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Antimicrobial Usage in Livestock Management in North-Eastern Nigeria: A Survey of Livestock Farmers

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ABSTRACT

Potential overuse of antibiotics has been shown to create a clear opportunity for introduction and transmission of pathogens exhibiting high resistance against many antibiotics in both humans and animals. This survey was carried out to investigate antibiotic usage in livestock management by farmers in northeast Nigeria. Two hundred copies of a close-ended Questionnaire designed to seek information from farmers about antimicrobial use referred to one day to one year period prior to the survey was administered to 200 randomly selected livestock farmers keeping one or more types of animal or livestock in the northeast region of Nigeria, in a face-to-face interview during March to December 2013. The questionnaire was pre-tested on a sample of farmers randomly selected from the study population by a pilot study. The region was clustered into three with each cluster consisting of two states and one state from each cluster was randomly selected. The researcher with the assistance of trained veterinary and livestock workers from each of the sampling clusters visited the respective farmers who have orally consented to the study and administered the questionnaire on them. Data collected were entered into a personal computer and analyzed using an SPSS data package software version 14 (2016) for descriptive statistic. Rates were computed by cluster and the results were tested for responses using chi-square test. P value was considered significant at $P < 0.05$. Results revealed that majority (75%) of the farmers in north-eastern Nigeria had sole ownership of the animals they kept and majority (52%) kept chickens more than other animals. About 67% of the farmers had less than or minimum of five years livestock management experience, and majority (75%) used antibiotics on their animals. The frequency of antibiotics usage showed that majority of the farmers administered antibiotics on their animals yearly (21%) and monthly (16%), and tetracyclines (25%) and penicillins (19.5%) appeared to be the most commonly patronized antibiotics by farmers in this region. Majority of the farmers indicated sourcing their antibiotics from veterinary pharmacy shops (31%) and veterinary clinics (27.5%), and most of the farmers indicated relying on veterinary Doctors for recommendation for antibiotic use (29.7%), dosage (27%) and withdrawal time (29.7%).The pattern of antibiotics use and administration observed in this survey revealed potential misuse of antimicrobials, despite the fact that more farmers relied on antibiotic prescriptions. Bearing in mind that antimicrobial resistance is a global issue of concern both in humans and animals, the need for policies promoting lower and more controlled use of antibiotics is imperative. Interventions that focus on training farmers on proper and judicious use of antimicrobials and improvement of existing Nigeria's veterinary law would help curtail antibiotic misuse in livestock.

INTRODUCTION

Livestock production constitutes an important economic index of any country, and its goal is to enhance animal health and welfare (Alrøe *et al*., 2001). There has been an increasing demand for intensive animal farming involving large numbers of animals, different species in the same area, and the use of growth promoters and antibiotics, in order to feed the world's growing human population (Pantosti, 2012). Antimicrobials have generally been used as a chemotherapy and prophylaxis to treat and prevent diseases, and as a promoter to promote growth in livestock including cattle, sheep, swine and poultry (CDC, 2007; Sawant *et al*., 2005), which has advanced animal production (Abdellah *et al*., 2009). Extensive use of antibiotics has been shown to create a clear opportunity for introduction and transmission of pathogens exhibiting high resistance against many antibiotics (Abdellah *et al*., 2009). The recent emergence of MRSA as a frequent colonizer of animal population is possibly favored by the large antibiotic usage in animals especially food animals (Pantosti, 2012). Antimicrobial treatment of animals for infectious diseases is relatively a common and necessary practice worldwide (McEven *et al*., 1991), and the use of antibiotics in agriculture is invariably well accepted across the world, but preventive management practices including use of vaccines have been accepted as a practice (Zwald *et al*., 2004).

Many experts consider preventive therapy necessary in the modern livestock management, because preventive therapy involves deviations from approved posology including under-dosing and prolonged duration of treatment, often without diagnosis (Timmerman *et al*., 2006). Such practices are commonly seen in majority of intensively reared animals like the broiler chickens, fattening pigs and veal calves (Catry *et al*., 2010). Many types of antibiotics including penicillins, tetracyclines, aminoglycosides, macrolides, lincosamides and sulphonamides have been found in use on animals worldwide (Mitchell *et al*., 1998), but determination of accurate assessment of dosage and treatment duration has been a global limitation to the measurement of antibiotics usage in animals (Zwald *et al*., 2004), whether administered topically, orally or by injection. In developed countries, drug administration and withdrawal periods, and drug residues in live, as well as in slaughtered animals, especially food animals, have been thoroughly monitored (More, 2011; DANMAP, 2007). This is contrary in developing countries where 'I don't care attitude' has clouded the order of the day (Fagbamila *et al*., 2010; Adetunji, 2008).

Recent studies in Nigeria have reported high levels of antibiotic residues in food animals, due to indiscriminate usage or excessive use of antimicrobial (Fagbamila *et al*., 2010; Adetunji, 2008). There are reports of increasing emergence and spread of resistant strains of bacterial pathogens as a result of indiscriminate use of antibiotics in food animals, which pose a serious challenge to both animal and human health (Adesokan *et al*., 2014). In Nigeria, many livestock farmers are heavily indulged in self administration of drugs including antibiotics to their animals without prescription. This situation has greatly undermined the importance of veterinary practice especially in the north-eastern part of the country. Some of these farmers only consult veterinarians or take their animals to veterinary clinics after their attempts at self-treatments have failed. This usually follows excessive administration of several drugs including antibiotics known to them, and at instances where the affected animal(s) have grossly been grounded, emaciated with visibly prominent rib bones. In some cases, the animal(s) might have lost the ability to move about, and are hardly able to survive, as death usually resulted in most cases (personal experience). There is a dearth of published information on antimicrobial usage in animals in north-eastern Nigeria. This survey was therefore conducted to assess the antimicrobial use, frequency and withdrawal time in livestock production in North-Eastern Nigeria.

MATERIALS AND METHODS

The survey instrument was a close-ended Questionnaire designed to seek information from farmers about antimicrobial use referred to one day to one year period prior to the interview. The questionnaire was pre-tested on a sample of farmers randomly selected from the study population by a pilot study. The study was conducted in the northeast region of Nigeria consisting of six states. The region was clustered into three with each cluster consisting of two states and one state from each cluster was randomly selected. Questionnaire was used in face to face interviews carried out between March and December 2013. The researcher with the assistance of trained veterinary and livestock workers from each of the sampling clusters visited the respective farmers who have orally consented to the study and administered the questionnaire on them. The researcher maintained absolute confidentiality throughout the study. Total number of respondents included 200 livestock farmers, keeping either one or more types of animals.

Data Analysis

Data collected were entered into a personal computer and analyzed using an SPSS data package software version 14 (2016) for descriptive statistic. Rates were computed by cluster and the results were tested for responses using chi-square test. P value was considered significant at $P < 0.05$.

RESULTS

A total of 200 copies of the questionnaire were administered on farmers and 100% were completely or partially answered.

Demography and animal ownership characteristics of respondents

The result on demographics and animal ownership characteristics of the respondents is presented in table 1. It was observed that male generally constituted majority (54%) of the respondents than females (46%). However, in cluster 2 female (55%) were more than male (45%) respondents. Over 80% of the respondents were above 30 years of age and 19.5% were between 15 and 30 years of age. The result also showed that 74.5% of the respondent farmers indicated sole ownership of the animals they possessed, 17.5% indicated family ownership and 6.0% indicated joint ownership, while 2.0% indicated others (Government farms, cooperative farms, or Institutional farms). It was observed that 51.5% of the respondents owned chickens, 49.5% owned goats, 37% owned sheep, 33% owned pigs, 31% owned cattle, and 35.5% in addition to owning these animals also owned other animals (like fishes, ducks, geese, pets etc.). The majority of respondents (66.5%) had 5 years or less of animal rearing or management experience and 33.5% had more than 5 years management experience. In cluster 2 more respondents (51.7%) had more than 5 years of animal management experience, whilst 48.3% had 5 years or less of animal rearing experience.

Table 1 Survey on antimicrobial usage in Livestock Management in Northeast Nigeria:

Demography and animal ownership Characteristics of Respondents (N = 200)

Demography	No (%) of responses			
	Cluster 1 (n = 70)	Cluster 2 (n = 60)	Cluster 3 (n = 70)	Total (N = 200)
Age of respondent (yrs)				
15 – 30	14 (20.0)	17 (28.3)	8 (11.4)	39 (19.5)
> 30	56 (80.0)	43 (71.7)	62 (88.6)	161 (80.5)
Sex of respondent				
Male	39 (55.7)	27 (45.0)	42 (60.0)	108 (54.0)
Female	31 (44.3)	33 (55.0)	28 (40.0)	92 (46.0)
Ownership of animals				
Sole ownership	59 (84.3)	35 (58.3)	55 (78.6)	149 (74.5)
Joint ownership	3 (4.3)	4 (6.7)	5 (7.1)	12 (6.0)
Family ownership	8 (11.4)	18 (30.0)	9 (12.9)	35 (17.5)
Others[α]	0 (0.0)	3 (5.0)	1 (1.4)	4 (2.0)
Types of animals owned				
Cattle	18 (25.7)	16 (26.7)	28 (40.0)	62 (31.0)
Sheep	32 (45.7)	12 (20.0)	30 (42.9)	74 (37.0)
Goats	31 (44.3)	20 (33.3)	48 (68.6)	99 (49.5)
Pigs	13 (18.6)	28 (46.7)	25 (35.7)	66 (33.0)
Chickens	46 (65.7)	29 (48.3)	28 (40.0)	103 (51.5)
Others[β]	20 (28.6)	30 (50.0)	21 (30.0)	71 (35.5)
Livestock management experience				
≤ 5 years	46 (65.7)	29 (48.3)	58 (82.9)	133 (66.5)
> 5 years	24 (34.3)	31 (51.7)	12 (17.1)	67 (33.5)

[α] Government Institutions and Cooperatives; [β]pets, other poultry and fish

Antibiotics use on animals in northeast Nigeria

The result on antibiotic usage in animals by farmers in northeast Nigeria revealed that 30% of the farmers used antibiotics in apparently sick animals, while 12.5% used antibiotics in apparently healthy animals. Farmers that used antibiotics in newly purchased or introduced animals constituted 21%, and 11.5% of the respondents used antibiotics only when instructed by a veterinarian or on prescription, whereas, 25% of the farmers indicated not using antibiotics in their animals. The frequency of antibiotics administration amongst farmers showed that 4% administered antibiotics on animals weekly, 16% monthly, 12% quarterly

(every 3 months) and 14% of the respondent farmers indicated administering antibiotics on their animals biannually (every 6 months). Whereas 21% of the respondents used antibiotics on their animals yearly and 7.5% indicated using antibiotics on their animals anytime they felt like (table 2).

Respondents were asked when last they administered antibiotics to their animals prior to this study, and responses indicated that 27.5% administered antibiotics on their animals less than 4 weeks prior to the study, 16% indicated 3 months, 29.5% indicated 6 months and 3.5% indicated one year prior to this study. Across cluster, observation revealed that 40% and 31.7% of the respondents in cluster one and two respectively, indicated not using antibiotics on their animals, whereas 48.3% of respondents in cluster three indicated using antibiotics on apparently healthy animals. The frequency of antibiotics use amongst clusters indicated that more farmers in cluster one used antibiotics monthly (15.7%) whereas in cluster two (21.7%) and in cluster three (36.7%) used antibiotics yearly on their animals. More farmers administered antibiotics to their animals less than one month (27.1%) and 3 months (22.9%) prior to the present study in cluster one, and 23.3% and 21.7% administered antibiotics less than one month and 3 months respectively in cluster two, whereas, 70% administered antibiotics 6 months and 36.7% administered less than 1 month in cluster three prior to this study.

Table 2 Survey on antimicrobial usage in Livestock Management in North-eastern Nigeria:

Responses on Rationale for antibiotics use and frequency of administration (N = 200)

Rationale/frequency of antibiotic use	Number (%) Responses			
	Cluster 1 (n = 70)	Cluster 2 (n = 60)	Cluster 3 (n = 70)	Total (N = 200)
Administered antibiotics to animals				
When animals were apparently sick	16 (22.9)	15 (25.0)	29 (48.3)	60(30.0)
When animals were apparently healthy	6 (8.6)	3 (5.0)	16 (26.7)	25(12.5)
When new animals were introduced	18 (25.7)	15 (25.0)	9 (15.0)	42(21.0)
When instructed by a veterinarian	2 (2.9)	8 (13.3)	13 (21.7)	23(11.5)
Don't use antibiotics on my animals	28 (40.0)	19 (31.7)	3 (5.0)	50(25.0)
Frequency of antibiotics administration				
Weekly	3 (4.3)	3 (5.0)	2 (3.3)	8 (4.0)
Monthly	11 (15.7)	5 (8.3)	16 (26.7)	32(16.0)
Quarterly	8 (11.4)	9 (15.0)	7 (11.7)	24(12.0)
Biannually	10 (14.3)	7 (11.7)	11 (18.3)	28(14.0)
Yearly	7 (10.0)	13 (21.7)	22 (36.7)	42(21.0)
Any time	3 (4.3)	3 (5.0)	9 (15.0)	15 (7.5)
When was last antibiotics administered?				
< 1 month prior to the study	19 (27.1)	14 (23.3)	22 (36.7)	55(27.5)
3 months prior to the study	16 (22.9)	13 (21.7)	3 (5.0)	32(16.0)
6 months prior to the study	7 (10.0)	10 (16.0)	42 (70.0)	59(29.5)
1 year prior to the study	0 (0.0)	4 (6.7)	3 (5.0)	7 (3.5)

Responses on the type and form (preparations) of antibiotics used by farmers investigated in this study are shown in table 3. Results showed that tetracyclines (25%), followed by penicillins (19.5%) and multiple antibiotics combination (13.5%) were the most common and frequently used antibiotics by the farmers in this study. Other antibiotics commonly used include fluoroquinolones (9%) and sulphonamides (5%), whereas cephalosporins (1.5%) and streptomycin (1.0%) were less commonly used. Single or one form (oral, topical or parenteral) preparations of the antibiotics was most commonly observed (62.5%), followed by more than one preparation (14.5%), while the use of all preparations or forms of antibiotics was less commonly observed (3%) amongst the farmers. In cluster one penicillin (22.9%) followed by tetracycline (20%), in cluster two tetracycline (25%) followed by

multiple antibiotics combination (16.7%) and in cluster three tetracycline (30%) followed by penicillin (21.4%) were observed as the most common antibiotics used in animals by the farmers in this region. The most common preparation or form of the antibiotics used by the farmers in each cluster was one preparation or form (cluster one, 64.3%; cluster two, 55%; cluster three, 67.1%).

Table 3 Survey on antimicrobial usage in Livestock Management in North-Eastern Nigeria: Responses on type and preparation of antibiotics used by farmers (N = 200)

Types and preparation of antibiotic	Number (%) Responses			
	Cluster 1 (n = 70)	Cluster 2 (n = 60)	Cluster 3 (n = 70)	Total (N = 200)
Type of antibiotic used				
Penicillins	16 (22.9)	8 (13.3)	15 (21.4)	39 (19.5)
Tetracyclines	14 (20.0)	15 (25.0)	21 (30.0)	50 (25.0)
Sulphonamides	4 (5.7)	3 (5.0)	4 (5.7)	10 (5.0)
Streptomycins	0 (0.0)	0 (0.0)	2 (2.9)	2 (1.0)
Cephalosporins	0 (0.0)	0 (0.0)	3 (4.3)	3 (1.5)
Fluoroquinolones	4 (5.7)	5 (8.3)	9 (12.9)	18 (9.0)
Multiple antibiotics combinations	4 (5.7)	10 (16.7)	13 (18.6)	27 (13.5)
Form or preparation of antibiotic used*				
One	45 (64.3)	33 (55.0)	47 (67.1)	125 (62.5)
More than one	6 (8.6)	8 (13.3)	15 (21.4)	29 (14.5)
All preparations	1 (1.4)	0 (0.0)	5 (7.4)	6 (3.0)

***Oral, Topical or Parenteral

Table 4 shows the antibiotic treatment record as indicated by respondent farmers. Result indicates that 47.5% of the respondents treated both young and adult animals, 0.5% treated adult animals only, 3.5% treated young animals only, 15.5% treated lactating animals and 6% treated pregnant animals. The majority (31%) of the respondents indicated sourcing their antibiotics from veterinary pharmacy shops, while 27.5% and 13.5% sourced their antibiotics from veterinary clinics and market displays respectively, whilst 8% of the respondents

sourced antibiotics from drug hawkers. It was observed that 14% of the respondents used non-antibiotic drugs or treatments on their animals such as multivitamins and/or anthelminthic drugs, while others (11%) used traditional concoctions or treatments such as salts, ashes, pepper, onion, potash or herbs (observed more common among swine farmers). It was observed that majority of the farmers in cluster one (37.1%), cluster two (40%) and cluster three (64.3%) treated both adult and young animals, and that 22.9% of farmers in cluster one sourced antibiotics from veterinary clinics, while 26.7% of the farmers in cluster two and 52.9% in cluster three sourced antibiotics from veterinary pharmacy shops. Also, more of the farmers that didn't subscribe to antibiotics for their animals in clusters one (25.7%) and two (16.7%) indicated using multivitamins and anti-helminthics, while those in cluster three (4.3%) indicated using traditional concoctions.

Table 4 Survey on antimicrobial usage in Livestock Management in North-eastern Nigeria:

Responses on antibiotic treatments and sources of antibiotics (N = 200)

Treatment/antibiotics	Number (%) Responses			
	Cluster 1 (n = 70)	Cluster 2 (n = 60)	Cluster 3 (n = 70)	Total (N = 200)
Antibiotic Treatment				
Treated both young and adult animals	26 (37.1)	24 (40.0)	45 (64.3)	95 (47.5)
Treated only adult animals	3 (4.3)	1 (1.7)	1 (1.4)	5 (0.5)
Treated only young animals	2 (2.9)	4 (6.7)	1 (1.4)	7 (3.5)
Treated lactating animals	7 (10.0)	9 (15.0)	15 (21.4)	31 (15.5)
Treated pregnant animals	4 (5.7)	3 (5.0)	5 (7.10)	12 (6.0)
Source of antibiotic				
Veterinary Pharmacy shop	9 (12.9)	16 (26.7)	37 (52.9)	62(31.0)
Market displays	11 (15.7)	7 (11.7)	9 (12.9)	27 (13.5)
Drug hawkers	6 (8.6)	6 (10.0)	4 (5.7)	16 (8.0)
Veterinary clinics	16 (22.9)	12 (20.0)	27 (38.6)	55 (27.5)
Non-antibiotic treatments				
Multivitamin/ anthelminthics	18 (25.7)	10 (16.7)	0 (0.0)	28 (14.0)
Traditional treatment*	10 (14.3)	9 (15.0)	3 (4.3)	22 (11.0)

*(use salt, ashes, pepper, onion, herbs, potash to make concoctions)

The results on recommendations for antibiotics use, dosage and withdrawal time is presented in Table 5. Results showed that more (29.7%) of the respondents used antibiotics on the recommendation by a veterinary Doctor (on prescription), 15.5% used antibiotics from personal experience, and 21.6% of the respondents indicated using antibiotics on the recommendations by drug sellers and on advice from fellow farmers respectively and 12.8% of the respondent farmers used antibiotics based on advertisements. The results also show that 27% of the respondents used antibiotic dosages on the recommendation of a veterinary Doctor, 21.6% indicated personal experience and 20.3% administered dosages on the

recommendations of drug seller, while 16.9% indicated advice from fellow farmers and 15.5% read dosages from drug leaflets. The results also showed that 29.7% of the farmers used antibiotic withdrawal time on the recommendations by veterinary Doctor, 10.1% indicated personal experience and 23% used withdrawal time on the recommendations by drug seller, whilst 16.9% indicated advice from fellow farmers and 21.6% read from drug leaflets.

Observation across clusters revealed that more of the respondents in cluster one used antibiotics on the recommendations of a drug seller (35.7%), in cluster two on the advice from a fellow farmer (36.6%) and in cluster three on the recommendation of a veterinary Doctor (51.7%). Also, 33.3% of the farmers in cluster one administered antibiotics dosages on the recommendations by veterinary Doctor, 31.7% in cluster two administered dosages on the recommendations by drug seller and 35.4% of the farmers in cluster three administered dosages based on personal experience. More respondents in cluster one (33.3%) and cluster two (31.7%) indicated recommendations by veterinary Doctor for their antibiotics withdrawal time, while 30.8% of the farmers in cluster three indicated drug seller as recommendations for antibiotics withdrawal time.

Table 5 Survey on antimicrobial usage in Livestock Management in North-Eastern Nigeria:

Responses on recommendations for antibiotics use, dosage and withdrawal time (N = 148)

Recommendation, use and withdrawal	Number (%) Responses			
	Cluster 1 (n = 42)	Cluster 2 (n = 41)	Cluster 3 (n = 65)	Total (N = 148)
Recommendation for antibiotics use				
Veterinary Doctor	14 (33.3)	9 (22.0)	21 (51.2)	44 (29.7)
Personal experience	2 (4.8)	4 (9.8)	17 (41.5)	23 (15.5)
Drug seller	15 (35.7)	6 (14.6)	11 (26.8)	32 (21.6)
Advice from fellow farmers	8 (19.0)	15 (36.6)	9 (22.0)	32 (21.6)
Advertisement	3 (7.1)	7 (17.1)	9 (22.0)	19 (12.8)
Recommendation for antibiotics dosage				
Veterinary Doctor	14 (33.3)	9 (22.0)	17 (26.2)	40 (27.0)
Personal experience	5 (11.9)	4 (9.8)	23 (35.4)	32 (21.6)
Drug seller	9 (21.4)	13 (31.7)	8 (12.3)	30 (20.3)
Advice from fellow farmers	10 (23.8)	6 (14.6)	9 (13.8)	25 (16.9)
Read from drug leaflet	4 (9.5)	9 (22.0)	10 (15.4)	23 (15.5)
Recommendation for antibiotics withdrawal time				
Veterinary Doctor	14 (33.3)	13 (31.7)	17 (26.2)	44 (29.7)
Personal experience	4 (9.5)	3 (7.3)	8 (12.3)	15 (10.1)
Drug seller	7 (16.7)	7 (17.1)	20 (30.8)	43 (23.0)
Advice from fellow farmers	9 (21.4)	7 (17.1)	9 (13.8)	25 (16.9)
Read from drug leaflet	8 (19.0)	11 (26.8)	13 (20.0)	32 (21.6)

4.1.5 DISCUSSION AND CONCLUSION

The present study was undertaken to investigate antibiotics usage by livestock farmers in the northeast region of Nigeria. Antibiotics usage in animals may result in the selection of antimicrobial resistant bacteria and occurrence of harmful residues in meat and products of livestock origin, which might consequently have a negative impact on human health and food safety upon consumption of such products.

The findings in the present survey revealed that the majority of the respondents were males constituting 54% of the farmers. This implies that males more than females were more likely ready to respond to questionnaires, and perhaps because they are the heads of their families and are responsible for their households including their properties or possessions. This confirmed the experience during the interview where many females referred the researcher to their spouses for response to the questionnaire. This finding concurs with a recent study conducted on commercial poultry layer farmers in southwest Nigeria by Adebowale *et. al.*, (2016), in which they reported 71.8% of respondents as men and 14.6% as women. The present study also reports that higher percentage (80.5%) of respondents were above 30 years of age (adults) as at the time of data collection and were the major livestock farmers observed during the course of the study. This might suggest that age is significant in livestock management. Similar finding was observed in a recent study (Adebowale *et. al*., 2016) where 83.5% of the respondents were reported to have attended tertiary education. One must be an adult to acquire this level of education. However, age is insignificant in livestock management when experience is the point of consideration. It was observed in this study that majority of the farmers had < 5 years of livestock management experience. More percentage of the respondents in cluster two appeared to have had more duration of livestock management experience (> 5 years) compared to the respondents in clusters one and three. In a similar study in Ghana (Boamah *et. al*., 2016) majority of poultry farmers were reported to have had more than 5 years management experience. Findings in the present study also showed that high percentage of the respondents kept only one type or kind of the animals studied, and those that kept all the 5 types of the animals were the least. This implies that the choice of keeping a number of animal species may be determined by factors like economic status of the farmer, availability of space owned by the farmer, ease of management, religion, and the usefulness or economic importance of the animal as well as, the cost of the animal, amongst others. Possession of types of animals was not associated with either age or livestock management experience, but there was close relationship between sex and possession of type of livestock, as the percentage of females (46%) was in close agreement with possession of one type of animal (47%). However, farmers keeping more than one type of animals in the same premises may have the tendency of using antibiotics for prophylaxis (Callens *et. al*., 2012) especially if such farmers are aware that cross-transmission of disease infections occurs between animal species (Garforth, 2015). Also, farmers keeping more than one type of animal species were less likely to seek advice from veterinarians and the use of

disinfectants (Boamah *et. al*., 2016), and were more likely also to use antibiotics without prescription than farmers that kept only one type of animal.

The present study also reports that majority of respondents solely owned the animals they kept, and there was no significant relationship between sole ownership, joint ownership and family ownership of animals ($P<0.05$). Most of the respondents kept chickens and goats more frequently than any of the other animals studied. This may probably be due to their relative prices and their management, which appeared to be much cheaper and easier compared to those of sheep, cattle and pigs. In the northern part of Nigeria, goats are usually left to freely graze during the larger part of the season (dry season) and the first quarter of the rainy season, until all crops plantings are over, due to the relatively vast lands around that region. Goats, like chickens, are also relatively cheaper and can be afforded by almost every low income household owner. The high percentage (51.5%) of the respondents owning chickens in this study may also be attributable to festivities such as Sallah (particularly during fasting by Muslims) and Christmas celebrations (by Christians) in which chickens are mostly used. The high percentage of respondents in clusters 1 and 3 that kept sheep indicates the importance of this animal (sheep are used for big Sallah celebrations) in this region of the country. It is also probable that the patronage for sheep is likely to be more in these clusters, unlike pigs which had the highest percentage of farmers that kept them in cluster 2. This may also be due to their patronage in this part of the northeast than in clusters 1 and 3. There appeared to be high percentage of respondents that owned only pigs and no other animals, probably due to the high reproductive prolificacy of pigs (can produce up to 20 piglets per litter). Farm characteristics such as flock size, age, keeping more than one animals together and occurrence of infections, according to Boamah *et. al.,* (2016) may influence the use of antimicrobial agents. Swine and poultry species seem to be the main reservoirs of mobile genetic elements responsible for horizontal transfer of resistance determinants (Silveira *et. al*., 2009; Binh *et. al*., 2008). Therefore, farmers that kept other animals together with pigs and chickens (observed in this study) are likely to experience challenges of resistance transfer amidst their animals. Although, in Nigeria information about similar studies encompassing both poultry and other livestock, at the disposal of the present survey is scarce, in the southern part of the country however, poultry, rather than other livestock, are mostly reared (Oluwasile *e.t al*., 2014; Adebowale *et. al*., 2016), due probably to commercial benefits and lucrative of chicken which produces all year round (Adebowale *et. al*., 2016; Boamah *et. al*.,

2016). Another possible reason may be lack of vast lands for grazing in the southern part unlike obtainable in the north.

Antibiotics used in veterinary practice are in the form of therapeutic, prophylactic and growth promoters and can be used rationally or irrationally (Beyene and Tesega, 2014; Gilbert, 2012). The findings in this study indicated that majority of farmers administered antibiotics on their animals with 30% administered only when the animals were sick (for treatment) and 12.5% administered on healthy animals (for prophylaxis). Similar observations were reported recently in poultry production systems in Nigeria (Adebowale *et. al*., 2016; Oluwasile *et. al*., 2014; Geidam *et. al*., 2012), Cameroon (Kamini *et. al*., 2016), Ghana (Boamah *et. al.*, 2016) and Brazil (Medeiros *et. al*., 2011) in which antibiotics were administered for treatment and prophylaxis, and as growth promoters. This routine practice of administering antibiotic agents to domestic livestock for treatment, prophylaxis as well as, for growth promotion, is mostly found to influence the emergence of antibiotic-resistant bacteria that are subsequently transferred to humans through the food chain (Guetiya *et. al*., 2016; Carlet *et. al*., 2012; Byarugaba *et. al*., 2011; Silveira *et. al*., 2009;). Although, antibiotics use as growth promoter or feed supplements have been found to improve feed conversion efficiency and increase weight gain in livestock animals (Graham *et. al*., 2007), irrational use of antibiotics on animals has caused treatment failures in many conditions and consequent drug residual effect in edible livestock products (meat, milk and egg) upon consumption by humans of insufficiently cooked products (Lawal *et. al*., 2015; Vitomir *et. al*., 2011) due to overuse of antibiotics in food animals. Rational administration of drugs (appropriate clinical use in right dosage and route within withdrawal period) on animals however, reduces potential damages due to the drugs and increases the efficiency of such drugs (Vitomir *et. al*., 2011).

In this study, there was statistically no significant difference ($P>0.01$) between farmers that administered antibiotics to apparently healthy animals and those that used antibiotics on their animals only on prescription. Furthermore, there was no association between farmers that used antibiotics on sick animals, those that used on newly received or introduced animals and those farmers that never used antibiotics on their animals ($P<0.01$).

There appears to be very wide variation between countries in the use of veterinary antimicrobial agents that cannot be explained by differences in the demographics of animal species (Grave *et al*., 2010). The pattern of antibiotic consumption may differ from one country to another. In a study on correlation between veterinary antimicrobial use and

antimicrobial resistance in food-producing animals in Europe, Chantziaras *et. al* (2013) reports that among seven countries Norway, Belgium, Sweden, Denmark, Switzerland, Austria and The Netherlands, Belgium ranked first (86%) for antimicrobial use in animals. National mechanism for data collection on antibiotic use is lacking amongst many countries, as pharmaceutical industries seem to treat production and sales figures as confidential business information. Recent survey on global antibiotic consumption in livestock however, reports that China (23%), USA (13%), Brazil (9%), India (3%) and Germany (3%) had the largest shares of global antibiotic usage (Van Boeckel *et. al*., 2015). Accurate informed data on antibiotic consumption or use in developing countries, including Nigeria (Van Boaeckel *et al*., 2015; Moyane *et al*., 2013) is scanty but there appears to be increasing reports of isolation of antibiotic resistant bacterial strains in these regions (Carlet *et al*., 2012; Byarugaba *et. al*., 2011). This lack of informed data on antibiotic consumption in these regions may be partially due to non-funding of antibiotic surveillance programmes, failure of pharmaceutical companies to provide sufficient data on antibiotic sales, and/or the reluctance of livestock farmers and animal feed producers to provide detail antibiotic consumption records. Scanty information has also been published on attitudes and opinion of farm animal owners with regard to antimicrobial resistance and antimicrobial use in many regions (Ectayb *et. al*., 2012; Green *et. al*., 2010).

Antimicrobial resistance has been listed as a global problem and underlines the importance of trustworthy national surveillance systems (WHO, 2012). Continued use of antibiotics in veterinary medicine and the presence of other selective molecules among other things, in the livestock production setting, might co-select for multidrug resistance among bacteria that can last longer in the environment (Gilchrist *et al*., 2007; Phillips *et al*., 2004). In the present study, high percentage of farmers (21%) administered antibiotics to their animals yearly compared to those that administered monthly (16%), biannually (14%), quarterly (12%), at any time (7.5%) and weekly or more frequently (4%). Similarly, Geidam *et al.,* (2012) reported higher percentage (65%) of poultry farmers in Maiduguri that administered antibiotics on their chickens more frequently, and 35% administered biannually. The criteria for administering antibiotics weekly, monthly, quarterly, biannually or yearly or anytime as observed in this study could not be elucidated. This irrational use of antibiotics may however, be attributed to regulations on antimicrobial use in livestock production system which is non-existent or not available to public domain. Animal operations observed in this study which received antibiotics weekly or monthly may most likely be liable to rapidly acquire the ability

to build up antibiotic resistance than those operations that received antibiotics quarterly or biannually. Likewise, those operations which received antibiotics yearly might be unlikely to develop the capacity to build up antibiotic resistance easily due to the time interval between one dose of antibiotic and the other. The farmers that administered antibiotics to their animals anytime they felt like had no regular pattern of antibiotic administration, thus, their animals might rapidly build up the capacity to develop antibiotics resistance if antibiotics are administered more frequently. Farmers that administered antibiotics weekly and those that administered any time they felt like were involved in antibiotic overuse or abuse. Overuse or abuse of antibiotics in animals is a very serious problem because of the potential threat of direct toxic associated with antibiotic residues in humans upon consumption of the antibiotics in animal products (Moyane *et al.,* 2013; Donkor *et al*., 2012; Gilchrist *et al*., 2007), as antibiotic residues could not be degraded by cooking (Javadi *et al*., 2011). In this study there appeared to be no/or wide variation between clusters in the use of antibiotics on livestock that cannot be explained by differences in the demographics of the animal species. Differences in policies on controlling antimicrobial use, veterinarians' prescribing and dosing habits, pharmaceutics marketing strategies, animal demographics and specific needs for antimicrobial use in specific clusters or state related to specific diseases have been observed by Chantziaras *et al.,*(2013) as possible explanations for such differences. However, Bondt *et al.,* (2013) reported that animal demographics strongly influence antimicrobial use, as antimicrobial consumption is dependent on the age, sex and size of animals in a herd. The present study observed that for data on antibiotic use to have relevance to resistance development patterns, these data should be recorded on the farm, along with the indication for treatment, the route of administration, the dose and duration of treatment and other relevant data such as prevailing disease patterns and incidences, in conformity with recent explanation (Silley *et al*., 2012). The findings in this study revealed that 29.5% of the farmers administered antibiotics on their animals 6 months and 27.5% less than one month (3 weeks) prior to this study. Samples from recently treated animals might be devoid of bacterial growth if cultured, due to the fact that these treatments might have reduced a meaningful amount of bacterial populations. Although prolonged use of antibiotics in animals at low levels do not kill the bacterial organism (Gilchrist *et al*., 2007), it can however, present a risk of promoting bacterial resistance by selecting for resistant populations.

In this study tetracycline was observed as the most common and frequently selected antibiotic by farmers, followed by penicillins, fluoroquinolones, sulphonamides and multiple antibiotics

combinations, while streptomycin and cephalosporins were the least selected antibiotics. Similarly, the use of multiple antibiotics combination by majority of poultry farmers was reported in Maiduguri, northeast Nigeria (Akidarju *et al*., 2010) and Ogun, southwest Nigeria (Oluwasile *et al*., 2016), and in Cameroon (Kamini *et al*., 2016). Tetracyclines and aminoglycosides were reported as the most frequently used antibiotics in chickens in Maiduguri (Akidarju *et al*., 2010) in agreement with the finding in this study. Whereas in this study, sulphonamides and quinolones were rated among the common and frequently used antibiotics in chickens, these drugs were previously reported as the least used antibiotics in poultry in Maiduguri (Geidam *et al*., 2012). Also supporting the findings in this study were studies in poultry production in Ogun, southwest Nigeria (Adebowale *et al*., 2016; Oluwasile *et al*., 2014) which reported tetracycline as the most frequently used, and multiple antibiotic combinations as the most commonly used antibiotics by majority of poultry farmers. Similarly, in South Africa, Henton *et al.*, (2011) reported tylosin, followed by tetracyclines, sulphonamides and penicillins as the most frequently used antibiotics in poultry. So also, Boamah *et al.*, (2016) reports that tetracyclines, followed by aminoglycosides, fluoroquinolones, and penicillins were the most frequently used antibiotics in chickens in Ghana. Moreso, in Cameroon, fluoroquinolones, followed by sulphonamides and penicillins were reported as the most commonly used antibiotics in poultry (Kamini *et. al*., 2016). These studies were in agreement with the findings in the present study. Furthermore, previous study in cattle (Zwald *et al*., 2004) observed penicillin as the most common and frequently selected antibiotic, and chloramphenicol, tetracycline, trimethoprim-sulfamethoxazole, sulphonamides, and commercial mixtures (herbal concoctions) were commonly patronized by livestock farmers. This observation is consistent with the finding in the present study. Also, a recent study (Chantziaras *et. al*., 2013) in Europe reported tetracyclines, amphenicols, penicillins, third generation cephalosporins, sulphonamides, fluoroquinolones and aminoglycosides as the most commonly used antibiotics in food animals. Similarly, a previous study in Pennsylvania (Sawant *et. al*., 2005) reported that tetracycline and penicillins were the most frequently used antibiotics in dairy cattle. This study concurs with the previous findings, suggesting that tetracycline is the most commonly abused drug worldwide in animal production systems. Increase in use of some antibiotics such as third generation cephalosporins, amphenicols, and fluoroquinolones, observed in the previous study (Chantziaras *et., al*., 2013) and in this study might suggest a tendency to increase the resistance level of bacteria, for there exist a high correlation between antibiotic use and antibiotic resistance. In Europe however, the administration of antibiotics to farm animals are

strictly under the supervision of a veterinarian (Cogliani *et. al*., 2011) unlike in Nigeria, where antibiotic regulation is not obtainable due to lack of compliance. Similar scenario may be experienced in India where regulatory provisions for the use of antibiotics in livestock (cattle, chickens and pigs) reared for domestic purposes was reportedly absent (Van Boeckel *et. al*., 2015). Despite the continued resistance of many bacterial organisms against penicillin, this study has observed that penicillin is still very much commonly patronized for treatment of animals in northern Nigeria. Farmers that did not use antibiotics on their animals used non-antibiotics such as multivitamins and anthelminthic drugs. Some of the farmers (11%) used traditional treatments (concoctive mixtures of salts, ashes, potash, herbs and onions). This finding concurs with the previous study (Zwald *et. al*., 2004) which reported 3.5% farms that did not use antibiotics, used herbs in commercial mixtures in cattle.

Administration of antimicrobial drugs involved introduction of the drugs via different routes including parenteral (intramuscular, intravenous, subcutaneous), oral and topical routes for therapeutic or prophylactic use for a prescribed period of time (Hirsh and Zee, 1999). In this study, farmers found one form or preparation of the antibiotics (e.g. tablet, powder, liquid, syrup, or injectable) most suitable for administration. The farmers that used one preparation of antibiotics were higher than those that used more than one form or preparation. Similarly, in Cameroon, the use of single antibiotic preparation was reported recently in poultry production system (Kamini *et. al*., 2016). The frequency of selection or usage of single preparation of antibiotic might probably be influenced by ease and route of application. This assertion is supported by Bondt *et. al.*, (2013) who reported that oral administration of antibiotics was the most frequent and commonly used route than parenteral or other routes of administration.

It was observed in the present study that treatment of both young and adult animals and of lactating animals with antibiotics was more common by significant majority of livestock farmers. Similarly, a significantly high antibiotic treatment of both lactating and non-lactating animals was previously reported in dairy cattle (Zwald *et. al*., 2004). Majority of the farmers in this study relied on the recommendations by a veterinary Doctor for antibiotic use, but a significant percentage (21.6%) also relied on the recommendations by a drug seller and advice from fellow farmers ($P<0.05$). Similarly, in a recent study (Kamini *et. al*., 2016) reported majority (75.5%) of poultry farmers in Cameroon that relied on veterinary Doctor's recommendations for antibiotic use and minority (24.5%) used antibiotics without prescription (self-medication). In agreement with the present study also were studies in

Ogun, southwest Nigeria (Oluwasile *et. al.*, 2014) which reported 50% of poultry farmers that relied on prescription by veterinary Doctor for antibiotic use and 43% relied on self-medication, and in Ghana (Boamah *et. al*., 2016) which reported that 80% of poultry farmers relied on veterinary Doctor's recommendations for antibiotic use. Contrary to the finding in the present study, Geidam *et. al*., (2012) reported that 80% of poultry farmers in Maiduguri administered antibiotics without prescription. The present study however, did not compose of only poultry farmers unlike in the former studies and the findings in this study did not seem to contradict the former.

Observation in this study revealed a perfect association between reliance on veterinary Doctor's recommendations for antibiotic use and recommendations for antibiotic withdrawal time. There was also close association amongst reliance on drug seller and advice from fellow farmers on recommendations for antibiotic use, and reliance on personal experience on recommendation for antibiotic dosage and use of drug leaflets on recommendation for antibiotic withdrawal time. Significant percentage (20.3%) of farmers relied on recommendations by drug seller for antibiotic dosage and withdrawal time (23.0%). Similarly, Boamah *et. al*., (2016) reported significant percentage (34%) of poultry farmers in Ghana that relied on veterinarians for antibiotic withdrawal time. Whereas, about 43% of poultry farmers in Cameroon did not rely on veterinary Doctor's recommendations for antibiotic withdrawal time (Kamini *et. al*., (2016). Findings in the present and the former studies have observed quite a significant number of farmers that administered antimicrobials without prescription on their animals. Self-medication could most likely lead to misuse of antibiotics, and non-adherence to antibiotic withdrawal time could result to high concentration of drug residues in animal products (Guetiya *et. al*., 2016), as bacteria have ancient gene intelligence which they use to their advantage (Kirbis and Krizman, 2015). It was observed in this study a significant difference between treatment of both adult and young animals and reliance on veterinary Doctor's recommendations for antibiotic use ($P>0.05$). Reliance on drug sellers' recommendations for antibiotic use did not differ significantly from reliance on the advice from fellow farmer for antibiotic use ($P>0.05$). It was also observed that reliance on advertisement on recommendations for antibiotic use was least common among farmers in this study. In a previous study (Zwald *et. al*., 2004), reliance on veterinarian recommendations for antibiotic use, dosage, and withdrawal time was observed to be more common among cattle farmers in concordance with the present study. Strict adherence to recommended withdrawal periods most likely helps eliminate unwanted drug

residues in animal management practices, especially in food animals. However, variations have been observed across countries in the level of antibiotic use and withdrawal periods, while there appeared to be no variation in veterinary drugs licensed for use worldwide (Beyene and Tesega, 2014). Veterinary pharmacy shops and veterinary clinics or hospitals appeared to be the most common source of the antibiotics used by farmers in this study, but some significant percentage (13.5%) also sourced their antibiotics from market displays (local vendors or hawkers). This finding is supported by Oluwasile *et. al*., (2016) in which they reported that 91.4% of poultry farmer's sourced antibiotics from pharmacy shops and 8.6% sourced from vendors or drug hawkers.

CONCLUSION

In conclusion, this study to the best knowledge of the researchers is the first to describe antibiotics usage in livestock management practices in north-eastern Nigeria. The results of this study suggest that antibiotic misuse is attributed to improper, irrational administration of antimicrobial agents by livestock farmers and absence of or non-adherence to legislation (if available). Unlike in the UK, where antibiotics are authorized as veterinary medicinal products and zoo-technical feed additives, here in Nigeria, antibiotics are authorized as food and drugs by the National Agency for Food and Drugs Administration and Control (NAFDAC). Bearing in mind that antimicrobial resistance is a global issue of concern both in humans and animals, the need for policies promoting lower and more controlled use of antibiotics is imperative. Consequently, educational intervention focused on training of farmers on proper and judicious use of antimicrobials and improvement of existing Nigeria's veterinary law would help curtail antibiotic misuse, as well as, limit antimicrobial use in livestock.

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