinary advice, stopping the use of an antibiotic when it is no longer effective, administering the dose indicated by the veterinarian, and respecting the maximum time limit for antibiotic use before slaughtering and selling broilers. The interviews also revealed that the majority of poultry farmers use the same antibiotic five to ten times during a production cycle, and at all stages of development from start-up to growth and finishing. Overall, the score calculation showed that 67% of poultry farmers apply inappropriate antibiotic use practices, compared with only 33% who apply appropriate practices.

Furthermore, analysis of Table 4 shows that gender ($p = 0.043$), marital status ($p = 0.001$), and poultry flock size ($p = 0.001$) are factors statistically associated with poultry farmers' antibiotic use practices.

Table 3. Antibiotic use practices

Variables

Modalities

Proportions

Sources of the first call for illnesses

Veterinarian

75%

Para vet

3%

Poultry farmer

22%

Reasons for antibiotic use

Prevention

31%

Disease treatment

43%

Limiting disease spread

26%

Subjects of antibiotic molecule administration

Healthy animals only

2%

Healthy and sick birds

98%

Sources of advice on antibiotic use

Myself

5%

Veterinarian

85%

Para vet

1%

Neighboring poultry farmer

8%

Reasons for stopping antibiotic treatment

Expensive treatment

3%

Ineffective treatment

7%

Subject's recovery

40%

Sale

30%

Slaughter

20%

Poultry farmers' reaction to antibiotic treatment failure

Continue with the same treatment

8%

Increase dose

8%

Change antibiotic

27%

Follow-up by vet

23%

Stop treatment

5%

Apply biosecurity

29%

Table 4. Relationship between socio-economic characteristics and antibiotic use

Appropriate practices

N (%)

Inappropriate practices

N (%)

Test Pearson Chi2

Gender

Man

30 (28,85)

74 (71,15)

0,043*

Woman

15 (48,39)

16 (51,61)

Age range (years)

< 20

1 (25)

3 (75)

0,914

21-35

30 (32,97)

61 (67,03)

> 35

14 (35)

26 (65)

Education level

Primary

13 (36,11)

23 (63,89)

0,053

Secondary

28 (14,29)

43 (60,56)

University

4 (14,29)

24 (85,71)

Marital status

Single

12 (19,05)

51 (80,95)

0,001***

Married

33 (45,83)

39 (54,17)

Ethnic group

Diola

19 (34,55)

36 (65,45)

0,656

Manding

4 (23,53)

13 (76,47)

Others

22 (34,92)

41 (65,08)

Religion

Muslim

38 (34,33)

71 (65,14)

0,440

Christian

7 (26,92)

19 (73,08)

Experience (years)

< 5

22 (33,33)

44 (66,67)

0,794

5 to 10

13 (29,55)

31 (70,45)

> 10

9 (37,50)

15 (62,50)

Training

Yes

17 (36,96)

29 (63,04)

0,521

No

28 (34,46)

61 (68,54)

Number of chickens

<100

33 (57,58)

24 (42,11)

0,001***

100 to 300

11 (18,64)

48 (81,36)

More than 300

1 (5,56)

17 (94,44)

>500

48 (78,69)

13 (21,31)

Knowledge and attitude of AMR: 2 The results in Figure 2a show that just over half (53%) of poultry farmers have heard of AMR, compared with 47% who have never heard of it. Figure 2b shows that the main sources of information about AMR are through a veterinarian (24%), training (15%), radio, and social networks (15%). Concerning poultry farmers' attitudes to AMR, the evaluation showed that 72% of poultry farmers have a positive attitude, compared with 28% who have a negative attitude to AMR (Figure 3).

Figure 2: Knowledge of AMR existence (a) and Source of AMR knowledge (b)

Figure 3: Attitude to AMR

The results in Table 5 give more details on the assessment of poultry farmers' attitudes to AMR. Indeed, the majority (61.48%) of poultry farmers agreed that AMR is a major public health problem, compared with 18.52% who disagreed and 20% who were neutral. The majority of poultry farmers agree that the inappropriate 1 use of antimicrobials in poultry farming can hurt human health (73.33%), against 17.04% who disagree and 9.63% who are neutral. Similarly, more than half of poultry farmers believe that antimicrobial resistance is an important health problem (71.22%). Poultry farmers were also in favor of the need for biosecurity measures to prevent AMR (75.56%).

Table 5. Assessment of poultry farmers' attitudes to AMR

Variables	Modalities	Proportions
AMR is a major public health problem	I agree	61,48%
	Neutral	20%
	Disagree	18,52%
Inappropriate use of antimicrobials can hurt human health	Agree	73,33%
	Neutral	9,63%
	Disagree	17,04%
I'm aware of the seriousness and importance of AMR	Agree	71,22%
	Neutral	11,11%
	Disagree	17,78%

The application of bio-security measures 3 to limit the spread of disease and the use of antibiotics to prevent AMR

Agree

75,56%

Neutral

11,11%

Disagree

13,33%

Factors associated with AMR knowledge and attitude: Analysis of the results in Table 6 shows that age, level of education, and marital status are positively and statistically correlated with knowledge of AMR. In fact, poultry farmers under 20 years of age are 13.98 times more likely to have a higher knowledge of AMR (OR=13.92; CI=1.23-156.57; p=0.033) and 1.59 times more likely to have a positive attitude towards AMR (OR=1.59; CI=0.10-3.07; p=0.035) than those over 20 years of age. Similarly, university graduates were 3.75 times more likely to have better knowledge of AMR (OR=3.73; CI=0.86-16.19; p=0.078) and 0.84 times more likely to have a positive attitude to AMR (OR=0.84; CI=-0.04-1.73; p=0.06) than secondary and primary school graduates. Also, married poultry farmers were 2.99 times more likely to know about AMR (OR=2.99; CI=0.93-9.63; p=0.065) and 0.68 times more likely to have a positive attitude to AMR (OR=0.63; CI=-0.04-1.31; p=0.068) than those who were single. The analysis also revealed that poultry farmers who had received technical training and those with a flock size of over 300 chickens were more likely to be aware of AMR than those who had not received training (OR=0.40; IR=0.20-3.43; p=0.084) and who had a lower flock size (0.12; CI=0.01-1.24; p=0.07, respectively. In contrast, trained poultry farmers and those with a flock size of over 300 chickens were 0.55 and 1.22 times less likely to have a positive attitude to AMR than untrained farmers and those with a smaller flock size, with (OR= -0.55; CI= -1.16-1.04; p=0.072) and (OR= -1.22; CI= -2.49-0.04; p=0.06), respectively.

Table 6. Logistic regression of the factors associated with knowledge and attitude of AMR

Variables

Knowledge

OR; 95% CI; P-value

Attitude

OR; 95% CI; P-value

Gender

Woman

Reference

Reference

Man

0,76; 0,23-2,43; 0,644

-0,17; -0,85-0,51; 0,625

Age

<20

13,92; 1,23-156,57; 0,033

1,59; 0,10-3,07; 0,035

>35

0,94; 0,29-3,01; 0,926

-0,007; -0,68-0,67; 0,983

21–35

Reference

Reference

Education

Secondary

1,25; 0,39-4,01; 0,704

0,17; -0,51 – 0,87; 0,610

University

3,73; 0,86-16,19; 0,078

0,84; -0,04-1,73; 0,06

Primary

Reference

Reference

Marital status

Married

2,99; 0,93-9,63; 0,065

0,63; -0,04-1,31; 0,068

Single

Reference

Reference

Experience

<5 years

1,61; 0,42-3,14; 0,768

0,07; -0,50-0,62; 0,799

>10 years

0,83; 0,20-3,43; 0,803

-0,12; -0,95-0,69; 0,759

5-10 years

Reference

Reference

Training

yes

0,40; 0,20-3,43; 0,084

-0,55; -1,16-0,04; 0,072

No

Reference

Reference

Number of chickens

<100

0,78; 0,31-1,98; 0,609

-0,13; -0,68-0,40; 0,618

>300

0,12; 0,01-1,24; 0,07

-1,22; -2,49-0,04; 0,060

100-300

Reference

Reference

Discussion

This study relied on self-reported data, which may be subject to recall bias and social desirability bias. Recall bias could have led respondents to misremember or simplify past experiences related to climate risks, while social-desirability bias may have encouraged them to provide answers perceived as more acceptable or favorable. These potential biases might have influenced the accuracy of some responses, possibly leading to an over- or underestimation of poultry farmers' actual perceptions. While these limitations do not invalidate the findings, they should be kept in mind when interpreting the results.

The study showed that very few poultry farmers (11%) vaccinate their flocks, which is surprising given the high prevalence of viral and bacterial diseases in semi-intensive poultry farming. This could be due to the limited access to vets or vaccines. A similar result was found by [19], who showed that less than 5% of poultry farmers in Burkina Faso are vaccinated. Similarly, in Ethiopia, the study carried out by [20] showed that only 30% of poultry farmers vaccinate their flocks. In addition, the study also showed that more than half of poultry farmers had not received training in animal health management, which may explain the low uptake of vaccination. This result is in line with those of [21] and [22], who showed that the lack of information and training of poultry farmers on diseases and vaccination led to low uptake of vaccination and incorrect use of vaccines in Ethiopia. The study also revealed that livestock are exposed to several viral, bacterial, and parasitic diseases, such as Coccidiosis, Gumboro, Avian influenza, Coryza, and Newcastle disease. This seems to be justified by the low level of vaccination of livestock. These results are corroborated by previous studies in Senegal [9,13]. In addition, studies have shown that vaccination of chickens can significantly reduce disease prevalence, improve health, and increase the productivity of poultry flocks [23].

The study also highlighted the high use of antibiotics by poultry farmers, with a frequency of 98%, to treat disease. Overuse of antibiotics is very common on poultry farms. This result is similar to research findings indicating that antibiotics were widely used in poultry farming in Senegal [9,10], Burkina Faso [19], and Bangladesh [24]. Norfloxacin and Tetracolivit are the most widely used antibiotic molecules for this purpose. In fact, these two antibiotics, belonging respectively to the Quinolone and Tetracycline families, are widely used in livestock farming to combat stress due to the transport and placement of chicks in breeding buildings [9,10]. This massive use is also justified by the fact that they are the most prescribed by veterinarians, due to their affordable cost, their broad spectrum of activity against bacteria, their short waiting time, and their efficacy [25]. The results of the study indicate that the majority (67%) of poultry farmers make inappropriate use of antibiotics, which is deplorable. In fact, most of the poultry farmers surveyed administer antibiotic molecules to their animals to both prevent and treat disease. These practices are inappropriate, as the use of antibiotics is only authorized for treatment purposes [9]. The results also showed that poultry farmers overuse antibiotics, with frequencies of use varying from 5 to 10 times per month, which constitutes a risk for the proliferation of antibiotic resistance. On the other hand, the choice of antibiotic molecule is made in most cases by an attending veterinarian. This result confirms earlier work [9,26,27]. The study also showed that the majority of poultry farmers reported ending antibiotic treatment following the recovery of the birds or to sell the birds. This result is in line with that of [5], who showed that 75% of poultry farmers did not respect the antibiotic treatment deadline. Similarly, in Burkina Faso, the work of [19] revealed that 79% of poultry farmers consider it normal to consume and sell broiler chicken or eggs immediately after treatment with antibiotics. However, it should be noted that abrupt cessation of treatment for sales reasons, or repeated administration of antimicrobials, can favor the presence of residues in these commodities. This is confirmed by the work of [28], who found antimicrobial residues in dairy products due to the continued non-compliance with antimicrobial withdrawal periods by some poultry farmers, which favored the emergence of new infections carrying AMR genes. Overall, the study showed that 67% of poultry farmers apply inappropriate antibiotic use practices. Similar results were noted by [29], who showed that 61.3% of poultry farmers in Zambia have poor antibiotic use practices. The study showed that antibiotic use practices were positively and significantly associated with gender (p=0.043), level of education (p=0.053), marital status (p=0.001), and poultry flock size (p=0.001). Similar results were found in Bangladesh by [5] and in Burkina Faso by [19], who showed that gender, education, and flock size significantly influenced poultry farmers' antibiotic use practices.

In relation to antibiotic resistance, the study showed that just over half (53%) of poultry farmers had heard of the existence of AMR, compared with 47% who had never heard of it. The main source of information is the veterinary agent. The knowledge gap highlights the lack of training and awareness of AMR among poultry farmers and veterinary agents. In Senegal, the national action plan on AMR was recently adopted, but its dissemination is still partial. This raises the need to strengthen poultry farmers' AMR skills. Almost similar results were obtained by [29], who found that 46.2% of poultry farmers in Zambia had a very low level of knowledge of AMR. However, they differ from those of [30], who showed that 82% of poultry farmers in Nigeria have a good knowledge of AMR.

Factor analysis showed that poultry farmers aged under 20 years were more likely to have good knowledge of AMR than those aged over 35 years. Young people have more exposure to the internet, where AMR information is often shared. This result disagrees with those of [31] and [24], who showed that poultry farmers aged over 35 were more likely to have good knowledge of AMR. Also, the higher the level of education, the more likely poultry farmers were to have a better knowledge of AMR. Also, those with medium-sized flocks are more likely than others to have a good knowledge of AMR. These results are confirmed by other studies [5,31]. About attitude, it is surprising to note that poultry farmers who had received training were less likely to have a positive attitude towards AMR than those who had not been trained. This result disagrees with that of [31] and can be explained by the fact that the training courses did not focus on AMR, but rather on poultry production techniques. Also, those of average size were less likely to have a positive attitude to AMR, as confirmed by the results of [31].

The findings reveal a notable discrepancy between knowledge and practice: although just over half of the poultry farmers (53%) were aware of antimicrobial resistance (AMR), only 33% demonstrated appropriate antibiotic use practices. This indicates that awareness alone does not necessarily translate into responsible behavior. To better understand this, disconnect, the application of a behavioral framework, such as the Health Belief Model [32], could provide valuable insight by examining factors like perceived risk, benefits, and barriers to action that influence decision-making beyond mere knowledge acquisition.

The finding that trained poultry farmers were less likely to hold positive attitudes toward AMR is both surprising and contradictory, as training is generally expected to foster better awareness and responsible practices (see [31]). This anomaly may stem from the fact that most technical training focuses on productivity and poultry management, rather than on antimicrobial resistance or biosecurity. As a result, trained farmers may prioritize efficiency over cautious antibiotic use. Future studies should disaggregate training types and assess their content to clarify this relationship and ensure training aligns with public health goals.

Conclusion

This study demonstrated the inappropriate use of antibiotics by poultry farmers in

Senegal. These inappropriate practices constitute a major challenge that limits the productivity of semi-intensive poultry farms, and represent 3 a public health problem due to the interactions that exist between animals and humans, particularly in proximity areas such as urban and peri-urban areas. Furthermore, antimicrobial resistance (AMR) disproportionately affects low- and middle-income countries, which are heavily affected by infectious diseases, compounded by relatively easy access to antibiotics. To reduce 1 the inappropriate use of antibiotics in poultry farming in Senegal, our results suggest targeting the following areas: raising awareness among poultry farmers and strengthening access to quality veterinary services.

Acknowledgments

We would like to thank the staff of the Agroforestry and Ecology Laboratory (LAFE) at Assane Seck University in Ziguinchor and 2 the International Livestock Research Institute (ILRI), as well as everyone who contributed to this research project in any way. We would also like to thank the respondents who helped provide this valuable information.

Disclosure 4 statement: The authors declare no conflicts of interest.

Authors' contributions: SN, LD and MD conceptualized the study. SN developed the methodology and handled the software implementation. Formal analysis and data curation were performed by SN. The investigation was conducted by KK, AM, SN and LD prepared the original draft, which was subsequently reviewed and edited by MD, CLT, YAG, and FG. Visualization was performed by SN, MD, CLT, and LD. Validation was carried out by SN, MD and LD. Project supervision and administration were led by SN. 5 All authors have read and approved the final version of the manuscript.

References

1. Ly, C. Aviculture et Covid-19 au Sénégal : Situation et perspectives.; Initiative Prospective Agricole et Rurale (IPAR): Senegal, 2020; p. 43;.

2. MEPA Document de programmation pluriannuelle des dépenses (DPPD) 2020-2022; Ministère de l’Elevage et des Productions Animales: Senegal, 2019; p. 48;.

3. FAO The Future of Livestock in Ethiopia: Opportunities and Challenges in the Face of Uncertainty. (accessed on 14 August 2025).
4. WHO Antimicrobial resistance Available online: https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance (accessed on 13 August 2025).
5. Hossain, A.; Habibullah-Al-Mamun, Md.; Nagano, I.; Masunaga, S.; Kitazawa, D.; Matsuda, H. Antibiotics, Antibiotic-Resistant Bacteria, and Resistance Genes in Aquaculture: Risks, Current Concern, and Future Thinking. Environ Sci Pollut Res 2022, 29, 11054–11075, doi:10.1007/s11356-021-17825-4.
6. Puvača, N.; Ljubojević Pelić, D.; Pelić, M.; Bursić, V.; Tufarelli, V.; Piemontese, L.; Vuković, G. Microbial Resistance to Antibiotics and Biofilm Formation of Bacterial Isolates from Different Carp Species and Risk Assessment for Public Health. Antibiotics 2023, 12, 143, doi:10.3390/antibiotics12010143.
7. Aidara-Kane, A.; Angulo, F.J.; Conly, J.M.; Minato, Y.; Silbergeld, E.K.; McEwen, S.A.; Collignon, P.J.; Balkhy, H.; Collignon, P.; Conly, J.; et al. World Health Organization (WHO) Guidelines on Use of Medically Important Antimicrobials in Food-Producing Animals. Antimicrob Resist Infect Control 2018, 7, 7, doi:10.1186/s13756-017-0294-9.
8. Aboah, J.; Ngom, B.; Emes, E.; Fall, A.G.; Seydi, M.; Faye, A.; Dione, M. Mapping the Effect of Antimicrobial Resistance in Poultry Production in Senegal: An Integrated System Dynamics and Network Analysis Approach. Front. Vet. Sci. 2023, 10, 10, doi:10.3389/fvets.2023.1189109.
9. Faye, A. Connaissances, Attitudes et Pratiques Des Éleveurs de Volailles Sur l'usage Des Antibiotiques En Zone Péri Urbaine de Dakar. PhD Thesis, Cheikh Anta Diop University: Dakar, 2022.
10. Emes, E.; Faye, A.; Naylor, N.; Belay, D.; Ngom, B.; Fall, A.G.; Knight, G.; Dione, M. Drivers of Antibiotic Use in Semi-Intensive Poultry Farms: Evidence from a Survey in Senegal. Antibiotics 2023, 12, 460, doi:10.3390/antibiotics12030460.
11. Diédhiou, S.O.; Margetic, C.; Sy, O. Stratégies des acteurs de l'aviculture commerciale à Ziguinchor, Sénégal. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux

2022, 75, 31–40, doi:10.19182/remvt.36907.
12. Traore, E.H.; Sall, C.; Fall, A.A.; Faye, P. Enjeux Économiques de l'influenza Aviaire Sur La Filière Avicole Sénégalaise. Bulletin du Réseau international pour le développement de l'aviculture familiale (Bulletin RIDAF) 2006, 16, 24–32.
13. FAO Secteur Avicole Senegal. Revues Nationales de l'élevage de La Division de La Production et de La Santé Animales de La FAO. No. 7. Rome. - Recherche Google (accessed on 14 August 2025).
14. Dasylva, M.; Ndour, N.; Diédhiou, M.A.A.; Sambou, B. Caractérisation Physico-Chimique Des Sols Des Vallées Agricoles de La Commune de Ziguinchor Au Sénégal. ESJ 2019, 18.
15. Dufour, C.; Larivière, V. Principales techniques d'échantillonnage probabilistes et non-probabilistes , SCI6060 – Cours, 4 (2012) Available online: https://www.studocu.com/row/document/universite-ibn-tofail/methodologie-de-recherche/tecnique-echantillonage/49353230 (accessed on 13 August 2025).
16. Dasylva, M.; Ndour, N.; Sambou, B.; Soulard, C.T. Les micro-exploitations agricoles de plantes aromatiques et médicinales : élément marquant de l'agriculture urbaine à Ziguinchor, Sénégal. Cah. Agric. 2018, 27, 25004, doi:10.1051/cagri/2018011.
17. Nanjundeswaraswamy, T.S.; Divakar, S. Determination of Sample Size and Sampling Methods in Applied Research. Proceedings on engineering sciences 2021, 3, 25–32, doi:10.24874/PES03.01.003.
18. Sullivan, G.M.; Artino Jr, A.R. Analyzing and Interpreting Data From Likert-Type Scales. J Grad Med Educ 2013, 5, 541–542, doi:10.4300/JGME-5-4-18.
19. Sawadogo, A.; Kagambèga, A.; Moodley, A.; Ouedraogo, A.A.; Barro, N.; Dione, M. 1 Knowledge, Attitudes, and Practices Related to Antibiotic Use and Antibiotic Resistance among Poultry Farmers in Urban and Peri-Urban Areas of Ouagadougou, Burkina Faso. Antibiotics 2023, 12, 133, doi:https://doi.org/10.3390/antibiotics12010133.
20. Robi, D.T.; Bogale, A.; Temteme, S.; Aleme, M.; Urge, B. Evaluation of Livestock Farmers' Knowledge, Attitudes and Practices Regarding the Use of Veterinary Vaccines in

Southwest Ethiopia. Veterinary Medicine & Sci 2023, 9, 2871–2884, doi:10.1002/vms3.1290.
21. Jemberu, W.T.; Molla, W.; Dagnew, T.; Rushton, J.; Hogeveen, H. Farmers' Willingness to Pay for Foot and Mouth Disease Vaccine in Different Cattle Production Systems in Amhara Region of Ethiopia. PloS one 2020, 15, e0239829, doi:https://doi.org/10.3390/antibiotics11010080.
22. Gebretnsae, H.; Hadgu, T.; Ayele, B.; Gebre-Egziabher, E.; Woldu, M.; Tilahun, M.; Abraha, A.; Wubayehu, T.; Medhanyie, A.A. Knowledge of Vaccine Handlers and Status of Cold Chain and Vaccine Management in Primary Health Care Facilities of Tigray Region, Northern Ethiopia: Institutional Based Cross-Sectional Study. PLoS One 2022, 17, e0269183, doi:https://doi.org/10.1371/journal.pone.0269183.
23. Ravikumar, R.; Chan, J.; Prabakaran, M. Vaccines against Major Poultry Viral Diseases: Strategies to Improve the Breadth and Protective Efficacy. Viruses 2022, 14, 1195.
24. Islam, M.Z.; Islam, M.S.; Kundu, L.R.; Ahmed, A.; Hsan, K.; Pardhan, S.; Driscoll, R.; Hossain, M.S.; Hossain, M.M. 1 Knowledge, Attitudes and Practices Regarding Antimicrobial Usage, Spread and Resistance Emergence in Commercial Poultry Farms of Rajshahi District in Bangladesh. Plos one 2022, 17, e0275856, doi:https://doi.org/10.1371/journal.pone.0275856.
25. Bedekelabou, A.P.; Talaki, E.; Dzogbema, K.F.-X.; Dolou, M.; Savadogo, M.; Seko, M.O.; Alambedji, R.B. Assessing Farm Biosecurity and Farmers' Knowledge and Practices Concerning Antibiotics and Antibiotic Resistance in Poultry and Pig Farms in Southern Togo. Veterinary world 2022, 15, 1727, doi:www.doi.org/10.14202/vetworld.2022.1727-1737.
26. Gemeda, B.A.; Amenu, K.; Magnusson, U.; Dohoo, I.; Hallenberg, G.S.; Alemayehu, G.; Desta, H.; Wieland, B. Antimicrobial Use in Extensive Smallholder Livestock Farming Systems in Ethiopia: 1 Knowledge, Attitudes, and Practices of Livestock Keepers. Frontiers in veterinary science 2020, 7, 55, doi:https://doi.org/10.3389/fvets.2020.00055.

27. Gebeyehu, D.T.; Bekele, D.; Mulate, B.; Gugsa, G.; Tintagu, T. Knowledge, Attitude and Practice of Animal Producers towards Antimicrobial Use and Antimicrobial Resistance in Oromia Zone, North Eastern Ethiopia. PLoS One 2021, 16, e0251596, doi:https://doi.org/10.1371/journal.pone.0251596.

28. Speksnijder, D.C. Antibiotic Use in Farm Animals: Supporting Behavioural Change of Veterinarians and Farmers. Thesis, University of Utrecht: Netherlands, 2017.

29. Chilawa, S.; Mudenda, S.; Daka, V.; Chileshe, M.; Matafwali, S.; Chabalenge, B.; Mpundu, P.; Mufwambi, W.; Mohamed, S.; Mfune, R.L. [1] Knowledge, Attitudes, and Practices of Poultry Farmers on Antimicrobial Use and Resistance in Kitwe, Zambia: Implications on Antimicrobial Stewardship. Open Journal of Animal Sciences 2022, 13, 60–81, doi:https://doi.org/10.4236/ojas.2023.131005.

30. Yakubu, Y.; Daneji, A.I.; Mohammed, A.A.; Jibril, A.; Umaru, A.; Aliyu, R.M.; Garba, B.; Lawal, N.; Jibril, A.H.; Shuaibu, A.B. Understanding the Awareness of Antimicrobial Resistance amongst Commercial Poultry Farmers in Northwestern Nigeria. Preventive Veterinary Medicine 2024, 228, 106226.

31. Hassan, M.M.; Kalam, M.A.; Alim, M.A.; Shano, S.; Nayem, M.R.K.; Badsha, M.R.; Al Mamun, M.A.; Hoque, A.; Tanzin, A.Z.; Nath, C. Knowledge, Attitude, and Practices on Antimicrobial Use and Antimicrobial Resistance among Commercial Poultry Farmers in Bangladesh. Antibiotics 2021, 10, 784, doi:https://doi.org/10.3390/antibiotics10070784.

32. Alyafei, A.; Easton-Carr, R. The Health Belief Model of Behavior Change. In Treasure Island (FL): StatPearls Publishing; 2025; StatPearls Publishing, 2024; p. 9.

Sources

1	https://www.scirp.org/journal/paperinformation?paperid=122292 INTERNET 3%
2	https://www.frontiersin.org/journals/veterinary-science/articles/10.3389/fvets.2023.1189109/full INTERNET 1%
3	https://en.wikipedia.org/wiki/Poultry_farming INTERNET <1%
4	https://pubmed.ncbi.nlm.nih.gov/35326846/ INTERNET <1%
5	https://www.mdpi.com/1099-4300/24/10/1469 INTERNET <1%
6	https://chartexpo.com/blog/4-point-likert-scale INTERNET <1%
7	https://www.simplypsychology.org/likert-scale.html INTERNET <1%
8	https://www.linkedin.com/pulse/cultivating-wisdom-education-beyond-knowledge-samia-henaine-0pspf INTERNET <1%
9	https://statisticsbyjim.com/glossary/dummy-variable/ INTERNET <1%
10	https://www.fda.gov/media/144427/download INTERNET <1%
11	https://pubmed.ncbi.nlm.nih.gov/39507914/ INTERNET <1%

EXCLUDE CUSTOM MATCHES	ON
EXCLUDE QUOTES	OFF
EXCLUDE BIBLIOGRAPHY	OFF