LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

# Antibiotic use among poultry farmers in the Ghana Dormaa Municipality

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**Introduction**: Antibiotic use has contributed significantly to many successes in human medicine and improvement in animal welfare. There is however global concern about non-regulation of antibiotics in food producing animals due to the great threat it poses to public health. Local evidence is required to support the regulation of antibiotics in the thriving poultry sub-sector but such data are limited. The study was conducted to investigate antibiotic use among poultry farmers in the Dormaa Municipality of the Bono Region of Ghana.

**Method**: A cross-sectional study was conducted in February to March 2020. A total of 161 commercial and backyard poultry farmers were interviewed using a "Drug bag" containing antibiotics purchased from the study area in addition to questionnaires to elicit responses about medicines. Treatment log books were also inspected where available.

**Results**: Farms were classified as backyard (n=41) or small, medium or large scale commercial (n=120). Of the commercial farms, most respondents were farm managers or farm owners and most (91%) kept layer hens. All commercial farms reported using antibiotics, obtained mainly from the Agro-Vet shops without prescription, and for both therapeutic and non-therapeutic use, while 24% of backyard farmers also used antibiotics, obtained from human drug stores, primarily for therapeutic use. Over 60% of commercial farmers indicated the use of any of the four major classes of antibiotics, namely Aminoglycosides, Polymyxins, Macrolides and Tetracyclines which are critically important in human medicine. Backyard farmers mainly used penicillins. A majority (67%) of the commercial farmers reported self-administration of antibiotics based on the information they acquire from varied sources such as colleagues, drug and feed manufacturer representatives for therapeutic and non-therapeutic purposes on their farms with little or no supervision from the Veterinarian. Adherence to the withdrawal periods is very low due to financial implications of losing out on sales of batches of eggs, however, a few farmers did report complying to the withdrawal periods.

**Conclusion**: Key concerns for antibiotic use in poultry in the Dormaa region are frequent use of critically important antibiotics without supervision from a competent official, easy access to antibiotics without prescription and non-adherence to withdrawal periods of medicines. To address this problem, whilst recognising the need for productivity of the poultry industry, the following actions are recommended to be piloted and evaluated: (1) Enhancement of the capacities of Veterinarians and Para veterinarians (Veterinary Technicians) to guide and offer adequate supervision in the administration of antibiotics on farms; (2) Regular farm-based trainings to create awareness on the importance of improving farm hygiene for minimizing antibiotic use, and in effective, affordable and feasible biosecurity and animal husbandry to achieve this; (3) Promotion of biologicals (vaccines, pre and probiotics) as an alternative to antimicrobial use in husbandry to reduce the development of resistance and accumulation of residues; (4) Development and enforcement of regulatory and advertising guidelines and prohibitions in the manufacture, import, sale and use of antibiotics at all levels through antibiotic stewardship strategies that engage and coordinate all relevant actors in the animal sector; (5) Enhanced monitoring – through improved capacity of the Veterinary Services Directorate – of levels of antibiotic residues and certification of animal products (e.g. poultry, fish) prior to their release into the markets to protect public health, environment and ensure sustainable productivity in the industry; (6) Sanctions, such as fines for defaulting farms, to serve as a deterrent to other potential and existing farms. Operational research, which takes an evidence based approach to track the effectiveness of such strategies, is required in order to informs ongoing investment in policies and services that can reduce recourse to antibiotics as the poultry industry undergoes its rapid expansion in Ghana.

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## 1.1 Background information

Antimicrobials, widely used in both humans and livestock have greatly contributed to better human and animal health (1). Antimicrobials are primarily used in animal husbandry practices to preserve animals and public health as well as to promote growth. Antimicrobial consumption in food animals have been predicted to rise by 67% by 2030 globally, and to nearly double in Brazil, Russia, India, China, and South Africa (2). This rise is likely to be driven by the growth in consumer demand for livestock products in middle-income countries and a shift to large-scale farms where antimicrobials are used routinely (4,5). Amongst livestock, poultry is considered as the fastest food-producing animal in both developed and developing countries (6) with high dependence on veterinary medicines such as antimicrobials to ensure successful production through prevention and treatment of diseases, assuring healthy stocks and maximizing production (7). Antimicrobials can be used for both therapeutic and non-therapeutic purposes. Prudent use of antimicrobials is necessary to treat infections and/ or diseases in animals. However, abuse, misuse and overuse of antimicrobials can contribute to the development of antimicrobial resistant pathogens and accumulation of antimicrobial residues, thereby driving antimicrobial resistance (AMR). Antimicrobial resistance occurs when microorganisms such as bacteria, fungi, viruses and parasites fail to respond to antimicrobial substances like antibiotics (7).

Antimicrobial resistance (AMR) is a major global threat of increasing concern to human and animal health, the environment and ecology among others. At the 71st Session of the United Nations General Assembly meeting that was held in September 2016, the member states agreed that Antimicrobial resistance threatens the achievement of the Sustainable Development Goals and thus requires a global response.

In view of these global developments, the FAO and WHO offices in Ghana have played vital roles in supporting and collaborating with the relevant agencies and institutions to facilitate the development of Ghana National Antimicrobial Policy and Action Plans which was launched in 2018 by the President of Ghana. Addressing antimicrobial menace based on the One Health Approach was considered to fight issues of antimicrobial resistance holistically. Stakeholders from the government, private and civil society organisations have been engaged in the implementation of operational strategies outlined in the National Action Plan (NAP) with assistance from the funding agencies of which key among them is the Fleming Fund in all phases over the period.

Evidence has shown that there are challenges with use of antibiotics in animal husbandry, thus the need to strengthen the rational use of medicines in veterinary practice to prevent the emergence, persistence and spread of antibiotic resistant bacteria from animals and also transfer of these resistance determinants to human pathogens (8,9).

In Ghana, access to antibiotics is generally easy as existing regulatory framework and enforcement systems for humans are weak but non-existent in the case of animals in the country (10–13). Before the launch of the Antimicrobial Policy document in 2018, which outlined guidelines on antimicrobial use in both human and animals, the Public Health Act (851) of 2012 was the legal policy document which has a set of guidelines for handling of foods (i.e. meat), drugs and chemicals without specific mention of poultry and poultry products.

The poultry industry in Ghana plays a significant role in the rural and urban populations as it contributes to food security and nutrition by providing the protein needs of the poor and rich in society; means of livelihood, as well as income-generating venture, depending on the scale of production to alleviate poverty in households (14). In addition, the consumption of poultry is widely accepted in most communities in Ghana with little or no cultural/traditional restrictions as with other animal protein sources.

The unavailability of sufficient data on antimicrobial use in the livestock sector of which poultry is part serves as a major setback to institute and implement effective control systems and policies to ensure product safety and also reduce risks to public health. Hence, evidence from systematic enquiry will be needed to make well-informed management (institutional level) and policy (national level) decisions on regulations of antibiotic use and determination of residues to ensure a sustainable poultry industry which can significantly contribute to the Sustainable Development Goals (15).

## 1.2 General objectives

This current study primarily seeks to explore antibiotic use among poultry farmers in the Dormaa municipality to inform targeted public health interventions to combat the threat of antimicrobial resistance.

Specific Objectives

1. To examine the bio-data and farm characteristics of the selected poultry farmers in the Dormaa Municipal
2. To compare antibiotic use in different scales of poultry farming in the municipal.
3. To identify factors affecting antimicrobial use in poultry in Dormaa Municipal

## 1.3 Structure of report

The report has been put into five main segments namely; Introduction, Review of literature, Methodology, Results and Discussion. The Introduction focuses on the use of antimicrobials and the associated threat to global health due to resistance. This section also looks at the several efforts to curb the rising threat and the importance of this study with emphasis on the general and specific objectives of the study.

The Literature review section details previous or known global and local research/publications on antibiotic use and to identify the gaps in our knowledge.

The Methodology profiles the study location, population, sample size and techniques, data management as well as ethical considerations that had to be undertaken the study to be granted approval. The Results section presents the findings from the study in tables, graphs among others for interpretation which will be discussed with reference to literature.

The Discussion summarises the findings/evidence of the study and makes possible recommendations to inform policy or management actions regarding the subject matter.

## 2.1 Antibiotic Use in Animal Production

Recent rise in economic growth, wealth and consumption patterns have been associated with a scale-up in demand for animal proteins globally. This notable dietary trend has led the animal production industry to increase its dependence on antimicrobials to meet the expectations of consumers. Although the amount of antimicrobials used for agricultural purposes is globally not known and the estimates vary widely, some studies have estimated that about 60% of all the antibiotics produced find their way into the food animal production system (3,16,17). It is estimated that almost all the current antibiotics will be ineffective as preventive and treatment medicines by 2050 if nothing is done to preserve its efficacy (17).

Antimicrobials have been used for therapeutic (treatment) and non-therapeutic (infection prevention and growth promotion) purposes in animal husbandry over the decades. Infections that were once lethal are now treatable to improve the overall welfare of animals. Proper therapeutic use of antibiotics in animal production systems has been found to be beneficial to the farmers as they are able to treat herds/flocks of livestock from infections to produce efficiently and realise huge economic gains. However, in recent times serious public health concerns have arisen due to the imprudent use and abuse of antimicrobials in animal settings. There is increasing evidence that extensive use of antimicrobials in the food animal production sectors have led to the selection and spread of antimicrobial-resistant pathogens in the food chain and other transmission routes resulting in treatment failures as well as compromising on animal welfare.

Research suggests that higher use of antibiotics in animals drive drug resistance in a number of ways, described in the O’Neill report (2) as three forms of risk:

i. drug-resistant strains are passed on through direct contact between humans and animals (notably farmers)
ii. drug-resistant strains have the potential to be passed onto humans more generally through the food chain, i.e. when consumers prepare or eat the meat itself
iii. there is a further indirect threat to human health as result of animal excretion

Empirical evidence suggests that antibiotic use in animals serves as a factor in promoting resistance in humans (2,18) in addition to the accumulation of antibiotic residues in food animal products such as milk, eggs and meat. Antibiotic residues raises several public health concerns such as transfer of antibiotic resistant bacteria to humans, hypersensitivity reactions, toxicity, teratogenicity, and carcinogenicity (19–21).

## 2.2 Antimicrobial resistance

Antibiotic use in animals is the main cause for selection and dissemination of antimicrobial resistance in animals. The increase in antimicrobial resistance (AMR) is of great concern as evidence has shown resistant pathogens can spread between food – producing animals and humans (22,23) leading in treatment failure, economic losses, but also a source of resistant bacteria/genes (including zoonotic bacteria) that may represent a risk to human health.

Antibiotic resistance happens when bacteria develop the ability to survive or grow despite being exposed to antibiotics designed to kill them. AMR spreads through people, animals, and the environment.

Until recently the consequences for the development of antimicrobial resistance in animals have received comparatively less attention than in humans (24) although several studies conducted in different jurisdictions on food animals have reported on the existence of large numbers of isolates which are resistant to a wide range of antimicrobials and are multi-drug resistant too (25–30). In most industrialised countries, antibiotic use in food animal production for any intended therapy is highly supported by relevant diagnostics and strictly monitored over the period to minimise the development of resistant genes as well as accumulation of antibiotic residues (31,32). In Africa and other Low and Middle-Income Countries, the situation is usually worse due to the absence of effective monitoring systems or regulations (19), thus threatening both human and animal health systems.

## 2.3 Regulations and Guidelines on Antimicrobial use in Animal Production

In response to the political declaration at the United Nations General Assembly in September 2016 following WHO's Global Action Plan on antimicrobial resistance adopted at the Sixty-Eighth World Health Assembly in May 2015, most nations have committed to take actions such improvements in antimicrobial use, regulation and policy, surveillance, stewardship, infection control, sanitation, animal husbandry, and alternatives to antimicrobials as well as working towards a one health (3,17,25,33–35). The tripartite organisations (Food and Agriculture Organisation (FAO), World Health Organisation (WHO) and World Organisation for Animal Health (OIE)) agreed on the importance of addressing the phenomenon of antimicrobial resistance using the One Health approach in humans, animals and the environment will be established. Relevant stakeholders would collectively use their expertise to make significant contributions to the establishment of policies and legal frameworks aimed at fighting the global threat posed by antimicrobial resistance in these sectors. Evidence suggests that across high, middle and low income countries, some movement on plans to make progress in the fight against antimicrobial resistance has been made (6,27,36). In particular, multi-sectoral meetings have been established in many countries, often facilitated by in-country representatives of the tripartite.

In Ghana, through the diverse assistance of the tripartite, the Antimicrobial Policy Document was developed and launched in 2018 (37). The existing regulations for antimicrobial use for humans was weak but non-existent for the animals (12). This weak regulatory environment was coupled with non-adherence to antibiotic guidelines among prescribers and consumers, resulting in high prevalence of antimicrobial use in both humans and animals (12,38,39). Evidence from some studies have indicated the presence of antimicrobial resistant pathogens in human and animal facilities in Ghana, presumed to be a result of the overuse of antimicrobials (13,18,39–43). Compared to the animal sector, antimicrobial use in humans is better regulated as there is adequate capacity in terms of infrastructure and resources to ensure compliance in most health care facilities. The veterinary sector has not built its capacity to meet the rapidly increasing agriculture sector. Antimicrobials are easily accessed and administered with limited or without any supervision in most farming areas. The few veterinary infrastructures and personnel found in the cities are not well resourced to deliver the needed services to the stakeholders, thus the wide gap that exists between stakeholders. These challenges have been clearly outlined in the National Action Plan of the Policy Document. The implementation of the various strategies and actions within the National Action Plan and being supervised duly by the tripartite country representatives in-country. Guidelines to regulate and monitor antimicrobials have been clearly outlined to inform public health actions/interventions such as enforcement of regulation, imposition of high taxes on antimicrobials and provision of subsidies to industries with potential to manufacture certain biologicals.

## 2.4 Rationale

The global fight against AMR in food producing animals looks challenging but achievable. The increasing demand for animal proteins resulting in the misuse of antibiotics in food producing animals coupled with absence of regulations or guidelines to prevent the development of resistant pathogens within the food chain. It demands the collective responsibility of all stakeholders through the use of effective collaboration and well-coordinated multi-disciplinary approach in surveillance programs at all levels.

Although the poultry sector is a thriving one, data collection on AMU is inadequate to plan for an effective surveillance program aimed at generating accurate data required to inform the policies on antimicrobials, national antimicrobial treatment and stewardship strategies, scale up on interventions and develop market reforms as well as ensuring sustainable drug development (bridges information gap on AMR). Findings from previous studies in Ghana have revealed the indiscriminate use and unrestricted access to antimicrobials due to policy and system gaps, weak adherence to regulations and guidelines, weak monitoring among others (10–12,44).

The public (farmers and other stakeholders) lack awareness on the effects of misuse of antimicrobials in animal production can have on burden of disease in human health with regards to antimicrobial resistance. The abuse of certain antimicrobials has led to the development and spread of new multi-drug resistance strains of pathogenic microbes in humans (18,45) and this has been a major concern to individuals, societies and modern economies.

Access to antimicrobial agents by farmers is very easy as they have been found to be prescribed and dispensed by a wide range of unauthorized persons (12,46). The use of antimicrobials as growth promoters, prophylaxis and treatment are mostly not done and monitored under supervision by the competent authority to ensure the right medicines, dosages, routes of administration as well as the withdrawal periods are adhered to, to avoid unintended consequences which will have negative implications on public health.

It was found in a study that about 93.6% of respondents who use manure on fish farms use poultry manure from commercial poultry farms and use it mainly to fertilize fish ponds without treating the manure (11). Any form of pathogenic microbe may be transferred from one production system to the other. The uncontrollable use of antimicrobials in poultry production would lead to unacceptable levels of antibiotic residues in the products and by - products (manure) that would expose consumers to resistant strains of bacteria which could be transmitted from animals to humans.

The current study seeks to explore antibiotic use among the different scales of poultry farmers in the Dormaa Municipal to build and strengthen local evidence (data) on AMU that will serve as a basis for future AMU research on poultry in other locations so that the regulator to be well informed on AMU trends to implement and monitor interventions to safeguard AMR menace to ensure sustainability of the poultry sector, environment and public health. In addition, the knowledge of AMU trends should guide the regulator in management. As the findings from the study will be presented to the poultry farmers' association in Dormaa Municipal to stimulate engagements among themselves and their stakeholders on addressing AMU issues in their practices to sustain future investments. The study seeks to answer the following questions:

1. What are the farm characteristics of the selected poultry farmers in the Dormaa Municipality?

2. What are the common classes of antibiotics used among poultry farmers in the Dormaa Municipality?
3. What are the indications of use of antibiotics among the poultry farmers in the Dormaa Municipality?
4. How does antibiotics use vary among the different scales of poultry farmers in the Dormaa Municipality?

## 3.1 Study sites

The Dormaa Municipality was established by Legislative Instrument (LI2087) of 2007. It is located at the western part of the Brong Ahafo Region. It lies within longitudes $3^0$ West and $3^0$ 30' West and latitudes $7^0$ North and $7^0$ 30' North. It is bound in the North by the Jaman South District and Berekum Municipal, in the east by the Sunyani Municipal, in the South and South-East by Asunafo and Asutifi Districts respectively, in the South-West by Western Region and in the West and North-West by La Cote D'Ivoire. The Municipal capital is Dormaa Ahenkro, located about 80 kilometres west of the Regional capital, Sunyani.

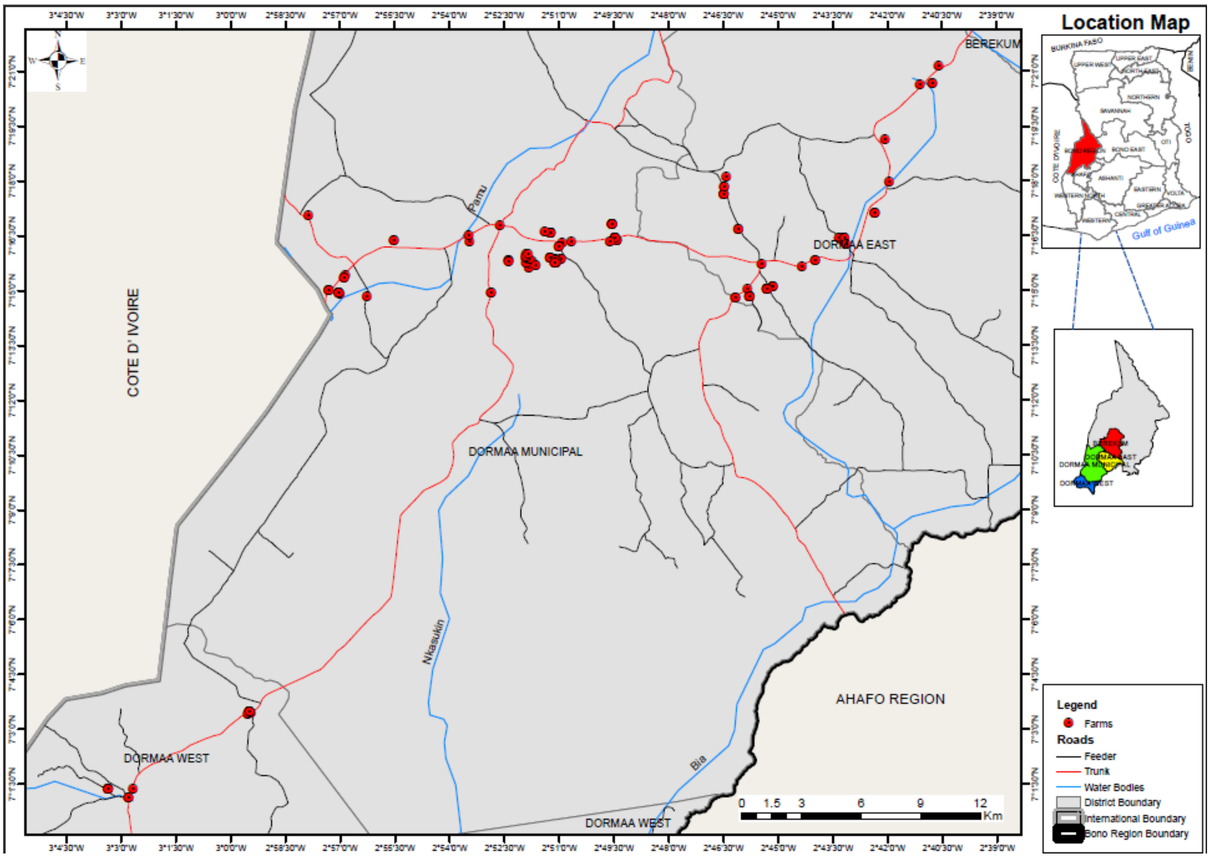


*Figure 1. Map showing study area*

The Municipality has a total land area of 917 square kilometres with 81 settlements. The population of the municipality according to the 2010 National Population and Housing Census is 50,871 which was projected to 62,851 in 2019 (47). Agriculture is the major economic activity in the Municipal in terms of employment and income generation as about 60.8% of persons employed are skilled agricultural, forestry or fishery workers while 15.1% of the employed population are employed either a service or sales workers. Craft and related trade workers contribute 9.6% of the employed population (47). The total livestock population is 291,715 of which 214,026 chickens (representing 73 per cent of all livestock) being kept.

Dormaa municipal was geographically targeted for this study as data from Ghana Statistical Service and discussions with officials from Ministry of Agriculture indicates that the poultry sector in the municipal is one of the thriving sectors in the country(48,49). Due to the municipal's proximity to Cote I'voire which has a number of large scale commercial poultry farms with hatcheries, poultry farmers in Dormaa have easy access to day old chicks from them. Cote Ivoire serves as a huge market for all poultry products which includes eggs, meat and poultry waste. Some Ivorian Commercial farms have set up poultry farms in Dormaa that are being operated by Ghanaians. These farms receive incentives and technical support from parent companies in Cote Ivoire (50).

The proliferation of Agro-Vet shops in Dormaa municipal is high as most households are involved in agro-related enterprises. The Agro-Vet shops obtained operating licences from the municipal assemblies by individuals/entrepreneurs. The Municipal has two (2) veterinarians who are being assisted by three (3) Veterinary Technicians to render routine extension services to the farms (Crop and Livestock) within the four (4) districts namely Dormaa Central, Dormaa East, Dormaa West and Berekum. Occasionally, extension service delivery is normally carried out by the few available personnel upon farmer's request due to the limited resources allocation. Among the commercial poultry farmers, the small and medium scale operators receive extension services from Agriculture Extension service agents and Veterinary Technicians while extension service is delivered to the large scale operators by the Government or Private Veterinarians.

In recent times, domestic production keeps declining due to the high cost of inputs and infrastructural challenges which has resulted in high import of poultry meats constituting about 80% of the total meat imports into the country. On the 25$^{th}$ of June, 2019, the President launched the "Rearing for Food and Jobs" program aimed at revamping the current livestock industry to increase domestic production, reduce importation of livestock products, contribute to employment creation, and improve livelihoods of livestock value chain actors. The government has set an ambitious target to invest in the poultry component of the program as a major step to stop the current importation of chicken worth USD 380 million of poultry meat every year into the country (51). Farmers will receive inputs such as day old chicks, vaccines and feed at subsidized rates in addition to technical support for period of time to strengthen the capacities of farmers.

## 3.2 Study design

A cross-sectional study involving three methods namely structured questionnaire, drug bag, and treatment records were used in the study. The questionnaire was categorized into six sections. Sections one and two captured the general information and location of the farm. Section three detailed the demographic parameters of the farmer/owner whereas section four highlighted issues on the farm characteristics. The last two sections dealt with availability and accessibility of antibiotics and antibiotic use. The full questionnaire typically took 40 minutes to complete.

The questionnaire elicited responses from participants on the types and sources of antibiotics that are easily accessed and used frequently, the proportion of farms and households that used the antibiotics within a given time frame and what the different antibiotics were being used for as well as whether antibiotics accessed were prescribed by the competent prescriber.

The drug bag method which had been developed and piloted in a similar study in Africa and some parts of the world (52) is a modified version of the established anthropological method of pile sorting in which the interviewer uses physical materials to stimulate deeper conservation with the interviewee. This method assisted respondents to recognize drugs under investigation which could easily be accessed or otherwise minimize recall bias. Reasons for the use of the antibiotics would also be known unless the respondents' declined to give indications. The antibiotics that can't be accessed easily would also be known from this exercise with possible reasons i.e. cost or proximity etc.

Available Treatment records or log book on farms were also inspected to ascertain which types of antibiotics have been used on the farms over a given period of time. Information from the treatment log books would likely indicate the mode or route of administration, the dosage and microbiological reports that necessitated the use of the antibiotic. Data collected using these three data collection tools were triangulated in the analysis. The data collection exercise for the study spanned six weeks in February to March 2020.

## 3.3 Study population

The target group of the study participants included both commercial and domestic (backyard poultry) farmers within the municipality. Existing registered list of commercial poultry farms at the Municipal Agriculture/ Veterinary Office revealed that there are four hundred (400) registered commercial poultry farmers whose farms could be stratified into large, medium and small depending on the number of birds reared per production cycle. This number was updated with the help of the chairperson of the commercial farmers' association to an estimated figure of five hundred and fifty-five commercial farmers. In addition to the registered commercial farms, the study targeted backyard or domestic poultry farmers within the municipality to participate in the study to get a sense of any differences or scale of issues in these farms.

**Population and sample size of farms**

| Farm size | Total number of farms | Sample size |
|---|---|---|
| **Large scale**: >10,000 birds | 66 | 34 |
| **Medium scale**: 5,001 -10,000 birds | 450 | 60 |
| **Small scale**: 50-5,000 birds | 39 | 26 |
| **Domestic**: under 50 birds | | 41 |
| **Total** | **555** | **161** |

**Exclusion Criteria**

1. All backyard poultry farmers who are not located within stratified location of the registered farms will be excluded from the study
2. Only commercial poultry farmers and backyard poultry farmers will participate in the study.
3. The farm should be located in the Municipality and must be functional in the last six months.

## 3.4 Sample Size Determination

The Yamane's formula (53) was used to estimate the sample size for poultry farmer in the municipality using a confidence interval of 90% and a margin of error of 10%.

$$n = \frac{N}{1 + N(e)^2}$$

Where

n = sample size

N = total number of commercial poultry farmers

e = margin of error (10 %)

## 3.5 Sampling Technique

A multi-stage sampling approach was used in this study. Firstly, the municipality was stratified into clusters such as Eastern, Western and Central. All communities with poultry farms in the clusters under study was purposively considered. Secondly poultry farms located in each cluster were sorted out using the list of registered farms. Within the clusters, samples were allotted on the basis of the calculated sample sizes for the various scales of production using statistical method. The Municipal Veterinary Officers, Ministry of Food and Agriculture (MoFA) staff and technicians assisted in the identification of the respondents. Snow ball effect was also applied to get to know other existing commercial poultry farms.

## 3.6 Data collection procedures

Questionnaires was pre-tested in Ga East Municipality within the Greater Accra Region of Ghana with similar characteristics of poultry farms to determine the clarity of the questionnaire, conduct further refinement as well as verify survey times.

The study began with a sensitization of the poultry farmers (managers and owners), Vets or animal health workers, feed manufacturers, and household heads on the intended research and what is required of them. A consent form was explained to all the selected farmers and household heads in the local language at the durbar to ensure clarity to the farmers. This exercise was facilitated by the Municipal Veterinary Officer.

A combination of three methods was employed for the study, namely development of structured questionnaire, drug bag, and treatment records. The latter two methods were necessary to validate the responses in the questionnaire. A semi-structured questionnaire was developed for the soliciting of information from the harvesters of oysters in the study areas. This was uploaded onto a Kobo Toolbox placed on a tablet for data collection.

Questionnaires were administered to selected poultry farmers (from the registered list) as well as the backyard farmers in the households within the clusters by the research team. The questionnaire elicited responses from participants on the types and sources of antibiotics that are easily accessed and used frequently, the proportion of farms and households that use the antibiotics within a given time frame and what the different antibiotics are being used for as well as whether antibiotics accessed are prescribed by the competent prescriber.

During the interview, the respondents were exposed to the bag containing different types of antibiotics that were purchased from the drug or vet outlets in and around the municipality to carefully sort in response to the questions in the questionnaire.

The drug bag method which has been developed and piloted in a similar study in Africa and some other parts of the world (52) is a modified version of the established anthropological method of pile sorting in which the interviewer used physical materials to stimulate deeper conservation with the interviewee. This method assisted respondents to recognize drugs under investigation which can easily be accessed or otherwise to minimize recall bias. Reasons for use of the antibiotics was recorded unless the respondents' declined to give indications. The antibiotics that can't be accessed easily was known from this exercise with possible reasons i.e. cost or proximity etc.

Available treatment records or log book on farms was inspected to ascertain the types of antibiotics used on the farms and over a given period of time. Information from the treatment log book indicated the mode or route of administration, the dosage and microbiological reports that necessitated the use of the antibiotic.

Combining all these three methods enabled triangulation in the analysis for increased reliability of interpretation.

## 3.7 Data handling

Study researchers ensured participants were aware that only the research team will have access to the raw data (including both raw data and data uploaded to the secured computer and any data shared beyond the group will be subject to approval from the study team on a case-by-case basis. Respondents from farms and households were given serial codes to ensure anonymity. For purposes of quality control, the daily administration of the questionnaires was monitored and data on the kobo tool box dataset was checked by the investigator.

## 3.8 Statistical Analysis

Data from the kobo tool box database was downloaded, cleaned and exported unto a secured computer for using Stata software version 11. Descriptive analysis was performed and results expressed in frequencies, from the variables (i.e. demographics, antibiotic use etc) in the study. Comparative analysis using chi – square tests was used to determine the association between variables of interest. A simple binary regression analysis was undertaken to examine the factors affecting the use of antibiotic use on the farms.

## 3.9 Dissemination of Results

The results from this study will be disseminated to the relevant regulatory agencies such as the Veterinary Services Division of the Ministry of Food and Agriculture, Ghana which is the Beneficiary Institution for the Fleming Fund Scheme for onward dissemination to the critical stakeholders such as the media, Environmental Protection Agency drug and feed manufacturers. The findings will also be disseminated to the Poultry Farmers and the farmer groups in the study area. A map showing the farms surveyed will be developed and distributed alongside small leaflets with the findings and recommendations about the subject matter. As part of the activities for the Fellowship, the results will be presented at international AMR workshops, seminars and conferences to compare to similar works on AMU from other jurisdictions to generate discourse on the poultry industry.

## 3.10 Ethical Consideration

In all the poultry farms that the study was conducted, participation in the survey was voluntary. Researcher team introduced themselves, stated why they were on the farm, read out content of consent form and asked whether the respondents agreed to be interviewed at the beginning of each interview. Farm owners/managers were assured that no identifiers will be used in the write-up on the research and farmers' identities will be protected at all times. The study was approved by the London School of Hygiene Ethics Review Committee, UK and the Ethics Review Board of the Ensign College of Public Health, Kpong, Ghana.

## 3.11 Funding

This study was funded by the Fleming Fund Fellowship Programme (GH06), a programme of the Department for Health and Social Care of the UK government through the management agent Mott McDonald and a grant for the Fellowship scheme to the London School of Hygiene & Tropical Medicine. The funders were not involved in the design, data collection, analysis or writing up of the study.

## 4.1 Demographics of Respondents and Farm Characteristics

### 4.1.1 Demographics of Respondents

Demographic characteristics of respondents such as sex, age, marital status, religion, nationality, educational status and primary occupation were summarized in Table 1.

*Table 1. Demographics*

| | Backyard (n=41) % | Small (n=26) % | Medium (n=60) % | Large (n=34) % | All (161) % |
|---|---|---|---|---|---|
| **Sex** | | | | | |
| • Male | 34.1 | 88.5 | 86.7 | 85.3 | 73.3 |
| • Female | 65.9 | 11.5 | 13.3 | 14.7 | 26.7 |
| **Age range** | | | | | |
| • 11-25 | 5.0 | 34.6 | 25.0 | 14.7 | 19.4 |
| • 26-40 | 22.5 | 38.5 | 38.3 | 44.1 | 35.6 |
| • 41-55 | 42.5 | 19.2 | 23.3 | 35.3 | 30.0 |
| • 56-70 | 17.5 | 7.7 | 13.3 | 5.9 | 11.9 |
| • 71-84 | 7.5 | N/a | N/a | N/a | 1.9 |
| • 85+ | 5.0 | N/a | N/a | N/a | 1.3 |
| **Marital status** | | | | | |
| • Married | 65.9 | 57.7 | 65.0 | 67.6 | 64.6 |
| • Single | 19.5 | 34.6 | 30.0 | 26.5 | 27.3 |
| • Divorced | 2.4 | 3.8 | 1.7 | 2.9 | 2.5 |
| • Widow/widower | 12.2 | 3.8 | 3.3 | 2.9 | 5.6 |
| **Religion** | | | | | |
| • Christian | 85.4 | 92.3 | 85.0 | 85.3 | 86.3 |
| • Muslim | 12.2 | 7.7 | 13.3 | 11.8 | 11.8 |
| • No religion | 2.4 | - | 1.7 | 2.9 | 1.9 |
| **Nationality** | | | | | |
| • Ghanaian | 100.0 | 100 | 98.3 | 94.1 | 98.1 |
| • Non-Ghanaian | - | - | 1.7 | 5.9 | 1.9 |
| **Educational level** | | | | | |
| • No formal | 24.4 | 3.8 | 5.0 | 2.9 | 8.7 |
| • Basic | 63.4 | 38.5 | 46.7 | 29.9 | 46.0 |
| • Secondary | 12.2 | 30.8 | 33.3 | 44.1 | 29.2 |
| • Tertiary | - | 26.9 | 15.0 | 23.5 | 14.9 |
| **Primary occupation** | | | | | |
| • Poultry farmer | 2.4 | 76.9 | 90.0 | 88.2 | 65.2 |
| • Crop farmer | 43.9 | | 1.7 | 2.9 | 12.4 |
| • Market vender | 19.5 | 3.8 | 1.7 | | 6.2 |
| • Government/Private sector employee | 4.9 | | 5.0 | | 3.1 |
| • Artisan | 7.3 | 7.6 | 1.7 | | 3.1 |
| • Tailor/Seamstress /hairdresser | 4.9 | | - | | 1.2 |
| • Unemployed | 2.4 | | - | | 0.6 |
| • Others | 14.6 | 11.5 | - | 5.8 | 4.3 |

• **Sex of Respondents**

There sampled respondents interviewed included 73.3% male and 26.7% females. With the exception of backyard category, all the groups recorded higher percentage of males involved in poultry farming. Generally, the sub-sector can be seen to be dominated by males.

• **Age of Respondents**

The age of respondents on the farm ranged between 18 and 88 years (40.08±14.81). The findings demonstrated that out of the total respondents interviewed, vast majority (35.6%) fell within the ages of 26 to 40 years followed by those (30.0%) within the ages of 41 to 55 years. It was seen from the investigation that a more noteworthy level of the respondents (65.0%) were between the ages of 36 to 55 years. The outcomes uncovered that small and medium scale farmers revealed of a higher percentage of respondents with ages less than 26 years. Younger persons were also involved in commercial poultry farming.

• **Marital Status**

The outcome of the study further revealed that most of the respondents were married (64.4%), trailed by those who were single (27.3%). This development applies to all the respondents from the different groups. There were quite a sizeable percentage who were divorced and widowed/widowers.

• **Religion**

As far as the religion was concerned, a decent number of the respondents (86.3%) were Christians, which followed by the Muslim (11.8%). There were likewise the individuals who had no religion. Additionally, high percentage of the respondents from all the groups were Christians.

• **Nationality**

Almost all the respondents sampled (98.1%) for the study were Ghanaians. Additionally, all the backyard/household operators and small scale commercial poultry farmers interviewed were Ghanaians while the other categories reported of very few foreigners from Burkina Faso, La Cote d'Ivoire and Nigeria involved in the commercial poultry farming.

• **Educational Level**

Results show a higher percentage of the sampled respondents attaining basic level of education (46.0%) followed by secondary level (29.8%). It was revealed from the result that quite a few of the respondents (8.7%) out of the total of 161 had no formal education. There were reported high percentages of respondents educated among the commercial farmers but the basic level run the highest among small (38.5%) and medium 46.7%) scale farmers. All the commercial farmers also showed highly educated (tertiary level) commercial farmers.

• **Primary Occupation**

The primary occupation cut across varied profession. The main primary occupation of the interviewed respondents included poultry farming (65.2%), crop farming (tree crop and seasonal crops) and market vending among others.

- **Status of respondents**

In all, most of the respondents interviewed were farm managers (44.7%) followed by farm owners (35.4%). The results further revealed that a higher percentage of farmers interviewed were farm managers along the different scales followed by farm owners. With the backyard farmers, the Household heads 18.6% dominated the other members of the households 6.8%. Figure 2 depicts the summary of the status of respondents sampled.

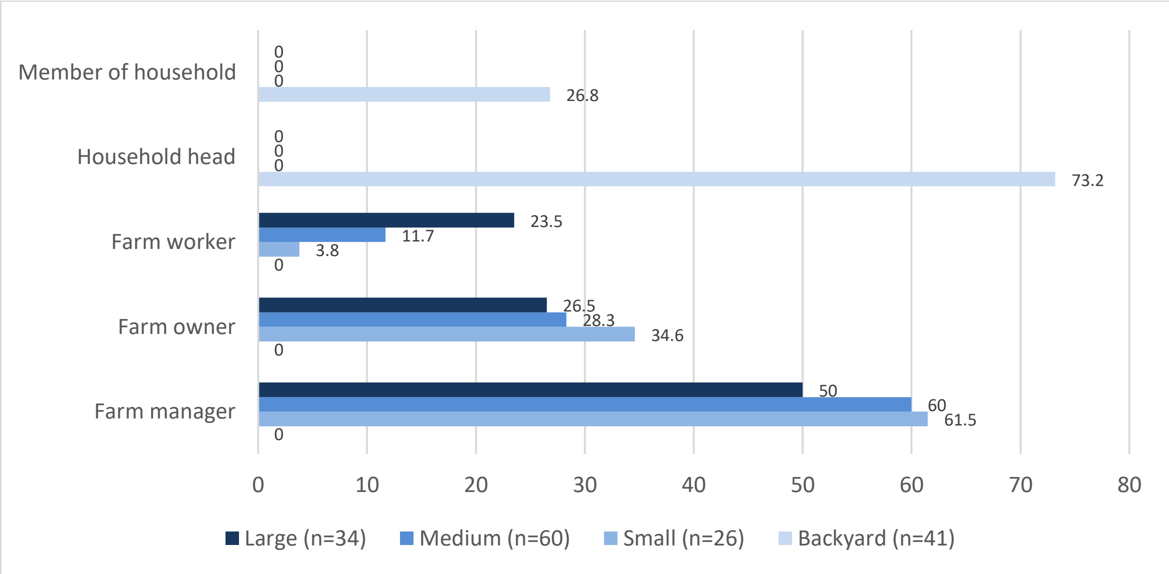


*Figure 2. **Status of Respondents Sampled***

### 4.1.2 Farm Characteristics of Respondents

The distribution of farms involved in the study is categorized into backyard, small scale, medium and large-scale poultry farming. The commercial farms according to the FAO have been classified into small, medium and large scales.

Experience of the respondents ranged from 1 to 38 years (10.16±7.53). In all, most of the respondents have been undertaking poultry farming for a period of less than 10 years (62.7%) followed by 29.7% of the respondents in poultry farming from 11 to 20 years. (Table 2).

*Table 2. **Experience of Respondents by scale***

| Years of Experience | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| • ≤ 10 | 24 (58.5%) | 21 (80.8%) | 39 (65.0%) | 17 (50.0%) | 101 (62.7%) |
| • 11-20 | 11 (26.8%) | 3 (11.5%) | 18 (30.0%) | 15 (44.1%) | 47 (29.7%) |
| • 21-30 | 3 (7.3%) | 1 (3.8%) | 1 (1.7%) | 2 (5.9%) | 7 (4.3%) |
| • 31+ | 3 (7.3%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 3 (1.9%) |
| • No response | N/a | 1 (3.8%) | 2 (3.3%) | N/a | 3 (1.9%) |

Figure 3 further shows years of poultry farming of total sampled respondents by three (3) years range. Most of the sampled respondents (22.4%) have being farming for a period of 1-3 years followed by 18.6% (10-12 years). Outcomes of the study indicated that 33.5% of respondents have been trained on farm biosecurity measures. Results revealed that about 17% of those interviewed with experience between 1-3 years had been trained on farm biosecurity measures (Appendix 7). A greater percentage of the small (42.3%) and medium (25%) scale poultry farmers have been operating for a period of 1-3 years except large scale farmers (23.5%) whose experience in poultry farming ranged from 10-12 years. A few (8.8%) of the large scale farmers have been involved in this business for 1-3 years.

In terms of training on farm biosecurity measures, majority of the respondents (11.1%) with experience between 1- 3 years had been trained by poultry farmers associations. This is followed by 5.6% who had received training from drug manufacturing companies/dealers while the rest (2.8%) were trained by feed manufacturers (Figure 7). None of those with poultry farming experience between 1-3 from this study had benefited from trainings from government agencies, projects nor Non-Governmental Organizations (Appendix 8). In all, most farmers interviewed (15.8%) were trained by poultry farmers association on farm biosecurity measures.

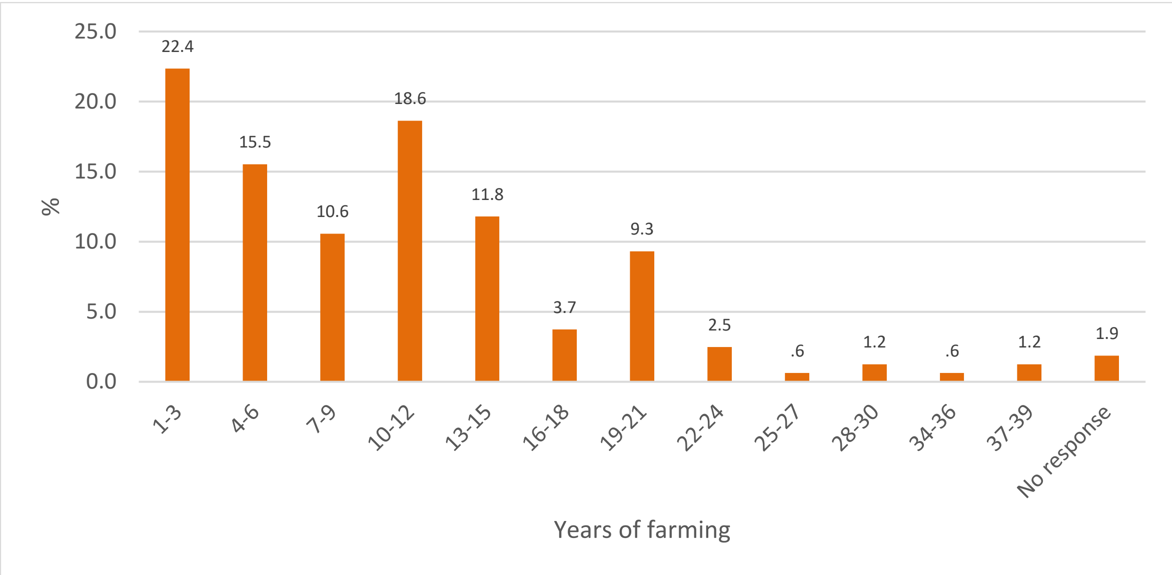


*Figure 3. Years of farming*

The results showed that most respondents used only imported day old chicks (52.8%) followed by 38% who bought day-old chicks from local hatcheries that import parent stocks (Table 3). Those who buy imported birds are the commercial poultry farmers thus the small, medium and large-scale farmers whereas the backyard farmers mainly used local birds. The results further showed that very few of the farmers purchased from more than one source. Quite a high percentage (13%) bought from imported source and as well as from local hatcheries.

*Table 3. **Source of Birds (Chicks/Day-Olds)***

| Sources of Birds | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| • Imported | 1 (2.4%) | 22 (84.6%) | 42 (70.0%) | 20 (58.8%) | 85 (52.8%) |
| • Imported & local | 1 (2.4%) | N/a | 1 (1.7%) | 1 (2.9%) | 3 (1.9%) |
| • Local | 38 (92.7%) | N/a | N/a | N/a | 38 (23.6%) |
| • Local hatchery | 1 (2.4%) | 1 (3.8%) | 10 (16.7%) | 2 (5.9%) | 14 (8.7%) |
| • Local hatchery & imported | N/a | 3 (11.5% | 7 (11.7%) | 11 (32.4%) | 21 (13.0%) |

Table 4 describes the sources of water for poultry farming by the respondents. The three main sources of water were borehole (57.1%), well (29.8%) and pipe-borne (18.0%) water in order of importance. Very few (3.1%) harvested rainwater as source of water for the birds. It was further revealed that out of the 161 sampled respondents, very few farmers (9%) accessed water from more than one source (Appendix 2).

*Table 4. **Source of Water***

| | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| Borehole | 20 (48.8%) | 15 (57.7%) | 32 (53.3%) | 25 (73.5%) | 92 (57.1%) |
| Well | 5 (12.2%) | 7 (26.9%) | 27 (45.0%) | 9 (26.5%) | 48 (29.8%) |
| Stream/river | 1 (2.4%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 1 (0.6%) |
| Pipe-borne | 17 (41.5%) | 6 (23.1%) | 2 (3.3%) | 4 (11.8%) | 29 (18.0%) |
| Harvested rain | 5 (12.2%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 5 (3.1%) |
| Others | 0 (0.0%) | 0 (0.0%) | 1 (1.7%) | 1 (2.9%) | 2 (1.2%) |

The respondents were asked to indicate the type of birds reared on their farms (Table 5). Outcomes of the study revealed that types of birds were broiler, layer and others (e.g. Cockerel) with layers being predominant (68.3%), thus very few of the respondents reared more than one type of bird. In addition, out of the 161 respondents, a greater percentage (71.4%) reared only layers while 24.2% reared only local birds. Backyard farmers mostly had local chickens that were reared to supplement household protein needs. But amongst the rest, it really is dominated by layers who are sold for their meat when their egg supplies were spent.

*Table 5. **Type of Birds***

| | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| Broiler | - | 1 (3.8%) | 2 (3.3%) | 2 (5.9%) | 5 (3.1%) |
| Broiler & Layer | - | 2 (7.7%) | 2 (3.3%) | - | 4 (2.5%) |
| Broiler & Local | 1 (2.4%) | - | - | - | 1 (0.6%) |
| Cockerel | 1 (2.4%) | - | - | - | 1 (0.6%) |
| Cockerel & Others | 1 (2.4%) | - | - | - | 1 (0.6%) |
| Layer | - | 23 (88.5%) | 55 (91.7%) | 32 (94.1%) | 110 (68.3%) |
| Layer & Cockerel | 1 (2.4%) | - | - | - | 1 (0.6%) |
| Local | 35 (85.4%) | - | 1 (1.7%) | - | 36 (22.4%) |
| Local & Cockerel | 2 (4.9%) | - | - | - | 2 (1.2%) |

The poultry farmers had various sources of farm vaccination regimes which included hatcheries, other farms, and Veterinary Service Directorate. Most of the respondents (47.8%) obtained their farm vaccination regimes from the Veterinary Services Directorate. There are those who followed the regime from other sources such as hatcheries and other farms (Table 6).

Results further showed that out of the total respondents (161), about 67% only followed the vaccination regime from the Veterinary Services Directorate, 17% only followed hatchery vaccination regime while 16% also followed other farmers' regime. Backyard farmers rarely reported following any vaccination regime.

*Table 6. **Source of Farm Vaccination Regime***

| | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| Hatchery | 1 (2.4%) | 5 (19.2%) | 5 (8.3%) | 5 (14.7%) | 16 (9.9%) |
| Other farmers | 1 (2.4%) | 4 (15.4%) | 6 (10.0% | 3 (8.8%) | 14 (8.7%) |
| Veterinary service Directorate | 1 (2.4%) | 14 (53.8%) | 42 (70.0%) | 20 (58.8%) | 77 (47.8%) |
| Veterinary Service Dir. & Hatchery | - | - | 4 (6.7%) | 4 (11.8%) | 8 (5.0%) |
| Veterinary Service Dir. & other farmers | - | 3 (11.5%) | 3 (5.0%) | 2 (5.9%) | 8 (5.0%) |
| None | 38 (92.7%) | - | - | - | 38 (23.6%) |

From the survey, it was revealed that respondents practiced two types of farming systems namely; integrated and monoculture. Most of the poultry farmers sampled practiced the monoculture system. In all, 83.9% of the sampled respondents practiced monoculture system (Table 7). Monoculture system of farming include crop (perineal and annual) and livestock. The crops included tick, cashew, cocoa, orange, and coconut (perineal) and maize, cassava, ginger, and plantain (annual), the livestock included rabbit, sheep, goats, pig, and guinea fowl.

*Table 7. **Type of System of Farming***

| | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| Integrated | 11 (26.8%) | 3 (11.5%) | 6 (10.0%) | 6 (17.6%) | 26 (16.1%) |
| Monoculture (only poultry) | 30 (73.2%) | 23 (88.5%) | 54 (90.0%) | 28 (82.4%) | 135 (83.9%) |

Litter type is a significant aspect in poultry farming, because of the health implications that it can on the birds when it is not managed properly. Respondents used different litter materials which included saw dusts, wood shavings and ashes among others. In all, most (42.2%) of the respondents used saw dust as litter in their cages followed by wood shavings (32.9%). A few (1.2%) of the respondents applied more than one type of the litter in their cages. Most household (backyard) respondents (78.0%) did not keep birds in a coop as they were kept on free range/extensive system, hence they did not require any form of litter. However, for the few who kept birds in the coop reported using wood ash, Charcoal dust and old cloth as their litter. Figure 4 summarizes the findings from the survey on litter type.

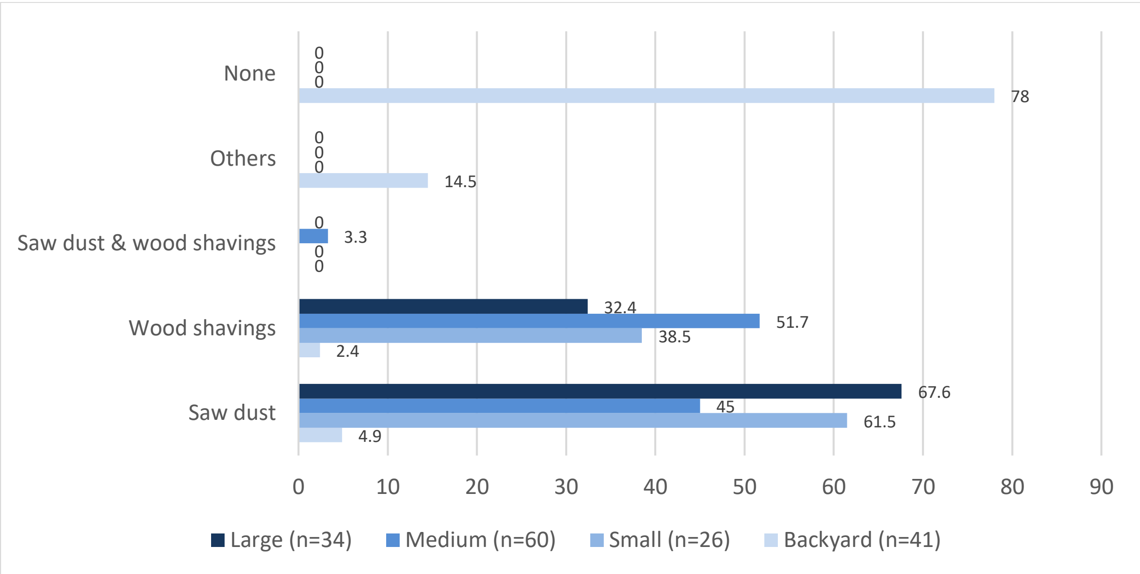


*Figure 4. **Type of Litter***

Table 8 summarizes the frequency of litter change among the category of respondents. Results revealed that most commercial farmers changed their litters quarterly followed by monthly. Most backyard farmers (78%) as previously indicated do not use litters and those who did reported of varied period of replacement. In all, majority of the respondents who are commercial farmers (49.1%) replaced the litters in their farms on quarterly basis whiles 13% swapped it a month. Frequency of litter change depended on the type of litter used, number of birds kept, the age of birds, the time of the year among others. For instance, litter can be changed more than once in a quarter in the wet season and just once in the dry season.

*Table 8.* ***Frequency of Litter Change***

| | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| Bi-annually | - | 2 (7.7%) | | 5 (14.7%) | 7 (4.3%) |
| Monthly | 2 (4.9%) | 5 (19.2%) | 9 (15.0%) | 5 (14.7%) | 21 (13.0%) |
| Two months | | | 2 (3.3%) | 2 (5.9%) | 4 (2.5%) |
| Quarterly | - | 16 (61.5%) | 44 (73.3%) | 19 (55.9%) | 79 (49.1%) |
| Thrice a month | - | 1 (3.8%) | 1 (1.7%) | | 2 (1.2%) |
| Twice a month | 2 (4.9%) | - | - | 2 (5.9%) | 4 (2.5%) |
| weekly | 2 (4.9%) | - | - | 1 (2.9%) | 3 (1.9%) |
| Daily | 2 (4.9%) | | | | 2 (1.2%) |
| Others specify | 1 (2.4%) | 2 (7.7%) | 4 (6.7%) | - | 7 (4.3%) |
| N/a | 32 (78.0%) | - | - | - | 32 (19.9%) |

Generally, the production system of farming can be classified as extensive, intensive and semi-intensive depending on the amount of input involved (Figure 5). Outcomes of the study showed that all the commercial farmers made up of small, medium and large scale undertook intensive system of farming due to the amount substantial amount of inputs that are invested in the farming. A few of the backyard farms were involved in the semi-intensive farming.

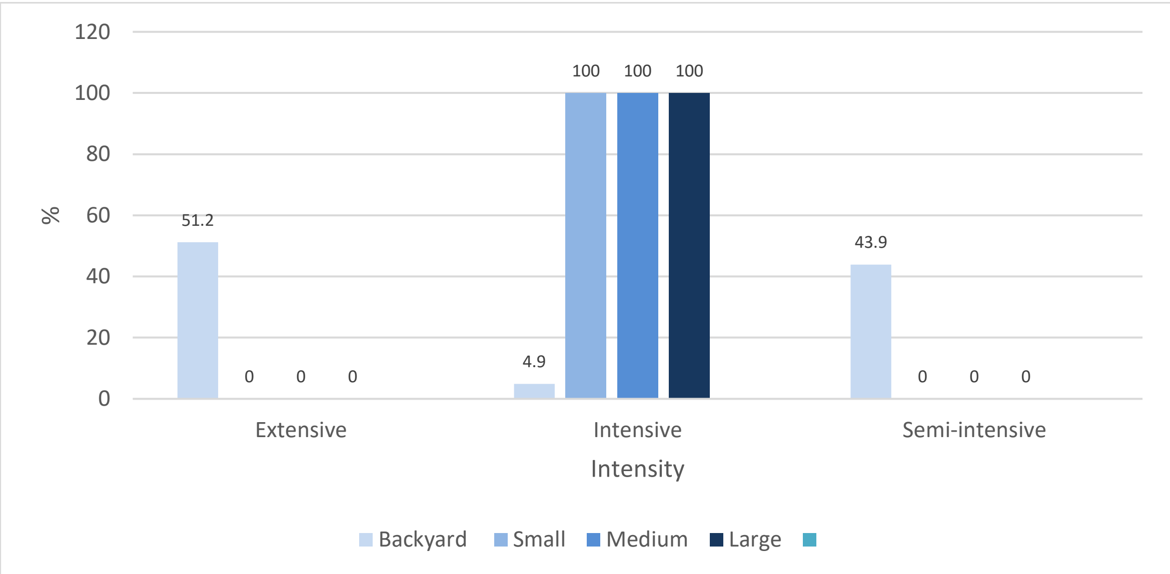


*Figure 5.* ***Intensity of Farming***

Commercial poultry operations are faced with the risk of not being fully productive because of poor sanitation standards. Respondents were asked to mention various sanitary methods they implement on their farms. In response to that, majority of the poultry farmers (71.4%) out of the 161 respondents interviewed disinfected feeders and drinkers, 65.8% sprayed to disinfect the farm, 64% changed litters while about 35% out of the 161 respondents disinfect their cages. Quite a few of the farms operated footbaths (13.0%). Observation from the field revealed that most footbaths at the entrance of farms and in front of the cages were empty or non-functional. The use of protective clothing among the commercial respondents was quite low as seen in Table 9.

*Table 9.* ***Sanitary Method Implemented***

| | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| Disinfection of pens | 4 (9.8%) | 20 (76.9%) | 50 (83.3%) | 31 (91.2%) | 56 (34.8%) |
| Disinfection of feeders/drinkers | 8 (19.5%) | 18 (69.2%) | 56 (93.3%) | 33 (97.1%) | 115 (71.4%) |
| Changing litter | 6 (14.6%) | 16 (61.5%) | 49 (81.7%) | 32 (94.1%) | 103 (64.0%) |
| Footbath | 0 (0.0%) | 4 (15.4%) | 7 (11.7%) | 10 (29.4%) | 21 (13.0%) |
| Protective clothing | 0 (0.0%) | 4 (15.4%) | 13 (21.7%) | 13 (38.2%) | 30 (18.6%) |
| Spraying farm | 2 (4.9%) | 25 (96.2%) | 53 (88.3%) | 26 (76.5%) | 106 (65.8%) |
| Others | 5 (12.2%) | 0 (0.0%) | 1 (1.7%) | 2 (5.0%) | 8 (5.0%) |
| Do not use | 27 (65.9%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 27 (16.8%) |

*Multiple response*

It was revealed from the survey, that 65.8% have not received any training on farm biosecurity whereas the rest (34.2%) responded affirmatively as indicated in Figure 6. The commercial farmers, about half of respondents from the large scale farms (52.9%) had received farm biosecurity training while the others reported of less than 50% being trained. This showed that a low level of knowledge in farm biosecurity among the sampled respondents.

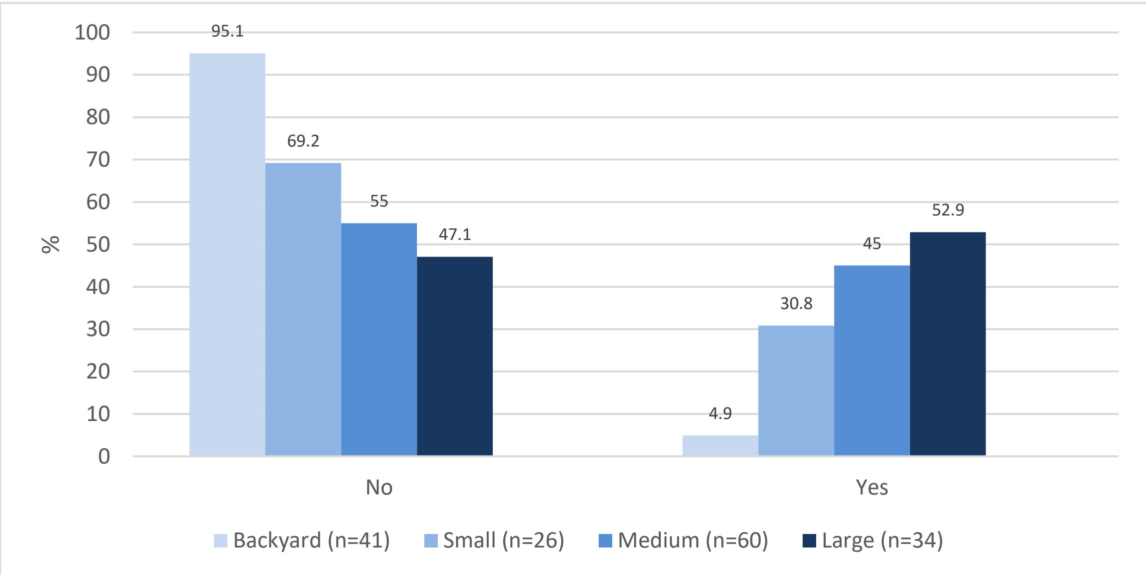


*Figure 6.* ***Received Training on Farm Biosecurity***

The farmers received training on farm biosecurity from varied sources which included Farmer Associations, Government Agencies, Drug Manufacturers / Companies / Sellers, Feed manufacturers, Projects and NGOs among others. Beneficiaries indicated biosecurity trainings by Farmer Associations (15.5%) (e.g. the Poultry Farmers' Association) followed by Government Agencies (10.6%), Drug manufacturers (9.9%) and Feed manufacturers (8.1%) as shown in Table 10.

Farmers had also benefited from trainings organized by NGO's and Projects to

*Table 10. **Sources of Training on Farm Biosecurity***

| | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| Farmers association | 2 (4.9%) | 2 (7.7%) | 13 (21.7%) | 8 (23.5%) | 25 (15.5%) |
| Gov't agencies | 1 (2.4%) | 3 (11.5%) | 8 (13.3%) | 5 (14.7%) | 17 (10.6%) |
| Drug manufacturers, companies, sellers | 0 | 2 (7.7%) | 7 (11.7%) | 7 (20.6%) | 16 (9.9%) |
| Feed manufacturers | 0 | 2 (7.7%) | 6 (10.0%) | 5 (14.7%) | 13 (8.1%) |
| Project | 0 | 0 | 6 (10.0%) | 3 (8.8%) | 9 (5.6%) |
| NGOs | 0 | 3 (11.5%) | 2 (3.3%) | 5 (14.7%) | 10 (6.2%) |
| Others | 0 | 2 (7.7%) | 3 (5.0%) | 1 (2.9%) | 6 (3.7%) |

*Multiple response*

Additionally, when the respondents who were trained on biosecurity measures were asked which period the training was undertaken, most (16.8%) indicated that they were trained during the last quarter of 2019. It implied that most of the training was quite recent. This response applied to all the groups except for the small-scale and backyard farmers as represented in Figure 7.

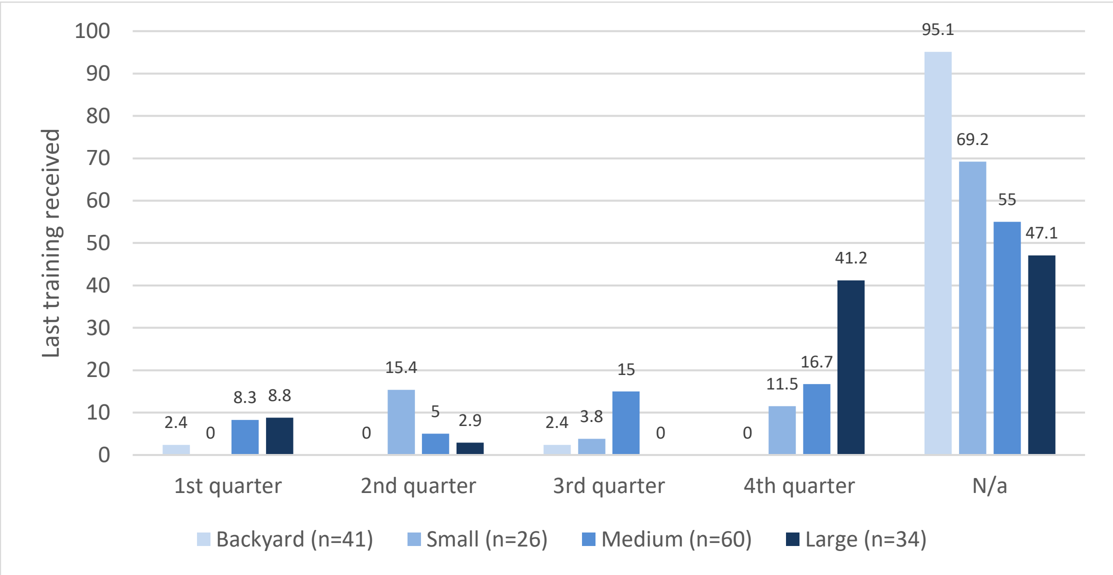


*Figure 7. **Last Training Received***

Extension service plays significant role in production, productivity and livelihood of the farmers. Most of the respondents indicated that extension officers do not visit the farms regularly. About 34.2% of the respondents reported that Vet Officers visited as and when they are called to address health challenges while (36.6%) of the respondents reported that veterinarians did not visit them and thus relied on their own experience or other sources such as colleague farmers to run their farms. However, some respondents stated that the Vet Officers visited once in a month (14.3%), quarterly (8.1%) and annually (1.9%).

Furthermore, most of the large scale respondents attested to the fact that the Vet Officers came to the farm when they needed them (32.4%) while a good number of the medium scale were of the view that they come once in a month (23.1%). Also, a greater percentage (23.1%) of the small scale respondents reported that the officers visited once in a month. Majority of the backyard operators indicated that the officers do not visit as presented in Table 11.

*Table 11. **Frequency of Veterinary Officer Visits to Poultry Farms***

| | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| As and when they are called | 1 (2.4%) | 12 (46.2%) | 31 (51.7%) | 11 (32.4%) | 55 (34.2% |
| Bi-annually | - | 1 (3.8%) | | 2 (5.9%) | 3 (1.9%) |
| Does not visit | 36 (87.8%) | 5 (19.2%) | 9 (15.0%) | 9 (26.5%) | 59 (36.6%) |
| Once a month | 1 (2.4%) | 6 (23.1%) | 12 (20.0%) | 4 (11.8%) | 23 (14.3%) |
| Others specify | 3 (7.3%) | 1 (3.8%) | 1 (1.7%) | 3 (8.8%) | 8 (5.0%) |
| Quarterly | - | 1 (3.8%) | 7 (11.7%) | 5 (14.7%) | 13 (8.1%) |

Table 12 shows the type of disease that occurred in the farm of the sampled respondents. This included Chronic respiratory, Coccidiosis, New castle, External parasites, among others. In all, majority of the respondents (46%) had experienced Chronic respiratory disease during the production cycle on their farm followed by coccidiosis (39.8%). The third and fourth major diseases that occurred on the farm were New castle (30.4%) and external parasites (19.3%).

The four main diseases affecting the farms of large scale respondents were Chronic respiratory (70.6%), Coccidiosis (41.2%), New castle (35.3%) and worm infestation (33.3%) in order of importance. Also, the four core diseases affecting medium scale respondents were Chronic respiratory (63.3%), Coccidiosis (58.3%), New castle (33.3%) and worm infestation (33.3%). Additionally, Coccidiosis (53.8%), Chronic respiratory (38.5%) New castle (26.9%), and External parasites (23.1%) were the four (4) main disease affecting the farms of small scale respondents in order of importance. Last but not the least, those operating backyard operations had new castle as the main disease affecting the birds. The respondents identified the disease after the enumerators had explained to them the symptoms of the diseases hence the high percentage. A high percentage (24.2%) did not know the name of the diseases that affected their farms. Very few mentioned other types of diseases that had occurred on their farms.

*Table 12. **Disease occurrence on the farm in 2019***

| | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| None | 12 (29.3%) | 10 (38.5%) | 10 (16.7%) | 6 (17.6%) | 38 (3.6%) |
| Fowl cholera | 0 | 1 (3.8%) | 0 | 2 (5.9%) | 3 (1.9%) |
| Worms | 1 (2.4%) | 1 (3.8%) | 20 (33.3%) | 6 (17.6%) | 28 (17.4%) |
| New castle | 10 (24.4%) | 7 (26.9%) | 20 (33.3%) | 12 (35.3%) | 49 (30.4%) |
| Coccidiosis | 1 (2.4%) | 14 (53.8%) | 35 (58.3%) | 14 (41.2%) | 64 (39.8%) |
| Gumboro | 0 | 2 (7.7%) | 4 (6.7%) | 4 (11.8%) | 10 (6.2%) |
| Fowl pox | 2 (4.9%) | 0 | 0 | 0 | 2 (1.2%) |
| External parasites | 2 (4.9%) | 6 (23.1%) | 16 (26.7%) | 7 (20.6%) | 31 (19.3%) |
| Chronic respiratory | 2 (4.9%) | 10 (38.5%) | 38 (63.3%) | 24 (70.6%) | 74 (46.0%) |
| Don't know | 10 (24.4%) | 0 | 1 (1.7%) | 0 | 11 (6.8%) |
| Others | 5 (12.2%) | 2 (7.7%) | 4 (6.7%) | 3 (8.8%) | 14 (8.7%) |

*Multiple responses*

Early disease detection and diagnosis is necessary to prevent the development and spread of a disease to other stock/farms. The respondents had varied responses to who they contact when birds are sick (Table 13). Generally, most respondents in the survey engaged in self-medication (54.7%) while 52.8% also involved the Vet/Vet Technical officer for advice. Some respondents (14.9%) relied on other colleague farmers for advice when their birds are sick. However, higher percentage of the respondents from commercial poultry farms approached the vet officer for assistance when birds fall sick followed by those who undertook self-medication.

Results further revealed that 25.3% of the respondents approached two or more than two sources for assistance when birds are sick on the farms (Appendix 3).

Table 13. ***Contact Person when birds are sick***

| | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| Vet/vet tech officer only | 2 (4.9%) | 16 (61.5%) | 46 (76.7%) | 21 (61.8%) | 85 (52.8%) |
| Extension officer only | 2 (4.9%) | 0 | 0 | 0 | 2 (1.2%) |
| Other farmers only | 1 (2.4%) | 8 (30.8%) | 11 (18.3%) | 4 (11.8%) | 24 (14.9%) |
| No one (self-medication) | 33 (80.5%) | 10 (38.5%) | 26 (43.3%) | 19 (55.9%) | 88 (54.7%) |
| Others | 6 (14.6%) | 1 (3.8%) | 1 (1.7%) | 2 (5.9%) | 10 (6.2%) |

*Multiple responses*

The respondents had different means by which they communicated with health officials (vet officers) /extension officials/colleagues when their birds fall sick. Overall, most respondents (40.4%) used phone calls to report on sick birds to Vet officer for any help whereas 9.3% carried out disease reportage through phone by means of either phone calls, through a Vet officer and shop visits (Table 14).

The results further point out that in all, 60.2% employed only phone calls followed by paying a visit to the Vet either in the office or at home (18.6%). The respondents from the various categories/scale gave same response (Appendix 4).

*Table 14*. ***Means of contact***

| | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| N/a | 33 (80.5%) | 6 (13.3%) | 8 (13.3%) | 6 (17.6%) | 53 (32.9%) |
| Phone calls | 4 (9.8%) | 17 (65.4%) | 29 (48.3%) | 15 (44.1%) | 65 (40.4%) |
| Phone calls & Visit vet | 1 (2.4%) | 1 (3.8%) | 5 (8.3%) | 8 (23.5%) | 15 (9.3%) |
| Phone calls, Visit & vet shop | - | 2 (7.7%) | 4 (6.7%) | | 6 (3.7%) |
| Phone calls, Visit vet shop, & Visit vet | - | - | 9 (15.0%) | 1 (2.9%) | 10 (6.2%) |
| SMS | - | - | 1 (1.7%) | - | 1 (0.6%) |
| Visit vet | - | - | 3 (5.0%) | 2 (5.9%) | 5 (3.1%) |
| Visit vet shop | - | - | 1 (1.7%) | 2 (5.9%) | 3 (1.9%) |
| Others specify | 2 (4.9%) | - | - | - | 2 (1.2%) |
| No response | 1 (2.4%) | | | | 1 (0.6%) |

Record keeping is extremely important to successfully manage poultry production. Results disclosed that a high percentage of the poultry farmers interviewed attested to the fact that they kept records (71.4%) while a few (4.3%) kept the records sometimes did so. With the exception of backyard operators, all the commercial farmers kept records (Figure 8).

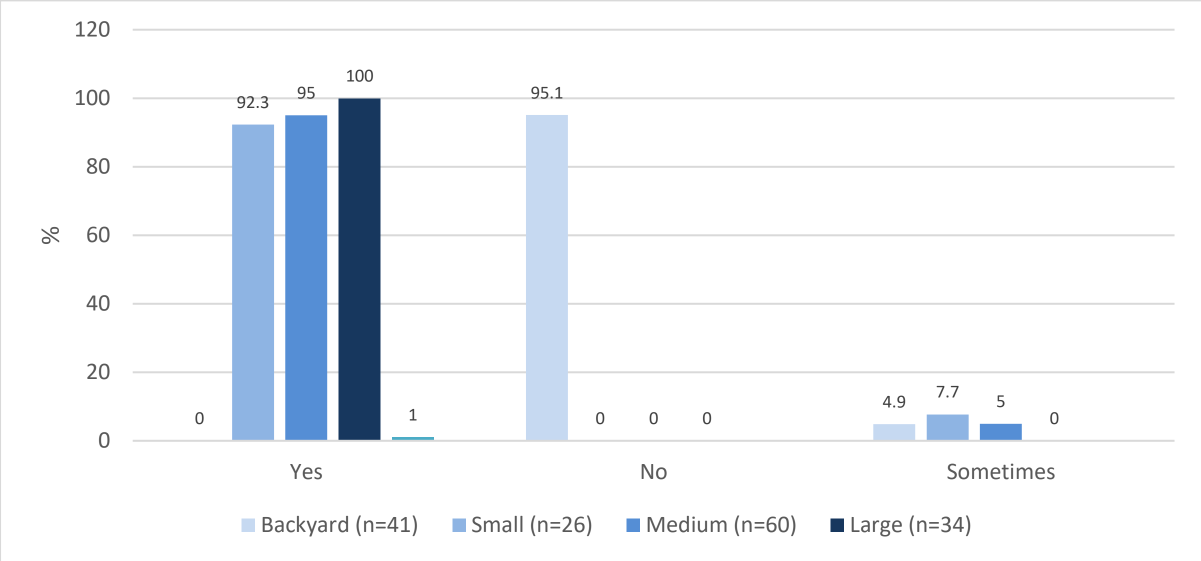


*Figure 8. **Farm Record Keeping***

Results further showed that respondents kept records for various husbandry activities which include Inventory, feeding, Meat, egg sales; meat, egg production; medicine administration, vaccination, litter disinfection, operational cost, water management, and mortality among others. Among these, the four major recorded activities were vaccination (68.9%), meat, egg production (67.1%), Mortality (66.5%), as well as feeding (55.3%). It could be shown from Table 15 that higher percentages of respondents in the various scale of production adhere to record keeping for various activities undertaken in the farm.

*Table 15. **Type of Record Kept on Farm***

| | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| Litter change | 0 | 1 (3.8%) | 4 (6.7%) | 6 (17.6%) | 11 (6.8%) |
| Litter disinfection | 0 | 3 (11.5%) | 9 (15.0%) | 11 (32.4%) | 23 (14.3%) |
| Vaccination | 1 (2.4%) | 19 (73.1%) | 57 (95.0%) | 34 (100.0%) | 111 (68.9%) |
| Meat, egg production | 1 (2.4%) | 14 (53.8%) | 46 (76.7%) | 32 (94.1%) | 108 (67.1%) |
| Medicine administration | 1 (2.4%) | 20 (76.9%) | 53 (88.3%) | 34 (100.0%) | |
| Meat, egg sales | 0 | 16 (61.5%) | 38 (63.3%) | 24 (70.6%) | 78 (48.4%) |
| Inventory | 0 | 7 (26.9%) | 27 (45.0%) | 23 (67.6%) | 57 (35.4%) |

| | | | | | |
|---|---|---|---|---|---|
| Feeding | 1 (2.4%) | 17 (65.4%) | 42 (70.0%) | 29 (85.3%) | 89 (55.3%) |
| mortality | 0 | 23 (88.5%) | 51 (85.0%) | 33 (97.1%) | 107 (66.5%) |
| Operational cost | 2 (4.9%) | 14 (53.8%) | 36 (60.0%) | 24 (70.6%) | 76 (47.2%) |
| Water management | 0 | 11 (42.3%) | 24 (40.0%) | 24 (70.6%) | 59 (36.8%) |
| Others | 0 | 2 (7.7%) | 0 | 0 | 2 (1.2%) |

*Multiple responses*

Poultry waste may usually contain the following: a mixture of faecal and urinary excreta, litter, waste feed, dead birds among others. It can have a negative effect on the birds. Results from this study showed that there are various ways of disposal of poultry waste at the farm of the sampled respondents (Table 16). This include disposing it off (throwing it away), selling it to people as manure for their farms and using it in own farm as manure. Outcome of the findings showed that most commercial farmers (small:76.9%; medium:81.7%; large:73.5%) sold their waste to people from La Cote d'Ivoire who mostly buy and transport them in trucks.

*Table 16. **Means of Poultry Waste Disposal***

| | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| Sold out | - | 20 (76.9%) | 49 (81.7%) | 25 (73.5%) | 94 (58.4%) |
| Thrown away | 27 (65.9%) | 1 (3.8%) | 1 (1.7%) | | 29 (18.0%) |
| Use as manure | 7 (17.1%) | 3 (11.5%) | 1 (1.7%) | 2 (5.9%) | 13 (8.1%) |
| Around the poultry farm | 6 (14.6%) | - | - | - | 6 (3.7%) |
| Burnt | 1 (2.4%) | - | 2 (3.3%) | - | 3 (1.9%) |
| Use as manure and sold out | - | 2 (7.7%) | 7 (11.7%) | 6 (17.6%) | 15 (9.3%) |
| Thrown away and sold out | - | - | - | 1 (2.9%) | 1 (0.6%) |

## 4.2: Comparing antibiotic use in different scales of poultry

From the survey, majority of the respondents (80.7%) reported they used antibiotics on their farms while the remaining 19.3% did not (Table 17). All categories of commercial poultry farmers (respondents) used antibiotics while with the backyard farmers 24.4% of the respondents confirmed usage. Majority of the backyard respondents did not use antibiotics as they engaged in farming as a pastime to supplement protein needs of their households and not for commercial reasons. Among the commercial respondents, antibiotic use was common due to the large number of birds kept in the same environment and the likelihood of disease occurrence. Antibiotics were used either for prophylaxis or treatment.

*Table 17. **Antibiotic Use***

| | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| No | 31 (75.6%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 31 (19.3%) |
| Yes | 10 (24.4%) | 41 (100.0%) | 60 (100.0%) | 34 (100.0%) | 145 (80.7%) |

Tetracyclines, aminoglycosides, macrolides and polymyxins were the four (4) antibiotics that were recognized by most of the respondents in the survey (Figure 9). Outcome of the findings showed that 24.8% of the total respondents did not recognize any of the antibiotics showed them. The three major antibiotics recognized were tetracyclines (98.3%), aminoglycosides (97.5%), macrolides (90.9%) and polymixin (89.3%).

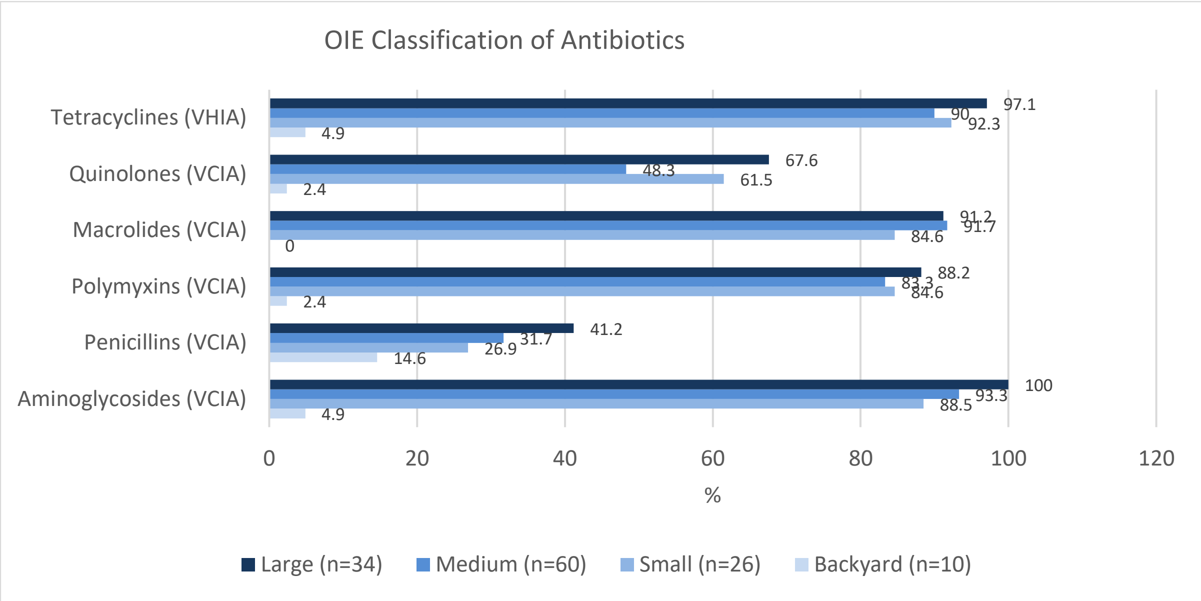


*Figure 9.* ***Class of Antibiotics Recognized***
*Multiple Responses*

*VCIA: Veterinary Critically Important Antibiotics, VHIA: Veterinary Highly Important Antibiotics (OIE). These are antibacterial agents that are of critical importance to humans although they are also used in veterinary practice.*

Among the backyard respondents who used antibiotics, penicillins (14.6%) were mostly used in addition to other antibiotics (12.2%) (Figure 10). The aminoglycosides, tetracyclines, polymyxins and quinolones were sparingly used. There was no indication of the use of cephalosporins and sulfonamids among the respondents from the backyard and commercial poultry farmers. The four major antibiotics used by the commercial farmers were aminoglycosides, polymyxins, macrolides and tetracyclines.

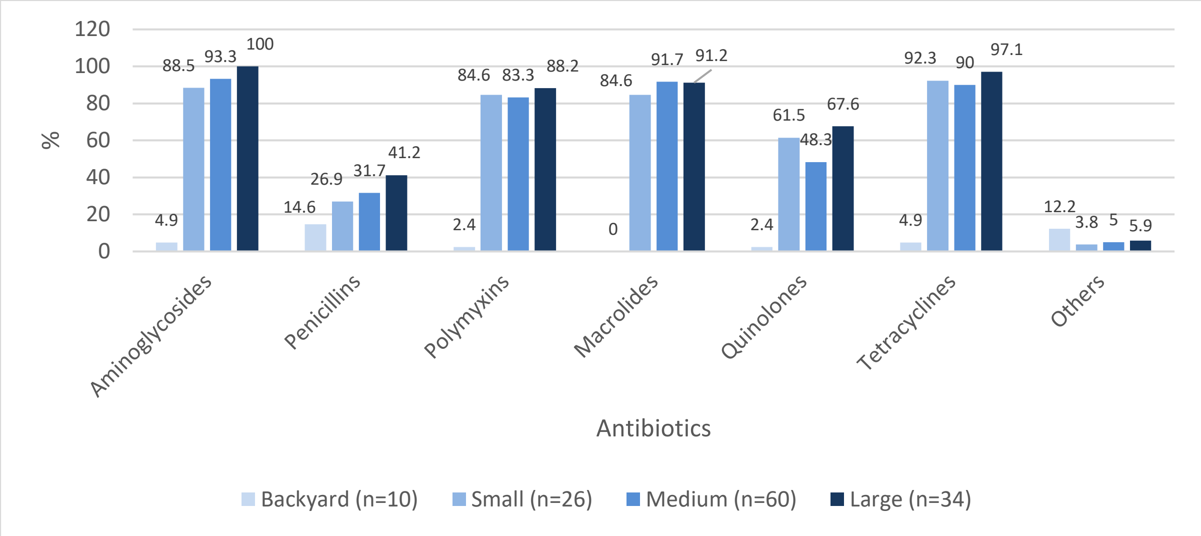


*Figure 10. **Class of Antibiotic Used***
*Multiple response*

In the survey, it became evident antibiotics were used differently by respondents. The medicines were classified under four (4) categories (Figure 11). In the classification of antibiotics based on spectrum, the outcomes of this analysis showed that about 70% of the respondents used only antibiotics on their farms where as 65% used the antibiotics that contained vitamins. Moreover 60% of the respondents used broad spectrum antibiotics while some 59% used broad spectrum containing vitamins. Most of the respondents used either only antibiotics to prevent or treat infections or diseases while the combined antibiotics and vitamins might have been used to prevent, treat and enhance growth and egg production.

The spectrum of the antibiotics gives an indication of the number of organisms that the antibiotic(s) affects or targets. The Broad spectrum antibiotics affect several types of bacteria and fungi and it is usually used where the specific type of the microorganism is unknown. Over 80% of the total number of respondents from the commercial farms (small, medium and large) used narrow spectrum antibiotics in their operations as compared to 19.5% of the respondents from the backyard. The large (91.2%) and medium (80%) scale respondents used broad spectrum antibiotics as compared to the small (61.5%) scale respondents. The use of antibiotic that contains vitamins was highest amongst respondents from the small (88.5%), large (85.3%) and medium (83.3%) scales respectively. Only 7.3% of the backyard respondents used antibiotic plus vitamins. The use of broad spectrum plus antibiotics was high in the large (82.4%), small (80.8%), medium (78.3%) and least in backyard respondents (2.4%).

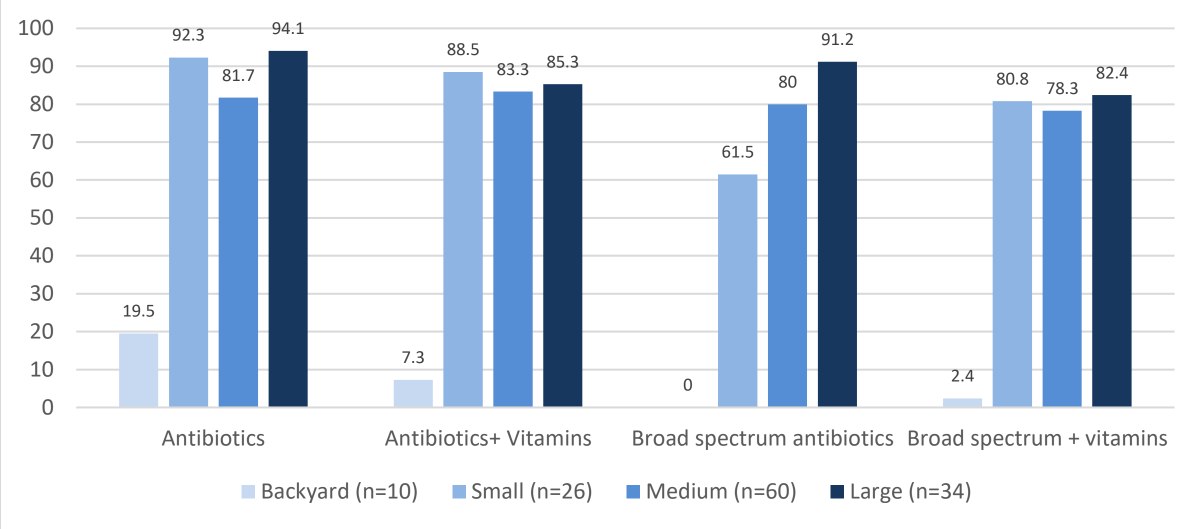


*Figure 11. **Classification of Antibiotics based on Spectrum***
*Multiple responses*

The 130 respondents who used antibiotics were asked to state the frequency of antibiotic used in their farms. The respondents who said they used antibiotics when birds are sick amongst the commercial farms was highest for medium scale (73.3%) respondents, followed by the large scale (52.9%) and the least was observed with the small scale (46.2%) (Table 18).

The frequency of antibiotics used on a monthly basis was highest amongst the large scale farmers (26.5%) and trailed by small (23.1%) scales whereas 2.4% respondents were recorded for the backyard (Table 18). The frequency of antibiotic use among the respondents bi-monthly was also highest in small (11.5%), followed by large (8.8%) and with the least from the backyard (2.4%).

*Table 18. **Frequency of Antibiotic Use***

| | Backyard (n=10) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=130) |
|---|---|---|---|---|---|
| Bi-monthly | 1 (2.4%) | 3 (11.5%) | 2 (3.3%) | 3 (8.8%) | 9 (6.9%) |
| Monthly | 1 (2.4%) | 6 (23.1%) | 9 (15.0%) | 9 (26.5%) | 25 (19.2%) |
| Others | - | 3 (11.5%) | 2 (3.3%) | 4 (11.8%) | 9 (6.9%) |
| Weekly | - | 2 (3.3%) | 3 (5.0%) | - | 5 (3.8%) |
| When birds are sick | 8 (19.5%) | 12 (46.2%) | 44 (73.3%) | 18 (52.9%) | 82 (63.1%) |

Of the total respondents of 130 who used antibiotics, about half (50.9%) used tetracyclines whereas about 39%, 37% and 31% used aminoglycosides, macrolides and polymyxins respectively in anticipation of sickness (i.e. as prevention) in their farms (Table 19). Penicillins and Quinolones were used by 16% and 20% of the respondents.

Results revealed that tetracyclines were the most common antibiotic used by most of the respondents in anticipation of infections and diseases among the commercial farmers in the study.

Generally, respondents from the commercial farms: small (73.1%), medium (66.7%) and large (64.7%) used tetracyclines mostly in anticipation of any sickness which is followed by aminoglycosides, polymyxins, macrolides, quinolones with the least being penicillins. Penicillins (12.2%) were mostly used in anticipation of sickness among the backyard respondents as compared to aminoglycosides (2.4%), tetracyclines (2.4%) and quinolones (2.4%).

*Table 19. **Antibiotics Used in Anticipation of Sickness***

| | Backyard (n=10) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=130) |
|---|---|---|---|---|---|
| Aminoglycosies | 1 (2.4%) | 14 (53.8%) | 34 (56.7%) | 13 (38.2%) | 62 (38.5%) |
| Penicillins | 5 (12.2%) | 4 (15.4%) | 11 (18.3%) | 5 (14.7%) | 25 (15.5%) |
| *Cephalosporins* | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) |
| Polymyxins | 1 (2.4%) | 13 (50.0%) | 27 (45.0%) | 9 (26.5%) | 50 (31.1%) |
| *Lincosamides* | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) |
| Macrolides | 0 (0.0%) | 12 (46.2%) | 35 (58.3%) | 12 (35.3%) | 59 (36.6%) |
| Quinolones | 1 (2.4%) | 9 (34.6%) | 16 (26.7%) | 7 (20.6%) | 33 (20.5%) |
| *Sulfonamids* | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) |
| Tetracyclines | 1 (2.4%) | 19 (73.1%) | 40 (66.7%) | 22 (64.7%) | 82 (50.9%) |
| Others | 6 (14.6%) | 7 (26.9%) | 14 (23.3%) | 14 (41.2%) | 41 (25.5%) |

*Multiple responses*

Access to antibiotics have been easy for respondents in the study site and the following three reasons were attributed; ability to buy without prescription (71.4%), reliable supply (71.4%) and efficacy of the drug (55.3%) (Table 20).

Respondents were of the view that these reasons had been enforced due to the thriving nature of the poultry industry (proliferation of commercial poultry farming) in the study site, and hence the sale of agro-chemicals (i.e. antibiotics) has always been a viable economic venture over the years. As a border town, poultry farmers from the neighbouring country (La Cote d'Ivoire) also buy antibiotics, thus promoting the sale of agro-chemicals in the study location.

With the large scale respondents, 100%, 94.1% and 70.6% of respondents attributed their ease of accessing antibiotics to ability to buy without prescription, reliable supply and its efficacy respectively. A good number of the medium scale respondents comprising of 93.3%, 85.0% and 70.0% respondents indicated reliable supply, ability to buy without prescription and efficacy as reasons for accessing antibiotics easily respectively. Among the small scale producers, 84.6%, 76.9% and 57.7% of respondents accessed antibiotics easily due to their reliable supply, ability to buy without prescription and efficacy respectively. Results further points out that in relation with the backyard farmers, 24.4%, 19.5% and 12.2% accessed antibiotics with ease as a result of ability to buy without prescription, affordability, efficacy as well as reliable supply respectively.

*Table 20. **Easy Access to Antibiotics***

| | Backyard (n=10) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=130) |
|---|---|---|---|---|---|
| Ability to buy without prescription | 10 (24.4%) | 20 (76.9%) | 51 (85.0%) | 34 (100.0%) | 115 (71.4%) |
| Affordable | 8 (19.5%) | 13 (50.0%) | 31 (51.7%) | 12 (35.3%) | 64 (39.8%) |
| Efficacy | 8 (19.5%) | 15 (57.7%) | 42 (70.0%) | 24 (70.6%) | 89 (55.3%) |

| | | | | | |
|---|---|---|---|---|---|
| Reliable supply | 5 (12.2%) | 22 (84.6%) | 56 (93.3%) | 32 (94.1%) | 115 (71.4%) |
| Nearness to source | 1 (2.4%) | 5 (19.2%) | 20 (33.3%) | 13 (38.2%) | 39 (24.2%) |
| Others | 0 (0.0%) | 1 (3.8%) | 0 (0.0%) | 1 (2.9%) | 2 (1.2%) |

*Multiple responses*

Furthermore, respondents who had difficulty in accessing antibiotics were asked to give reasons. Results suggest that 13.7% and 13.0% of the reasons given by the respondents were that the antibiotics were expensive and due to unreliable supply respectively (Table 21).

Those respondents who indicated that antibiotics were expensive and hence access was difficult might have been part of some small scale and backyard farmers whose productivity did not make it economical to buy veterinary antibiotics in such volumes to cater for their few flocks

*Table 21.* ***Difficulties with Antibiotic Access***

| | **Backyard (n=10)** | **Small (n=26)** | **Medium (n=60)** | **Large (n=34)** | **All (n=130)** |
|---|---|---|---|---|---|
| Unable to buy without prescription | 0 (0.0%) | 0 (0.0%) | 3 (5.0%) | 2 (5.9%) | 5 (3.1%) |
| Expensive | 1 (2.4%) | 4 (15.4%) | 11 (18.3%) | 6 (17.6%) | 22 (13.7%) |
| Poor quality antibiotics | 1 (2.4%) | 2 (7.7%) | 10 (16.7%) | 0 (0.0%) | 13 (8.1%) |
| Unreliable supply | 1 (2.4%) | 3 (11.5%) | 14 (23.3%) | 3 (8.8%) | 21 (13.0%) |
| Source of antibiotics is further away | 0 (0.0%) | 2 (7.7%) | 1 (1.7%) | 5 (14.7%) | 8 (5.0%) |
| Others specify | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) |

Majority of the respondents (69.6%) who used antibiotics in their farm had applied them in the last quarter of 2019 (Table 22). Furthermore, over 67% of the respondents confirmed the use of antibiotics between July to September whilst the respondents 60% used it between April and June in 2019. Antibiotic use on the farms occurs throughout the year but increases in the dry season as the season is characterized with avian diseases or infections if no intervention is instituted by the farmers. With the onset of the rains (i.e. may) there is reduction in infections and thus antibiotic use are also reduced. Equal percentage of the large scale respondents used antibiotics between January-March and July – September. Also, a good percentage of the medium scale farmers used antibiotics between January to March with the least between April to June. Additionally, equal percentage of small scale producers used antibiotics mostly between July-September and October-December.

*Table 22.* ***Period of Antibiotic Use on the farm***

| | **Backyard (n=10)** | **Small (n=26)** | **Medium (n=60)** | Large (n=34) | **All (n=130)** |
|---|---|---|---|---|---|
| Jan-Mar | 4 (9.8%) | 20 (76.9%) | 52 (86.7%) | 32 (94.1%) | 108 (67.1%) |
| April-June | 1 (2.4%) | 21 (80.8%) | 48 (80.0%) | 28 (82.4%) | 98 (60.9%) |
| July-Sep | 2 (4.9%) | 24 (92.3%) | 51 (85.0%) | 32 (94.1%) | 109 (67.7%) |
| Oct-Dec | 6 (14.6%) | 24 (92.3%) | 51 (85.0%) | 31 (91.2%) | 112 (69.6%) |

*Multiple responses*

Prescription of antibiotics use according to the respondents interviewed is administered by Vet/vet technical officers, colleagues' farmers and self-medication among others (Figure 12). Results showed that 57.8% of the respondents practice self – medication with regards to antibiotic use on their farms whereas 48.4% indicated that vet/vet tech prescribed antibiotics for their use. Some (14.9%) of the respondents also sought to use antibiotics based on the recommendation by colleague farmers.

The significant number of respondents practicing self-medication might be attributed to the fact that the farmers in the municipal have been equipped with relevant skills from several governmental and non-governmental seminars and workshops due to the commercial scale of farming, robust nature of their associations as well as their contribution to agriculture sector as a whole.

In addition, in conversations with farmers in the course of the data collection, we came to understand that poultry farming in the municipality is considered as family enterprise (characterized with huge investments) to many households which has been passed down from generation to generation, with the transfer of knowledge and skills to manage and ensure sustainability of the enterprises. Majority of the respondents from large (73.5%), small (73.1%) and medium (66.7%) as well as backyard (22.0%) farmers self-medicated with antibiotics on their farms whereas more than half of the respondents from the commercial farms use antibiotics prescribed by a veterinarian or vet technician who double as extension officers. Quite a number of the respondents from the small (38.5%), medium (15.0%) and large (11.8%) used antibiotics recommended by colleague farmers.

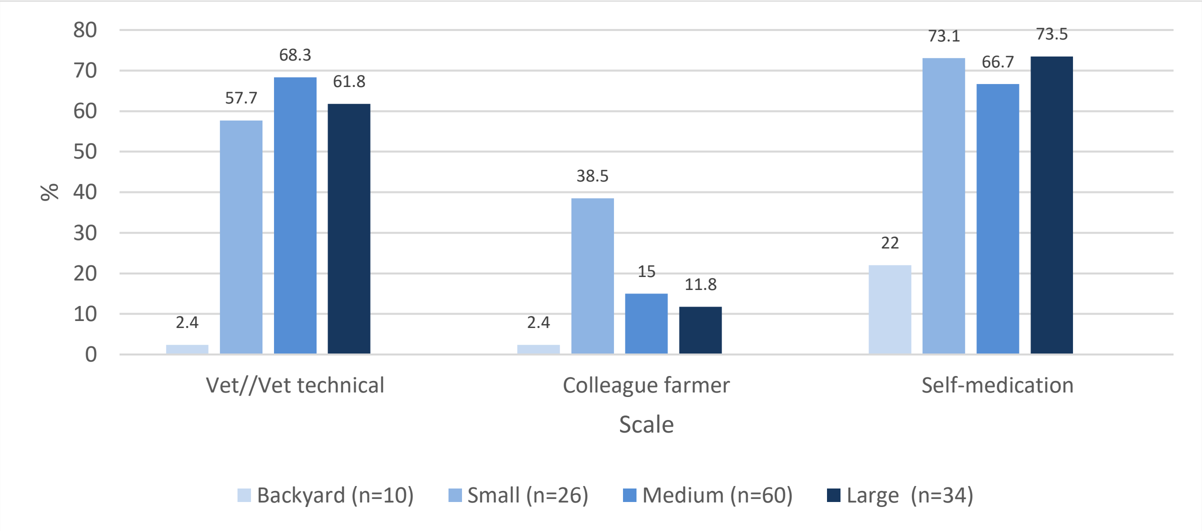


*Figure 12. Prescription or Recommendation of Antibiotic Use*
*Multiple responses*

Farmers bought their antibiotics from different sources including licenced Agro Vet shops and Veterinary/Agriculture Officers. Most of the respondents (75.2%) bought their antibiotics from the Agro Vet shops trailed by 11% who procured it from the Agric./Veterinary Officers (Figure 13). Farmers rarely imported antibiotics were available and easy to access within the municipality. The Agro vet shops within the municipality had in stock almost all the antibiotics that were also found in other parts of the country. Besides, discussions with the Veterinarians at the study site suggested that the variation in the cost of antibiotics in the municipality as compared to other towns/cities was minimal if not negligible even though the research did not gather data on price variation, as and thus majority of the farmers bought antibiotics locally. The Agric./Vet Officers in most cases acted as middle men in the acquisition of antibiotics as a result of their working relationship established (based on trust) with the farmers to get them the relevant antibiotics to achieve the best outcome. The respondents (8%) purchased human antibiotics from the drug stores and were likely to be backyard farmers with few birds to cater for.

Of the commercial poultry respondents; large scale (100%), medium scale (98.3%) and small scale (96.2%), antibiotics were bought from the Agro-Vet shops. A few of the respondents from the medium (18.3%) and small (19.2%) also bought from Agric. Officer. Among the backyard respondents, antibiotics were bought from drug store and Agro-Vet shops as seen in Figure 13.

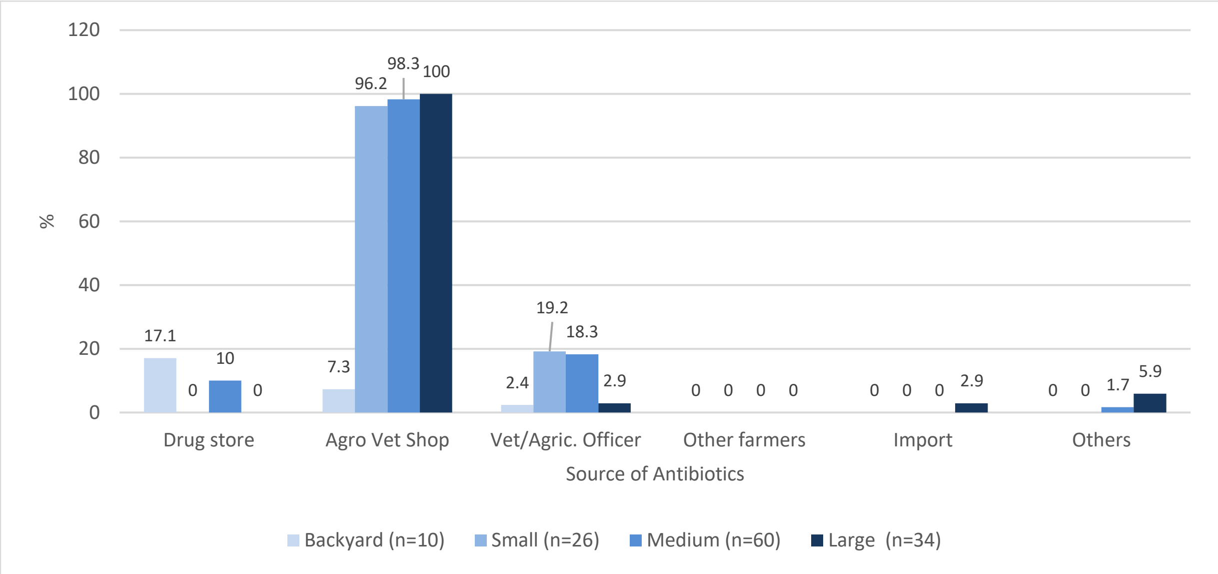


*Figure 13. **Source of Antibiotics***
*Multiple responses*

Several pieces of information can be found on the labels on medicine containers which may include dosage, number of days of administration, withdrawal period, date of manufacture and date of expiry among others. In the study, respondents were asked to indicate the information on the containers of the antibiotics that they use on their poultry farms which guides them in its administration.

Results showed that respondents indicated the labels of drug containers included information on the dosage (73.9%) and number of days (73.3%) to administer the antibiotics that is purchased (Table 23). Also, 52.2% also confirmed that information on withdrawal period is clearly outlined on the containers of the antibiotics. Respondents clearly stated that information on dosage, number of days of administration, withdrawal period and the disposal/expiry dates are the most important as far as the health and the sustainability of their flocks are concerned. Among the commercial poultry farmers, results suggested that the large and medium scale respondents recognized and ranked in order of importance information on dosage, the number of days the antibiotics was to be administered, withdrawal period and with the least being disposal of waste and expired drugs as shown in the Table 23.

Overall, more than 90% of the respondents from the commercial farms indicated dosage and number of days to administer antibiotics as two major pieces of information seen on the labels of antibiotic containers which are purchased. In the case of the backyard respondents the situation differed. Conversions with backyard respondents who occasionally used antibiotics on their birds revealed that they rarely disclose their intended use of antibiotics to the dispensers. The antibiotics purchased from the human drug stores are dispensed for them with the written dosage and number of days to be administered on the bags but usually respondents used their discretion to administer them based on the signs/symptoms of the infection/disease as well as previous experience with infection/disease.

Table 23. ***Type of Information on the container of the drug purchased***

| | Backyard (n=10) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=130) |
|---|---|---|---|---|---|
| Dosage | 3 (7.3%) | 25 (96.2%) | 58 (96.7%) | 33 (97.1%) | 119 (73.9%) |
| No. of days to be administered | 5 (12.2%) | 26 (100.0%) | 56 (93.3%) | 31 (91.2%) | 118 (73.3%) |
| Withdrawal period | 3 (7.3%) | 14 (53.8%) | 43 (71.7%) | 24 (70.6%) | 84 (52.2%) |
| Disposal of waste and expired drugs | 1 (2.4%) | 16 (61.5%) | 34 (56.7%) | 18 (52.9%) | 69 (42.9%) |
| Others | 1 (2.4%) | 1 (3.8%) | 10 (16.7%) | 11 (32.4%) | 23 (14.3%) |

*Multiple responses*

Generally, non- adherence to withdrawal periods was reported to be low from the study. Out of the 84 respondents who pointed out withdrawal period as one of the information found on the label of the medicine containers, fewer than half (46.4%) said that they adhered to withdrawal periods (Table 24). This may be due to the knowledge that they had acquired from regulators and other stakeholders to promote public health. All the categories of poultry farmers except backyard farmers reported of higher percentage of the farmers not adhering to withdrawal period (Table 24). The 52.4% of the respondents acknowledged during the interview the importance of withdrawal period to the health of the consumer but did not comply to it. They attributed their non-adherence to the economic implications on their businesses. General discussions further showed that the respondents were of the view that adherence to withdrawal periods was easier in broilers as their sale can be delayed without much losses but not in layers where discarding eggs laid during the period will impact on the farmer financially.

Table 24. Reported compliance with withdrawal period by scale of production

| | Comply with withdrawal period | | | |
|---|---|---|---|---|
| Scale of production | No response | No | Yes | Total |
| backyard below 200 | - | - | 3 (100.0%) | 3 (100.0%) |
| small=200-1,000 | - | 8 (57.1%) | 6 (42.9%) | 14 (100.0%) |
| medium=1001-10,000 | 1 (2.3%) | 21 (48.8%) | 21 (48.8%) | 43 (100.0%) |
| large > 10,000 | - | 15 (62.5%) | 9 (37.5%) | 24 (100.0%) |
| Total | 1 (1.2%) | 44 (52.4%) | 39 (46.4%) | 84 (100.0%) |

Very few of the respondents (3.1%) relied on veterinarians/veterinary technical officers for antibiotic administration. Half of the respondents (50.3%) confirmed that farm managers administered antibiotics on the farms. This may be because they are mostly on farms to supervise the daily husbandry operations of other farm hands. Also, 28.6% of the respondents indicated that other farm hands were responsible for administering antibiotics. Interactions with those respondents suggest that those farm hands may have understudied farm managers over a period to have gained the know-how in practice. In addition, in small scale commercial farms in which acquiring the services of a farm manager may be expensive for the farmer, owners train farm hands to carry out such duties and responsibilities with supervision from either the farm owner or another farm manager who might have been contracted for a period to train farm hand on such operations. It may be concluded from the above findings self-administration of antibiotics is a common practice.

The outcomes of the findings disclosed that mostly farm managers (70.6%) administered antibiotics in the large scale farms followed by other farm hands (52.9%). Also, a high percentage of the medium scale farmers (75.0%) depended on the farm managers to administer antibiotics trailed by other farm hands (41.7%). Additionally, most of the small scale farmers (57.7%) rather depended mostly on their farm owners and then the farm managers (46.2%) as presented in Table 25. In addition, more of the backyard farmers relied on the farm owners to administer antibiotics at their farms. Very few respondents reported relying on vets to administer antibiotics.

Table 25. ***Antibiotic Administration***

| | **Backyard (n=10)** | **Small (n=26)** | **Medium (n=60)** | **Large (n=34)** | **All (n=130)** |
|---|---|---|---|---|---|
| Farm owner | 0 (0.0%) | 15 (57.7%) | 18 (30.0%) | 6 (17.6%) | 39 (24.2%) |
| Farm manager | 0 (0.0%) | 12 (46.2%) | 45 (75.0%) | 24 (70.6%) | 81 (50.3%) |
| Other farm hands | 0 (0.0%) | 3 (11.5%) | 25 (41.7%) | 18 (52.9%) | 46 (28.6%) |
| Veterinary | 0 (0.0%) | 1 (3.8%) | 3 (5.0%) | 1 (2.9%) | 5 (3.1%) |
| Extension officer | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) |
| Household member/head | 6 (3.7%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 6 (3.7%) |
| Self | 5 (12.2%) | 5 (19.2%) | 12 (20.0%) | 8 (23.5%) | 30 (18.6%) |
| Others | 8(19.5%) | 0 (0.0%) | 2 (3.3%) | 1 (2.9%) | 11(6.8%) |

*Multiple responses*

The respondents were asked a general statement about the ways antibiotics are used (all antibiotics were grouped into one category and it was assumed that respondents know and use this same category). Results show that 59.6% of the respondents indicated that veterinary antibiotics are used to prevent, treat and enhance growth and egg production with 11.2% also administering antibiotics to treat and prevent infections (Figure 14). About 4% of the respondents also confirmed the use of antibiotics to prevent infections on their farms. Commercial poultry farmers follow a regime of antibiotic administration on their farms as part of their husbandry operations to ensure that diseases are prevented, treated and eggs or growth of flocks are enhanced to sustain the enterprise. This was evident in the

respondents of the commercial farmers (small-84.6%), (medium-85%), (large-64.7%) indicated their use of antibiotics to prevent, treat and promote egg production.
Thirty-one (31) of the forty-one (41) respondents who did not have any reason to use antibiotics (veterinary antibiotics) on their flock were households with backyard poultry farm. If it becomes necessary to use antibiotics in the event of a disease, they resort to the use of human antibiotics to prevent and treat infections and diseases due to their low cost of antibiotics as compared to the veterinary antibiotics that are sold in packages that are generally expensive to the backyard farmers. Table 32 summarized the purpose for antibiotic use of respondents in the study.

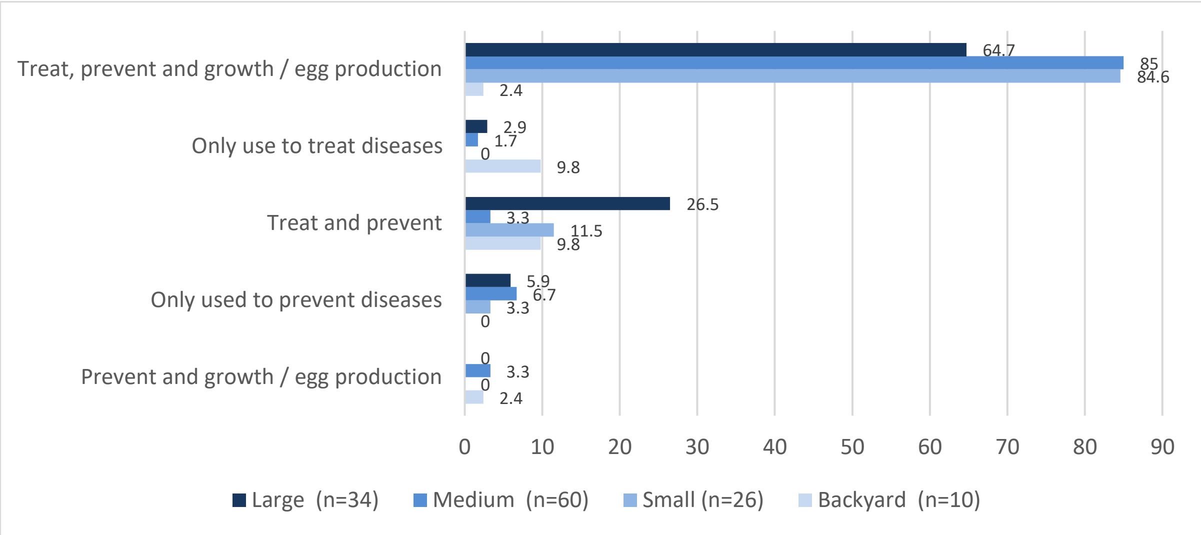


*Figure 14. **Purpose for General Antibiotic Use on the farm***

The findings presented in Figure 15 suggested that in all, 62% of the total respondents who self – administered antibiotics were not supervised by a competent professional. This may be as a result of the experience and foreknowledge gained through practice with administering antibiotics. Further interactions with the respondents revealed that, they occasionally offer technical assistance to colleague farmers (existing and prospective).

In addition, conversations with respondents suggested that they sometimes invited competent professionals to supervise antibiotics administered by their farm hands/managers to ensure that the right process is being followed to promote productivity.

Generally, self-administered antibiotics were not supervised by competent professionals in the commercial farms. Most respondents from the large (76.5%), medium (80.0%) and small (80.0%) scale producers admitted that self-administrations of antibiotics on their farms were not supervised were not supervised by a competent professional as opposed to few respondents from the large (23.5%), medium (20.0%) and small (19.2%) scale producers who self-administered antibiotics under the supervision of a competent professional.

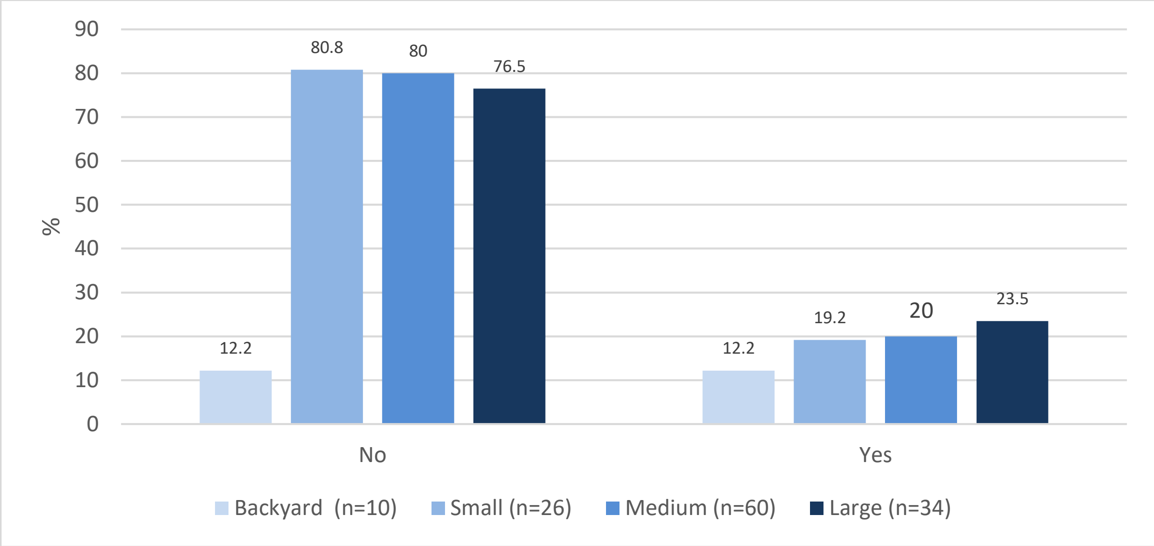


*Figure 15*. ***If Antibiotics is self-administered, is the process supervised by a competent professional?***

The choice of antibiotic use on the farm were informed by several reasons (Figure 16). According to about 79% of the respondents, their choice of antibiotic use is determined by signs and symptoms of illness. The choice of antibiotics for 54% and 44.1% of respondents was influenced by their routine farm practice and abnormal mortalities respectively. In most of these cases, the choice of antibiotic use by respondents could be influenced by more than one reason (Appendix 5). Few respondents (12.4%) confirmed their choice of antibiotics by laboratory reports received as most farmers don't take their sick birds for laboratory diagnosis. In their view it's cost effective to decide on antibiotic use based on signs and symptoms amongst others other than laboratory examination as there may be delays awaiting reports. This was evident in all scales of farming as seen in Figure 16. However, in all the commercial farms, respondents also indicated that routine farm practice and abnormalities informed their choice of antibiotic use. Few respondents agreed that laboratory results informed their choice of antibiotic use on the farm.

In addition, the absence of a functional veterinary laboratory in the municipality over the years has not encouraged stakeholders to resort to such services and have devised other means to investigate suspected infections, diseases and mortalities on their farms to inform their choice of antibiotics for prevention and treatment of their flock.

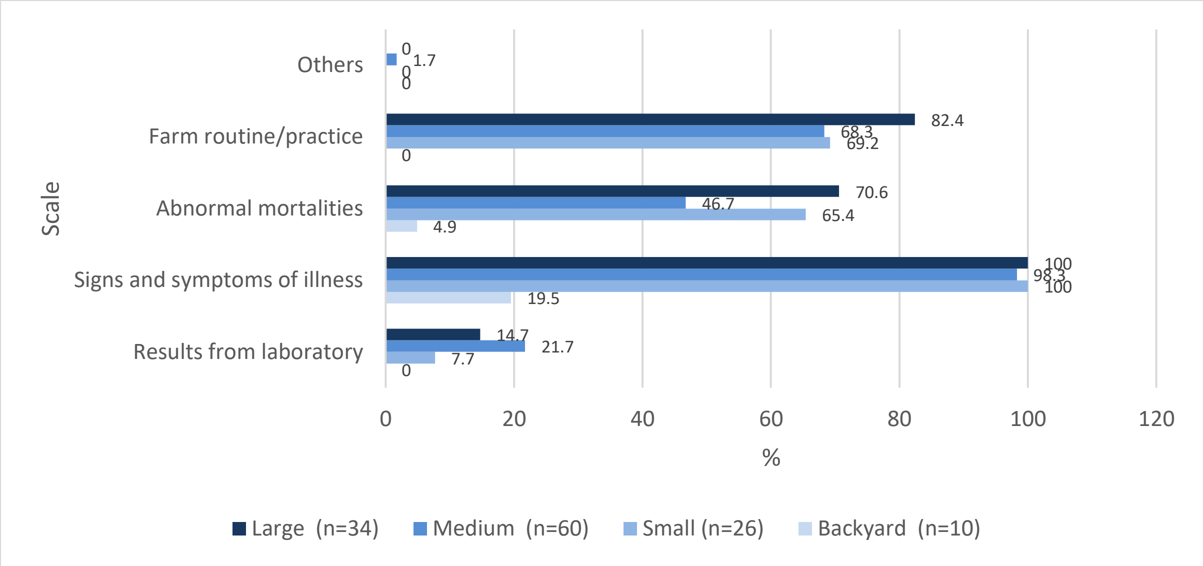


*Figure 16. **Choice of Antibiotic Use***
*Multiple responses*

Farmers use different routes or means to administer drugs (antibiotics). This may involve injections, oral (in water or feed), on the skin among others. Results showed that generally about 81% and 45% of the respondents frequently administered antibiotics orally in water and feeds for their flock respectively whereas 29% administered antibiotics through injections (Table 26). The oral route (water) was commonly used by all the farmers regardless of the scale of production, with the reasons that it is easy and convenient, required less skill and cost effective as compared to the others. In addition, the oral route of administration is associated with minimal or no adverse effects from antibiotics. Antibiotics application by injection ranked as the second route among the scale of producers. There also a high percentage of the farmers who administered the drugs in feed.

*Table 26. **Frequently Used Route of Administration of Antibiotics***

| | Backyard (n=10) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=130) |
|---|---|---|---|---|---|
| Injection | 1 (2.4%) | 10 (38.5%) | 22 (36.7%) | 13 (38.2%) | 46 (28.6%) |
| In water | 10 (24.4%) | 26 (100.0%) | 60 (100.0%) | 34 (100.0%) | 130 (80.7%) |
| On the skin | 0 (0.0%) | 4 (15.4%) | 10 (16.7%) | 5 (14.7%) | 19 (11.8%) |
| In feed | 1 (2.4%) | 15 (57.7%) | 32 (53.3%) | 24 (70.6%) | 72 (44.7%) |

*Multiple responses*

More than half of the respondents (60.2%) kept records on antibiotic use on their farms while 19.2% did not. Similarly, 1.2% of the respondents kept records sometimes. Results revealed that most farmers (commercial farmers) kept records of antibiotics use on the farm. Among the commercial farmers, respondents from the large (91.2%), medium (83.3%) and small (61.5%) scale producers admitted keeping records on antibiotic use on their farms. Almost one third of the small scale respondents (38.5%) did not keep records on antibiotic use as shown in Table 27.

*Table 27. **Record Keeping on Antibiotic Use***

| | Backyard (n=10) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n =130) |
|---|---|---|---|---|---|
| No | 9 (22.0%) | 10 (38.5%) | 9 (15.0%) | 3 (8.8%) | 31 (19.3%) |
| Sometimes | 1 (2.4%) | - | 1 (1.7%) | - | 2 (1.2%) |
| Yes | - | 16 (61.5%) | 50 (83.3%) | 31 (91.2%) | 97 (60.2%) |

Most farmers (42%) preferred storing antibiotics at the store house while 28.0% stored it at the farm or in the shelf cupboard on the farm as indicated in Table 28. Generally, the commercial farm respondents stored their antibiotics either in the farm house cupboard or store house. Store houses referred to structures in which feed and other essential agricultural logistics were safely kept for use. These facilities were mainly common among the large and medium scale farmers. Vaccines and other medications which required to kept under certain conditions were mostly kept refrigerated at the residence of the farm manager and taken to the farm when needed. The backyard farmers who used antibiotics had other places for storing their antibiotics for use such as domestic fridges, kitchen cabinet, drawer etc.

*Table 28. **Place of Storage of Antibiotics***

| | Backyard (n=10) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=130) |
|---|---|---|---|---|---|
| Farm house/shelf cupboard | 2 (4.9%) | 14 (53.8%) | 19 (31.7%) | 10 (29.4%) | 45 (28.0%) |
| Refrigerator in residence | 0 (0.0%) | 0 (0.0%) | 1 (1.7%) | 5 (14.7%) | 6 (3.7%) |
| Refrigerator in farm | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) |
| Store house | 0 (0.0%) | 9 (34.6%) | 39 (65.0%) | 19 (55.9%) | 67 (41.6%) |
| Others | 8 (19.5%) | 4 (15.4%) | 4 (6.7%) | 6 (17.6%) | 22 (13.7%) |

Table 29 summarized results of how expired drugs and empty drug containers are disposed of. Generally, in the disposal of expired drugs, the study revealed that more than half (53%) of the respondents disposed of expired and empty drug containers by burning whereas 33% buried them in the ground. Some (27%) also dumped the expired drugs and empty drug containers at the refuse dumps with 13% of them re-using the containers for other things.

Most respondents from the commercial farms indicated burning and burying in the ground as means of disposing of expired drugs and empty drug containers. Quite a high percentage of the large scale framers re-used the containers as compare to the others. According to such respondents, these containers can be used to fetch water or some medicines/antibiotics can be put into these containers for use. In terms of the backyard farmers, expired drug and empty drug containers are either burnt (4.9%) or disposed of at the public refuse dump.

*Table 29.* ***Disposal of Expired Drugs and Empty Containers***

| | Backyard (n=41) | Small (n=26) | Medium (n=60) | Large (n=34) | All (n=161) |
|---|---|---|---|---|---|
| Burying in the ground | 1 (2.4%) | 10 (38.5%) | 25 (41.7%) | 17 (50.0%) | 52 (32.9%) |
| Burning | 2 (4.9%) | 15 (57.7%) | 43 (71.7%) | 25 (73.5%) | 85 (52.8%) |
| Public refuse dump | 8 (19.5%) | 12 (46.2%) | 19 (31.7%) | 5 (14.7%) | 44 (27.3%) |
| Reuse | 1 (2.4%) | 3 (11.5%) | 9 (15.0%) | 8 (23.5%) | 21 (13.0%0 |
| Others | 0 (0.0%) | 4 (15.4%) | 1 (1.7%) | 3 (8.8%) | 8 (5.0%) |

## 5.1 Key Findings

The use of antimicrobials in food producing animals is linked to animal welfare, food safety, and productivity. However, extensive use of antibiotics in food producing animals contributes significantly to the development and emergence of antimicrobial resistance. In the current study, the key findings revealed that antibiotics are mostly used in poultry farming for disease prevention, treatment and growth promotion. This seems to be a common practice among the commercial poultry farmers as they have incorporated antibiotic administration into their routine husbandry practices on the farms. Antibiotics administered were easily accessed without prescriptions. There was a wide range of antibiotics that were used by farmers some of which are critically important for human use, thus threatening public health. Majority of the poultry farmers reared layers and were unable to manage withdrawal periods. In several instances, antibiotics were administered routinely and not just for treatment, providing it through water and so withdrawal periods for eggs was impossible for many. However, some find ways to manage antibiotic administration by either giving antibiotics prior to the laying age while others throw away few eggs, which becomes a cost that is incurred by the farmers as indicated in discussions during the survey. It was also observed from the findings that most of the farmers engaged in self-medication although some also requested veterinary inputs at times: with a variety of information sources. The back yard farmers used antibiotics less often but still quite a large number, and their sources predominantly included human health drug stores.

### 5.1.1 Antibiotic use

The unregulated use of antibiotics for prevention, treatment and growth promotion among poultry farmers as observed in the current study poses a threat to food safety and public health due to the risk of accumulation of antibiotic residues and the development of antimicrobial resistant pathogens (2,4,54,55). The above indications of antibiotics seem to be evident among commercial poultry farmers in many countries since it forms part of their routine husbandry practice (54–56) although the practice contradicts with the provisions in the Public Health Act of 2012 (Act 851) and Environmental Protection Act of 1994 (Act 490). Findings from several studies have revealed that the unregulated usage of antibiotics in any of the above ways have the potential to select for bacteria strains that may be resistant to the antibiotics used while it positively impacts on the health of animal population and also end up in the human food chain (10,54–57). The food safety concerns associated with the presence of antimicrobial residues in food producing animals have been found to constitute to socioeconomic challenges in international trade in animal and animal products (58,59) to ensure consumer protection. Additionally, studies have reported the huge financial implication of AMR which include extremely high healthcare costs due to an increase in hospital admissions and medicine usage (60).

The World Animal Health Organisation (OIE) and the World Health Organisation (WHO) have categorised and revised similar antibiotics for use according to their importance of use to safeguard their integrity for better health outcomes for member countries over the years (17,61). Evidence from most low and middle-income economies has shown that the existence of weak or absence of policies/regulations/systems for monitoring and enforcing prudent use of antimicrobials in especially animals makes the situation difficult for stakeholders to generate accurate data to make relevant recommendations on antibiotic use in the sector (2,9,12,35,62,63) as compared to the advance economies where mechanisms have been instituted to minimize/control the widespread use of antibiotics in food animal producing sectors to curb antimicrobial resistance (2,64,65). Over use of antibiotics in animal husbandry have also raised concerns over the potential transfer of resistant genes to the environment i.e. soil by the application of poultry manure for either aquaculture or crop farming (57,66). Easy access to antibiotics influenced farmer's use of antibiotics in animal husbandry which results in the contamination of animal food products with antibiotic residues that promotes the development of resistance in human pathogens (68).

About a quarter of the backyard poultry respondents admitted using antibiotics for treatment and upon suspicion of an infection, but reported rarely using them as growth enhancers (67). Some studies have indicated that the contribution to AMR from backyard farmers was less (68), but somewhat routine use of antibiotics will still lead to the development of antimicrobial resistant pathogens (67,69), and thus have a long term impact on public health. The backyard farmers obtained their antibiotics from mainly the human drug stores due to economic reasons and absence of any form of extension interventions from the competent authority in contrast to other jurisdictions (70) in situations of morbidities and mortalities and thus practice self-medication. Backyard farmers kept broilers and cockerels usually on free range that are meant to supplement the protein needs of households with sale of surplus for income occasionally. It was also observed that some of the respondents of backyard farms administered herbal extracts from mango, neem, aloe vera etc to birds through the drinking water when infection or disease is suspected and realised positive outcomes.

### 5.1.2 Access to commonly used antibiotics

The results from the study showed that access to antibiotics was easy as respondents could buy antibiotics without prescription in both Agro-Vet shops for the commercial poultry respondents and human drug stores in the case of the backyard poultry respondents, a situation which is similar to many low and middle income countries, posing a great challenge to regulation (56,58).

The findings from the study also revealed that antibiotics such as Tetracyclines (Oxytetracycline and Doxycyclines), Aminoglycosides (Neomycin, Gentamicin, streptomycin), Polymyxins (Colistin), Macrolides (Erythromycin, Tylosin), Penicillins (Ampicillin, penicillin G) and quinolones (Enfloxacin) were commonly used by the poultry farmers in their husbandry operations which is also evident in several other studies (10,12,55,71). The above listed antibiotics are medically important in human medicine (36).

Apart from the tetracyclines that are classified as highly important, the rest are known to be critically important, thus unregulated use in animal husbandry threatens their integrity or potency for human health care due to its potential to select resistant strains and also contribute to emergence of bacterial resistance (2,35). Studies have also shown that the occurrence of resistance strains of bacteria in human pathogens severely limits the therapeutic options in human infections (72,73). The presence of antimicrobial residues in animal products have been suggested to result in allergies, cancers and other adverse events (74). The study confirmed multi-drug usage pattern which was observed among the farmers similar to other publications (55,63,71). Empirical evidence has shown that multi-drug resistance impacts negatively on human health care (55,65,75). The use of a crucial last-resort antibiotic such as colistin in poultry farming poses a serious threat to human lives as there is no alternative to this antibiotic resulting in limited/no treatment options. The bacteria that is resistant to major antibiotics is more likely to develop resistance to colistin too (76).

Although it was not clear why the practice was common by the farmers, but it could be inferred that different antibiotics were administered to ensure quicker positive outcomes were realised to protect and sustain their livelihoods and investments. There is therefore the need to institute surveillance programmes to monitor and evaluate the type of antibiotics used in veterinary practice to ensure the continuous effectiveness of these critical medicines for human health care (1,19,20,54). According to the WHO, there is considerable overlap of antimicrobial agents used in both human and veterinary medicine, and as such antimicrobials are regularly evaluated and reclassified based on their importance to humans and animal health to strengthen antimicrobial stewardship. This thus makes the judicious or prudent use of antimicrobials in food producing animals require the combination of political, regulatory and economic approaches to curb this threat.

### 5.1.3 Self-medication

Most of the poultry farmers said they self-medicated their animals (63), although they also requested veterinary inputs at times; with a variety of information sources that includes seminars from feed manufacturing companies and representatives from drug manufacturers. Self-medication usually refers to the misuse or overuse of antibiotics for any intended purpose without any expert supervision. Antibiotic use for any indication potentially drives resistance through the selection of resistant strains of bacteria and accumulation of residues that exceed levels recommended by the World Health Organizations or the Codex Alimentarius in animal products and the environment with potential threat to public health (3,62,63,74,77).

The main objective for self-medicating the flock was to reduce mortalities and morbidities in order minimise losses and sustain their investments (6,10,13,19,54,55,57). This practice is common in low and middle income countries where infrastructure/systems/expertize to support animal health is weak or absent (10,43,54,57,78) although some farmers have some level of knowledge on the negative effects/dangers of antibiotic use. Discussions with the respondents in the study location agreed that self-medication was inappropriate, but they still pursued it due to the convenience and avoidance of delay in waiting for the competent authority to respond to emergencies which usually impact negatively on their investments and means of livelihoods. In addition, self-medication was also indicated to be driven by uncontrolled sale or easy access to antibiotics (79). In the study more than half of the respondents from the commercial farms admitted to self-medication without supervision from a competent professional which raises a serious public health concern as the products could possibly accumulate antibiotic residues to increase resistance in consumers and the environment. Guidelines on sale and use should be strengthened and enforced at all levels. Farmers must be educated and trained on infection control strategies. The provisions within the National Antibiotic Policy document and the Public Health Act 2012 (Act 851) needs to be implemented to control the use of antibiotics in animals.

### 5.1.4 Withdrawal Periods

Studies have shown that the adherence to withdrawal periods of antibiotics allows for the traces of antibiotics to exit the animal system to ensure animal products are wholesome for consumption, failure to adherence have resulted in direct toxicity in humans (13,80). During the interview with farmers, it became clear that some had knowledge about the negative impact on food safety as well as public health issues associated with non-adherence but their actions/inactions were seen to be economically motivated (19,81). In the current study, the adherence to withdrawal periods was a challenge for the poultry farmers as they mostly kept layers. A lot of antibiotics were administered routinely and not just for treatment, through the water, thus making the withdrawal periods for eggs somewhat impossible for them. Eggs produced during the periods of treatment were sold disregarding the potential accumulation of antibiotic residues and the negative impacts on the health of the public (10,54,78). However, some farmers admitted the challenge but have had to manage antibiotic administration in their husbandry management schedules to practice adherence with some level of intervention from veterinary/extension officers as documented in some literature (13,55,82).

## 5.2 Limitations of this study

We recognise the study may have some limitations which were managed by the research team to ensure the success of the work. Prior to the time of the study, a low pathogenic Avian Influenza outbreak occurred in the study location which persisted for the entire period of the study. The situation made it difficult and impossible to visit the farms and thus questionnaires had to administered outside the farm premises to prevent the spread of infection from farm to farm. As a result of the outbreak, interviews had to be conducted at scheduled locations other than the farm premises to prevent transmission of the virus by the research team.

Some farms that were listed on the Veterinary Database were not operational at the time of the visit and thus other farms located within the study area had to be enrolled for the study. These occurrences made the research team to work extra hours and days to get the required number of respondents for the questionnaires to be administered to them. This did not have any significant impact on the quality and quantity of the data collected as the team met to go through every questionnaire administered by each enumerator for the day before they are finally submitted on the Kobo toolbox.

Almost at the tail end of the study, more persons had to be engaged in the administration of the questionnaire to assist the existing research team to speed up with the work due to the looming incidence of cases of the Covid 19 pandemic which eventually led to the partial lockdown of certain parts of the country to control the spread. In this study, antibiotics were grouped into classes to elicit responses from all respondents.

## 5.3 Methodological lessons learned for surveillance of ABU in animals in Ghana

This current study provides a basis for similar studies to be carried out in all the regions to monitor antibiotic use in the sub-sector to generate a harmonised baseline data as well as identify the gaps to inform regulators on the type of interventions/resources/actions to implement to curb indiscriminate antibiotic use, development of resistant pathogens and potential accumulation of residues in foods of animal origin.

Programs/Capacities can be developed and coordinated by relevant stakeholders to target antibiotics for the various species. Generally, the types of antibiotics used in the sector by the farmers seems to be similar irrespective of the geographical location. The Agro-Vet shops in the regions purchase their antibiotics from the big cities who procure from the same importers. Variations are almost non-existent in the compilation of the drug bag as observed in the pre-testing and actual study, implying that the same drug bag can be used with a few modifications in all the regions to replicate the study and thereby minimizing the cost of antibiotics to be purchased. Municipal and District veterinary offices should be resourced with functional mobile devices such as tablets to enable them to diligently carry out such surveys on at least bi-annual basis to ensure that the data gap on antibiotic use within the livestock sector (poultry) is minimized. Questionnaires as well as drug bag compilations can easily be updated to address an intended need or objectives by the Veterinarians or Extension officers.

Community entry played a very critical role in ensuring that the current study is carried out smoothly. The leader of the research team embarked on a reconnaissance study to meet with relevant stakeholders prior to the actual study to officially inform them of the intended study and seek their approval so that there will be minimal/no hindrance in the process. During the process, expert advice was sort from other researchers who were conducting research activities in the study area.

## 5.4 Recommendations

### 5.4.1. Addressing antibiotic use

Prudent use of antibiotics in food producing animals under veterinary supervision is critical in ensuring food safety and security. To ensure the success and sustainability of government's flagship program "Rearing for Food and Jobs", the Veterinary Services Directorate should collaborate with other stakeholders to create awareness on AMR for beneficiaries of such interventions to address the probable incentives that may drive AMU in their husbandry practices. The following recommendations have been made based on the evidence from other studies which impacted positively to reduce antibiotic resistance:

- The Veterinary Services Directorate must provide leadership through stakeholder engagements to establish Antibiotic Stewardship strategies aimed at protecting the efficacy of veterinary pharmaceuticals through the development and enforcement of regulatory guidelines in the manufacture, import, sale and re-evaluation of the indications for the use of

WHO critically important antibiotics for human use in the treatment of infections in animal health to curb antibiotic and multi-drug resistance (83,84).

• The field and laboratory capacities of veterinarians and para-veterinarians should be enhanced regularly at all levels to enable them to carry out their mandate in diagnostics, prescription and supervision of medicine (antibiotics) administration during therapies as well as conduct surveillance and testing of antibiotic residues in animal source foods/feeds to monitor the levels of contaminants within the food value chain as outlined by the Codex Alimentarius Commission (85–88) to facilitate certification processes to assure public health and environmental sustainability.

• The Veterinary Services Directorate should occasionally collaborate with pharmaceutical and feed manufacturing representatives to conduct farm-based trainings/workshops/seminars using simplified pictorial illustrations on Infection prevention and biosecurity measures and simple information on rational medicine (antibiotic) use in the form of leaflets and posters should be made available to farmers and other stakeholders to provide practical knowledge and skills to ensure the responsible use of antimicrobials in farm husbandry (89–91) to promote positive health outcomes in their flock as well as minimize the development and spread of antibiotic resistant pathogens in consumers and the environment (92,93).

• Advertisement of veterinary antimicrobials by veterinary pharmaceutical and feed manufacturers/representatives/distributers should also be vetted and approved by the competent authority to regulate the information delivered to the end users to protect the public health and sustain the productivity of the environment as outlined in the Public Health Act 2012 (Act 851). Contrary to these provisions in the Act, the defaulter will attract sanctions such as fines and ban advertisement of products.

• Stakeholders should work together to ensure that alternatives such as probiotics and commercial vaccines are affordable and available to farmers. In addition, vaccination programs should be enhanced, scaled up and monitored by the Veterinary Services Directorate to prevent the introduction of infections and potential disease outbreaks to minimize the use of antibiotics on the farms (44–47).

• Institution of a One Health approach by stakeholders has the potential to strengthen a multi-sectoral and multi-discipline collaboration between the animal and human health sectors to build and review Antibiotic Stewardship Strategies to enhance existing human and infrastructural capacities, improve communication mechanisms/channels, promote partnerships and create cross-disciplinary awareness and participation at all levels (56,57) to achieve the sustainable goals.

### 5.4.2. Addressing antibiotic surveillance

In order for Animal Health Professionals to be well equipped with adequate information (data) to develop antibiotic stewardship strategies aimed at effectively monitoring and regulating the activities of all stakeholders within the value chain against the misuse of antibiotics in the industry. There is the need for the VSD to take the role to revise its extension delivery approaches to incorporate new activities. For instance, surveys to capture data on antibiotics can be improved with the use of drug bag. Although these may be associated with costs of antibiotics, mobile devices (tablets, phones, power banks) which needs to be anticipated prior to such activities, the potential benefits outweigh them as certain information gaps will be bridged. The costs to be incurred could be reduced if other stakeholders are involved such as the Pharmaceutical companies and Managers of the Agro Vet shops in and within the study areas are engaged to compile drug bags for the exercise. which is intended to inform the policies, management and activities in the sector.

Functional mobile devices should be made available to conveniently capture the GPS location of the study sites (farms and households) in order to map out the study area for current and future references and planning purposes. Once the logistics are provided, these surveys can be included as part of routine extension delivery services.

Based on the AMU data built through these surveys over the period, relevant animal health professionals and other actors will be well informed to provide relevant interventions such as training for the poultry farmers/ associations on basic knowledge and skills in proper husbandry practices that would promote and sustain their production with minimal or no dependence on veterinary medicines.

The adherence to strict disease management strategies such as vaccination and farm biosecurity measures to protect the birds and prevent the occurrence of diseases will be enforced.

## 5.5 Conclusion

The current study has revealed that the widespread usage of antibiotics in poultry farming in Dormaa Municipality, which seems to be driven by farmers' priority for preventing and treating diseases to sustain their investments, combined with easy access to antibiotics without veterinary prescription, farmer's experience and judgement on the antibiotic attributes amongst others. Findings also showed that most of the respondents of the commercial poultry farmers practiced self-medication with or no supervision from competent professionals using classes of critical and important antibiotics with little or no adherence to withdrawal periods. For instance, the extensive usage of an antibiotic such as colistin (a reserve antibiotic) coupled with non-compliance to withdrawal periods has the potential to develop antimicrobial resistant pathogens and accumulate antimicrobial residues in the poultry products. Colistin resistance is a huge public threat due to the lack of an alternative antibiotic.

Regulating the prudent use of antimicrobials in food producing animals is of utmost importance since the threat of resistance extends to the humans as well as environment; it also therefore requires a one health approach that seeks to employ multi-sectorial collaboration between actors within the animal, human and environmental sectors to commit to building capacities (human and infrastructure), improving mechanisms of communication and partnerships to create awareness and encourage the needed participation at the various levels (66,94).

1. Magnusson, U., Sternberg, S., Eklund, G., Rozstalnyy A. Prudent and efficient use of antimicrobials in pigs and poultry. Rome; 2019. (FAO Animal Production and Health Manual). Report No.: 23.

2. O'NEILL J. Review on Antimicrobial Resistance. 2015.

3. Van Boeckel TP, Brower C, Gilbert M, Grenfell BT, Levin SA, Robinson TP, et al. Global trends in antimicrobial use in food animals. Proceedings of the National Academy of Sciences. 2015;112(18):5649–54.

4. Van Boeckel TP, Brower C, Gilbert M, Grenfell BT, Levin SA, Robinson TP, et al. Global trends in antimicrobial use in food animals. Proceedings of the National Academy of Sciences. 2015;112(18):5649–54.

5. Mehdi Y, Létourneau-Montminy MP, Gaucher M Lou, Chorfi Y, Suresh G, Rouissi T, et al. Use of antibiotics in broiler production: Global impacts and alternatives. Vol. 4, Animal Nutrition. 2018. p. 170–8.

6. Mottet A, Tempio G. Global poultry production: Current state and future outlook and challenges. World's Poultry Science Journal. 2017;73(2):245–56.

7. FAO. Antimicrobial resistance (A) in aquaculture. Committee on fisheries. Rome; 2017.

8. Gyansa-Lutterodt M. Antibiotic resistance in Ghana. The Lancet Infectious Diseases. 2013;13(12):1006–7.

9. Asare BA, Gyansa-Lutterodt M. The Ghana example: The challenges of antimicrobial use in low and Middle income countries. 2015; Available from: http://www.fhi.no/dokumenter/c8fa83000c.pdf

10. Johnson S, Bugyei K, Nortey P, Tasiame W. Antimicrobial drug usage and poultry production: case study in Ghana. Animal Production Science [Internet]. 2019;59(1):177–82. Available from: https://doi.org/10.1071/AN16832

11. Agoba EE, Adu F, Agyare C, Boamah VE. Antibiotic Use And Practices In Selected Fish Farms In The Ashanti Region Of Ghana. Journal of Infectious Diseases and Treatment. 2018;03(02):1–6.

12. Yevutsey SK, Buabeng KO, Aikins M, Anto BP, Biritwum RB, Frimodt-Møller N, et al. Situational analysis of antibiotic use and resistance in Ghana: Policy and regulation. BMC Public Health. 2017;17(1):1–7.

13. VE B, C A. Antibiotic Practices and Factors Influencing the Use of Antibiotics in Selected Poultry Farms in Ghana. Journal of Antimicrobial Agents. 2016;2(2).

14. Anang BT, Agbolosu AA. Profitability of broiler and layer production in the brong ahafo profitability of broiler and layer production in. 2013;(May).

15. FAO-AGAL. Synthesis - Livestock and the Sustainable Development Goals. 2016;(June).

16. Van Boeckel TP, Gandra S, Ashok A, Caudron Q, Grenfell BT, Levin SA, et al. Global antibiotic consumption 2000 to 2010: An analysis of national pharmaceutical sales data. The Lancet Infectious Diseases [Internet]. 2014;14(8):742–50. Available from: http://dx.doi.org/10.1016/S1473-3099(14)70780-7

17. World Health Organization. WHO guidelines on use of medically important antimicrobials in food-producing animals. World Health Organization [Internet]. 2017;(4):1–88. Available from: http://apps.who.int/iris/bitstream/handle/10665/258970/9789241550130-eng.pdf?sequence=1

18. Newman MJ, Frimpong E, Donkor ES, Opintan JA, Asamoah-Adu A. Resistance to antimicrobial drugs in Ghana. Infection and Drug Resistance. 2011;4(1):215–20.

19. Darwish WS, Eldaly EA, El-Abbasy MT, Ikenaka Y, Nakayama S, Ishizuka M. Antibiotic residues in food: the African scenario. The Japanese journal of veterinary research. 2013 Feb;61 Suppl:S13-22.

20. Bacanlı M, Başaran N. Importance of antibiotic residues in animal food. Food and chemical toxicology : an international journal published for the British Industrial Biological Research Association. 2019 Mar;125:462–6.

21. Sajid A, Kashif N, Kifayat N, Ahmad S. Detection of antibiotic residues in poultry meat. Pakistan journal of pharmaceutical sciences. 2016 Sep;29(5):1691–4.

22. Roth N, Annemarie K, Mayrhofer S, Zitz U, Hofacre C, Domig KJ, et al. The application of antibiotics in broiler production and the resulting antibiotic resistance in Escherichia coli : A global overview. 2016;

23. Carrique-mas JJ. Antimicrobial Resistance in Bacterial Poultry Pathogens : A Review. 2017;4(August):1–17.

24. Rabello RF, Bonelli RR, Penna BA, Albuquerque JP, Souza RM, Cerqueira AMF. Antimicrobial Resistance in Farm Animals in Brazil: An Update Overview. Animals : an open access journal from MDPI. 2020 Mar;10(4).

25. McEwen SA, Fedorka-Cray PJ. Antimicrobial Use and Resistance in Animals. Clinical Infectious Diseases [Internet]. 2002 Jun 1;34(Supplement_3):S93–106. Available from: https://doi.org/10.1086/340246

26. Sarba EJ, Kelbesa KA, Bayu MD, Gebremedhin EZ, Borena BM, Teshale A. Identification and antimicrobial susceptibility profile of Escherichia coli isolated from backyard chicken in and around ambo, Central Ethiopia. BMC Veterinary Research. 2019;15(1):1–8.

27. Kruse AB, Kristensen CS, Lavlund U, Stege H. Antimicrobial prescription data in Danish national database validated against treatment records in organic pig farms and analysed for associations with lesions found at slaughter. BMC Veterinary Research. 2019;15(1):1–9.

28. Schmitt K, Lehner C, Schuller S, Schüpbach-Regula G, Mevissen M, Peter R, et al. Antimicrobial use for selected diseases in cats in Switzerland. BMC Veterinary Research. 2019;15(1):1–11.

29. Choisy M, Van Cuong N, Bao TD, Kiet BT, Hien BV, Thu HV, et al. Assessing antimicrobial misuse in small-scale chicken farms in Vietnam from an observational study. BMC Veterinary Research. 2019;15(1):1–10.

30. Ekakoro JE, Caldwell M, Strand EB, Strickland L, Okafor CC. A survey of antimicrobial use practices of Tennessee beef producers. BMC Veterinary Research [Internet]. 2019;15(1):222. Available from: https://doi.org/10.1186/s12917-019-1978-6

31. Nhung NT, Chansiripornchai N, Carrique-Mas JJ. Antimicrobial Resistance in Bacterial Poultry Pathogens: A Review [Internet]. Vol. 4, Frontiers in Veterinary Science . 2017. p. 126.

Available from: https://www.frontiersin.org/article/10.3389/fvets.2017.00126

32. Franklin A. Current status of antibiotic resistance in animal production. Acta veterinaria Scandinavica Supplementum. 1999;92:23–8.

33. Speksnijder DC, Wagenaar JA. Reducing antimicrobial use in farm animals: How to support behavioral change of veterinarians and farmers. Animal Frontiers. 2018;8(2):4–9.

34. Access O. We are IntechOpen , the world ' s leading publisher of Open Access books Built by scientists , for scientists TOP 1 %. Long-Haul Travel Motivation by International Tourist to Penang. 2018;i(tourism):13.

35. Schar D, Sommanustweechai A, Laxminarayan R, Tangcharoensathien V. Surveillance of antimicrobial consumption in animal production sectors of low- and middle-income countries: Optimizing use and addressing antimicrobial resistance. PLoS Medicine. 2018;15(3):1–9.

36. World Health Organization. WHO guidelines on use of medically important antimicrobials in food-producing animals [Internet]. World Health Organization. 2017. 1–88 p. Available from: http://apps.who.int/iris/bitstream/handle/10665/258970/9789241550130-eng.pdf?sequence=1

37. Ghana Ministry of Health , Ministry of Food and Agriculture, Ministry of Environment, Science T and I and M of F and AD. Ghana National Action Plan for Antimicrobial Use and Resistance Republic of Ghana. Accra; 2018. p. 1–112.

38. Labi AK, Obeng-Nkrumah N, Nartey ET, Bjerrum S, Adu-Aryee NA, Ofori-Adjei YA, et al. Antibiotic use in a tertiary healthcare facility in Ghana: A point prevalence survey. Antimicrobial Resistance and Infection Control. 2018;7(1):1–9.

39. Ahiabu MA, Tersbøl BP, Biritwum R, Bygbjerg IC, Magnussen P. A retrospective audit of antibiotic prescriptions in primary health-care facilities in Eastern Region, Ghana. Health Policy and Planning. 2016;31(2):250–8.

40. Tagoe D, Attah C. A Study of Antibiotic Use and Abuse in Ghana: a case study of the Cape Coast Metropolis. The Internet Journal of Health. 2012;11(2):1–5.

41. Prah J, Kizzie-Hayford J, Walker E, Ampofo-Asiama A. Antibiotic prescription pattern in a Ghanaian primary health care facility. Pan African Medical Journal. 2017;28:1–10.

42. Labi AK, Obeng-Nkrumah N, Owusu E, Bjerrum S, Bediako-Bowan A, Sunkwa-Mills G, et al. Multi-centre point-prevalence survey of hospital-acquired infections in Ghana. Journal of Hospital Infection [Internet]. 2019;101(1):60–8. Available from: https://doi.org/10.1016/j.jhin.2018.04.019

43. Fianko JR, Donkor A, Lowor ST, Yeboah PO, Glover ET, Adom T, et al. Health Risk Associated with Pesticide Contamination of Fish from the Densu River Basin in Ghana. Journal of Environmental Protection. 2011;02(02):115–23.

44. Agyare C. Practices and factors influencing the use of antibiotics in selected poultry farms in Ghana. OMICS Journal of Antimicrobial Agents. 2016 Jun 15;2.

45. Donkor ES, Newman MJ, Tay SCK, Dayie NTKD, Bannerman E, Olu-Taiwo M. Investigation into the risk of exposure to antibiotic residues contaminating meat and egg in Ghana. Food Control [Internet]. 2011;22(6):869–73. Available from:

http://www.sciencedirect.com/science/article/pii/S0956713510003828

46. Caudell MA, Dorado-Garcia A, Eckford S, Creese C, Byarugaba DK, Afakye K, et al. Towards a bottom-up understanding of antimicrobial use and resistance on the farm: A knowledge, attitudes, and practices survey across livestock systems in five African countries. PLoS ONE [Internet]. 2020;15(1):1–26. Available from: http://dx.doi.org/10.1371/journal.pone.0220274

47. Nyarko P. Dormaa municipality. 2010.

48. Tetteh Anang B, Amison Agbolosu A. PROFITABILITY OF BROILER AND LAYER PRODUCTION IN THE BRONG AHAFO REGION OF GHANA Efficiency analysis of smallholder rice production View project Program participation View project. 2014;(May 2014). Available from: www.arpnjournals.com

49. Aning KG. The structure and importance of the commercial and village based poultry in Ghana. Poultry Review-Ghana [Internet]. 2006;(August):44. Available from: http://www.fao.org/docs/eims/upload/214147/Poultry Review - Ghana.pdf

50. Akunzule AN. Livestock Country Reviews. poultry Sector, Ghana. FAO Animal Production and Health. 2014;6.

51. Boschloo R. Analysis poultry sector Ghana 2019 <. 2019.

52. Dixon J, MacPherson E, Manyau S, Nayiga S, Khine Zaw Y, Kayendeke M, et al. The 'Drug Bag' method: lessons from anthropological studies of antibiotic use in Africa and South-East Asia. Global Health Action [Internet]. 2019;12(1):1639388. Available from: https://www.tandfonline.com/doi/full/10.1080/16549716.2019.1639388

53. Israel GD. Determinins Sample Size. 2003; Available from: http://edis.ifas.ufl.edu/pd005

54. Glasgow L, Forde M, Brow D, Mahoney C, Fletcher S, Rodrigo S. Antibiotic Use in Poultry Production in Grenada. Veterinary Medicine International. 2019;2019.

55. Oluwasile B, Agbaje M, Ojo O, Dipeolu M. Antibiotic usage pattern in selected poultry farms in Ogun state. Sokoto Journal of Veterinary Sciences. 2014;12(1):45.

56. Joshua A, Moses A, Ezekiel Olugbenga A. A Survey of Antimicrobial Agents Usage in Poultry Farms and Antibiotic Resistance in Escherichia Coli and Staphylococci Isolates from the Poultry in Ile-Ife, Nigeria. Journal of Infectious Diseases and Epidemiology. 2018;4(1):4–11.

57. Phares CA, Danquah A, Atiah K, Agyei FK, Michael OT. Antibiotics utilization and farmers' knowledge of its effects on soil ecosystem in the coastal drylands of Ghana. PLoS ONE. 2020;15(2):1–16.

58. Okocha RC, Olatoye IO, Adedeji OB. Food safety impacts of antimicrobial use and their residues in aquaculture. Vol. 39, Public Health Reviews. BioMed Central Ltd.; 2018.

59. Jasovský D, Littmann J, Zorzet A, Cars O. Antimicrobial resistance—a threat to the world's sustainable development. Vol. 121, Upsala Journal of Medical Sciences. Taylor and Francis Ltd; 2016. p. 159–64.

60. Dadgostar P. Antimicrobial resistance: implications and costs. Vol. 12, Infection and Drug Resistance. Dove Medical Press Ltd.; 2019. p. 3903–10.

61. Góchez D, Raicek M, Ferreira JP, Jeannin M, Moulin G, Erlacher-Vindel E. OIE annual report on antimicrobial agents intended for use in animals: Methods used. Frontiers in Veterinary

Science. 2019;6(SEP).

62. Kamini MG, Keutchatang FT, Mafo HY, Kansci G, Nama GM. Antimicrobial usage in the chicken farming in yaoundé, Cameroon: A cross-sectional study. International Journal of Food Contamination [Internet]. 2016;3(1). Available from: http://dx.doi.org/10.1186/s40550-016-0034-6

63. Alhaji NB, Isola TO. Antimicrobial usage by pastoralists in food animals in North-central Nigeria: The associated socio-cultural drivers for antimicrobials misuse and public health implications. One Health [Internet]. 2018;6(November):41–7. Available from: https://doi.org/10.1016/j.onehlt.2018.11.001

64. Van Boeckel TP, Pires J, Silvester R, Zhao C, Song J, Criscuolo NG, et al. Global trends in antimicrobial resistance in animals in low- and middle-income countries. Science (New York, NY). 2019 Sep;365(6459).

65. Shankar Pr. Book review: Tackling drug-resistant infections globally. Archives of Pharmacy Practice. 2016;7(3):110.

66. Yang Y, Ashworth AJ, Willett C, Cook K, Upadhyay A, Owens PR, et al. Review of Antibiotic Resistance, Ecology, Dissemination, and Mitigation in U.S. Broiler Poultry Systems. Frontiers in Microbiology. 2019;10(November):1–10.

67. A. AM, M.-U. A, E. R, M.A. I, M. A, M. R, et al. Poultry farming practices in Bangladesh: A potential contributor to the emergence and transmission of antimicrobial resistance in the community. American Journal of Tropical Medicine and Hygiene. 2018;99(4 Supplement).

68. Kamboh AA, Shoaib M, Abro SH, Khan MA, Malhi KK, Yu S. Antimicrobial Resistance in Enterobacteriaceae Isolated from Liver of Commercial Broilers and Backyard Chickens. Journal of Applied Poultry Research [Internet]. 2018;27(4):627–34. Available from: http://dx.doi.org/10.3382/japr/pfy045

69. N.P. B, J. E, M. G, L. Z, W. C, K. V, et al. Environmental reservoirs of antibiotic resistance associated with small scale poultry farming in Northwestern Ecuador. American Journal of Tropical Medicine and Hygiene. 2014;91(5 SUPPL. 1).

70. Bugeza J, Kankya C, Muleme J, Akandinda A, Sserugga J, Nantima N, et al. Participatory evaluation of delivery of animal health care services by community animal health workers in Karamoja region of Uganda. PLoS ONE. 2017;

71. Wongsuvan G, Wuthiekanun V, Hinjoy S, Day NPJ, Limmathurotsakul D. Antibiotic use in poultry: A survey of eight farms in Thailand. Bulletin of the World Health Organization. 2018;96(2):94–100.

72. Watkins RR, Bonomo RA. Overview: Global and Local Impact of Antibiotic Resistance. Infectious disease clinics of North America. 2016 Jun;30(2):313–22.

73. Marshall BM, Levy SB. Food animals and antimicrobials: Impacts on human health. Clinical Microbiology Reviews. 2011;24(4):718–33.

74. Mensah SEP, Koudandé OD, Sanders P, Laurentie M, Mensah GA, Abiola FA. Antimicrobial residues in foods of animal origin in Africa: public health risks. Revue scientifique et technique (International Office of Epizootics) [Internet]. 2014;33(3):987–96, 975–86. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25812221

75. Aarestrup FM. Veterinary Drug Usage and Antimicrobial Resistance in Bacteria of Animal Origin. 2005;271–81.

76. Walsh TR. A one-health approach to antimicrobial resistance. Nature Microbiology [Internet]. 2018;3(8):854–5. Available from: http://dx.doi.org/10.1038/s41564-018-0208-5

77. Truong DB. Assessment of Drivers of Antimicrobial Usage in Poultry Farms in the Mekong Delta of Vietnam : A Combined Participatory Epidemiology and Q-Sorting Approach. 2019;6(March):1–11.

78. Sirdar MM, Picard J, Bisschop S, Gummow B. A questionnaire survey of poultry layer farmers in Khartoum State, Sudan, to study their antimicrobial awareness and usage patterns. Onderstepoort J Vet Res. 2012;79(1):1–8.

79. Om C, McLaws M-L, Vlieghe E, Daily F, McLaughlin J. Cambodia: the first national study of antibiotic prescribing and resistance using mixed methods approach. Antimicrobial Resistance and Infection Control. 2015;4(S1).

80. Menkem ZE, Ngangom BL, Tamunjoh SSA, Boyom FF. Antibiotic residues in food animals: Public health concern. Acta Ecologica Sinica. 2019;

81. Turkson PK. Use of drugs and antibiotics in poultry production in Ghana. Ghana Journal of Agricultural Science. 2009 Sep 21;41.

82. Mamza SA, Geidam YA, Mshelia GD, Egwu GO. Antimicrobial Usage in Livestock Management in NorthEastern Nigeria: A Survey of Livestock Farmers. 2017;8(8):149–72. Available from: www.ijsrm.humanjournals.comwww.ijsrm.humanjournals.com

83. Price L, Gozdzielewska L, Young M, Smith F, MacDonald J, McParland J, et al. Effectiveness of interventions to improve the public's antimicrobial resistance awareness and behaviours associated with prudent use of antimicrobials: A systematic review. Vol. 73, Journal of Antimicrobial Chemotherapy. 2018.

84. Prescott JF. Outpacing the resistance tsunami: Antimicrobial stewardship in equine medicine, an overview. Equine Veterinary Education. 2020.

85. Rama C, Rao M, Cyril L, Kumar A, Sekharan CB. Quantitative Analysis of Oxytetracycline Residues in Honey by High Performance Liquid Chromatography. International Research Journal of Biological Sciences Int Res J Biological Sci. 2015;

86. Sampane-Donkor E, Newman MJ, Tay SCK, Dayie NTKD, Oointan J, Bannerman E. Veterinary Public Health: Monitoring Adverse Effects of Antimicrobial Drugs in Human Food in Ghana. Accra; 2009.

87. Pham DK, Chu J, Do NT, Degand G, Delahaut P, Pauw E De, et al. Monitoring Antibiotic Use and Residue in Freshwater Aquaculture for Domestic Use in Vietnam. 2015;480–9.

88. Mensah S, Dakpogan H, Aboh AB, Chabi Sika K, Abléto M, K B Adjahoutonon KY, et al. Occurrence of antibiotic residues in raw fish Clarias gariepinus and Oreochromis niloticus from intensive rearing system in Benin. 2019;68(2):91–4. Available from: https://hal-anses.archives-ouvertes.fr/anses-02336074

89. Renault V, Lomba M, Delooz L, Ribbens S, Humblet MF, Saegerman C. Pilot study assessing the possible benefits of a higher level of implementation of biosecurity measures on farm productivity and health status in Belgian cattle farms. Transboundary and Emerging Diseases.

2020;67(2).

90. Aleri JW, Laurence M. A description of biosecurity practices among selected dairy farmers across Australia. Animal Production Science. 2020;

91. Lozica L, Kazazić SP, Gottstein Ž. High phylogenetic diversity of Gallibacterium anatis is correlated with low biosecurity measures and management practices on poultry farms. Avian Pathology. 2020;

92. Liebenehm S, Affognon H, Waibel H. Collective livestock research for sustainable disease management in Mali and Burkina Faso. International Journal of Agricultural Sustainability. 2011;9(1).

93. Grace D, Randolph T, Diall O, Clausen PH. Training farmers in rational drug-use improves their management of cattle trypanosomosis: A cluster-randomised trial in south Mali. Preventive Veterinary Medicine. 2008;83(1).

94. Mitchell ME V, Alders R, Unger F, Nguyen-viet H, Thi T, Le H, et al. The challenges of investigating antimicrobial resistance in Vietnam - what benefits does a One Health approach offer the animal and human health sectors ? 2020;1–12.

## Appendix 1. Questionnaire

**Section 1: GENERAL INFORMATION**

| No. | Question | |
|---|---|---|
| 1. | Date of Survey | ………. / ………. / ……….. (DD/MM/YYYY) |
| 2. | Name / Tel. No. of Enumerator | ……………………………………………….. |

**Section 2: LOCATION**

| | | |
|---|---|---|
| 3. | Community/Town | |
| 4. | GPS Coordinates (Degrees, Minutes, Seconds) | |

**Section 3: DEMOGRAPHICS**

| | | |
|---|---|---|
| 5. | Status of respondent | 1. Farm Owner<br>2. Farm manager<br>3. Farm worker<br>4. Others (specify) |
| 7. | Sex of Respondent | 1. Male<br>2. Female |
| 8. | Age of Respondent (absolute number) | |
| 9. | Marital Status of Respondent | 1. Single<br>2. Married<br>3. Never married<br>4. Widow/widower<br>5. Divorced |
| 10 | Religion of Respondent | 1. Christian<br>2. Muslim<br>3. Traditionalist<br>4. Others (specify) |
| 11. | Nationality of Respondent | 1. Ghanaian<br>2. Non – Ghanaian |
| 12 | If Ghanaian, tick ethnicity | 1. Akan<br>2. Ga/ Ga Dangme<br>3. Ewe<br>4. Hausa<br>5. Other, specify ………………………………… |
| 13 | Educational Level of Respondent | 1. No Education<br>2. Primary<br>3. JHS/MSLC<br>4. Secondary/Vocational/Technical<br>5. Degree/Diploma/HND<br>6. Postgraduate<br>7. Others specify ________________________________ |
| 14 | Primary occupation of Respondent | 1. Government employee<br>2. Unemployed<br>3. Poultry Farmer<br>4. Taxis driver<br>5. Market vendor<br>6. Tailor/Seamstress<br>7. Mason<br>8. Carpenter<br>9. NGO employee<br>10. Refused to answer |

| | | |
|---|---|---|
| | | 11. Other (specify) |

**Section 4: FARM CHARACTERISTICS ASSOCIATED WITH ANTIBIOTIC USE (FACTORS)**

| | | |
|---|---|---|
| 15 | How many years has the farm been operational | 1. 1ess than 1 year<br>2. 1 – 5 years<br>3. 6 - 10 years<br>1. More than 10 years |
| 16 | Source of birds (chicks) | 1. Local hatchery<br>2. Imported<br>3. Local<br>4. Others (specify) |
| 17 | Source of Water<br>**Tick all options that apply** | 1. Borehole<br>2. Well<br>3. Stream/river<br>4. Pipe-borne<br>5. Others (specify) |
| 18 | Type of birds reared<br>**Tick all options that apply** | 1. Broiler<br>2. Layer<br>3. Others (specify) |
| 19 | Scale of Production | 1. Backyard: below 200<br>2. Small Scale: below 200-1,000<br>3. Medium Scale: 1001-10,000<br>4. Large Scale: >10,000 |
| 20 | Type of farm | 1. Monoculture (only poultry)<br>2. Integrated (poultry and livestock) |
| 21 | Type of litter | 1. Saw dust<br>2. Wood shaving<br>3. Straw<br>4. Shredded sugar cane<br>5. Groundnut hulls<br>6. Others (specify) |
| 22 | Frequency of litter change | 7. Monthly<br>8. Quarterly<br>9. Bi-annually<br>10. Annually<br>11. Others (specify) |
| 23 | Type of Production System | 1. Extensive<br>2. Semi-intensive<br>3. Intensive |
| 24 | Which of the following sanitary methods did you implement on this farm in the last year (2018)? **Tick all options that apply** | 1. Disinfection of Pens<br>2. Disinfection of feeders/Drinkers<br>4. Changing of litter<br>5. Others, specify……. |
| 25 | Have you received training on farm biosecurity in the last year (2018)? | 1. Yes<br>2. No |
| 26 | If Yes, which organization has provided training to you before? **Tick all options that apply** | 1. Poultry Farmers' Association<br>2. Government Agencies<br>3. Drug Manufacturing Companies/Sellers<br>4. Feed Manufacturers<br>5. Other (specify) |
| 27 | When did you receive your last training? | 1. Last six months<br>2. Last year<br>3. Two and above years<br>4. Other specify …………………………… |
| 28 | How often does the vet / vet technician / Animal Husbandry officer offer extension service to the farm? **Tick as apply** | 1. Once a month<br>2. Quarterly<br>3. Bi-annually<br>4. Annually<br>5. Others (specify) |

| | | | |
|---|---|---|---|
| 29 | Can you identify some common illnesses experienced on your farm in the last year? **Tick all options that apply** | 1. Fowl Cholera<br>2. Worms<br>3. Newcastle disease (fall down and die)-viral<br>4. Coccidiosis – parasite (protozoa)<br>5. Gumboro disease - viral<br>6. Fowl pox -viral<br>7. Skin disease/wounds<br>8. General weakness<br>9. External parasites<br>10. Others (specify) | |
| 30 | Who do you contact when you notice that your birds are sick? **Tick all options that apply** | 1. Vet/Vet Technical officers<br>2. Extension Officer<br>3. Buy antibiotics from Agro-Vet shop to treat<br>4. Other farmers for help<br>5. Others (specify)…………… | |
| 31 | How do you contact for help? | 1. Phone call<br>2. Visit the vet shop<br>3. Visit the vet | |
| 32 | What activities on the farm do you keep records of? **Tick all options that apply** | 1. Litter change<br>2. Litter disinfection<br>3. Vaccination<br>4. Medicine administration<br>5. Others (specify) | |
| **SECTION 5: AVAILABILITY AND ACCESSIBILITY OF ANTIBIOTICS – DRUG BAG** | | | |
| | Pile sorting for animals<br>We have brought some medicines that are commonly used in poultry from the different classes<br><br>**Hint**: Show the bag of medicines with different brand names to the respondent to go through them for recognition. | | |
| 33 | Which antibiotics do you recognize (**Tick all that apply**) | 1. Aminoglycosides e.g. gentamycin, streptomycin<br>2. Penicillins e.g. amoxicillin<br>3. Cephalosporins e.g. cefotaxime<br>4. Polymyxins e.g. colistin<br>5. Lincosamides e.g. lincomycin<br>6. Macrolides e.g. erythromycin, tylosin<br>7. Quinolones e.g. flouroquinolones<br>8. Sulfonamides e.g. sulphur drugs<br>9. Tetracyclines e.g. oxytetracycline<br>10. Others | [ ]<br>[ ]<br>[ ]<br>[ ]<br>[ ]<br>[ ]<br>[ ]<br>[ ]<br>[ ]<br>[ ]<br>[ ]<br>[ ] |
| | **Hint**: Remove the medicines from the unrecognized pile (they're now gone for good). Put out the recognized medicines in front of the respondent. Resort recognized medicines into two piles (frequently used, and all other recognized) | | |
| 34 | Which antibiotics do you frequently use in poultry or domestic birds (**Tick all that apply**) | 1. Aminoglycosides e.g. gentamycin, streptomycin<br>2. Penicillins e.g. amoxicillin<br>3. Cephalosporins e.g. cefotaxime<br>4. Polymyxins e.g. colistin<br>5. Lincosamides e.g. lincomycin<br>6. Macrolides e.g. erythromycin, tylosin<br>7. Quinolones e.g. flouroquinolones | [ ]<br>[ ]<br>[ ]<br>[ ]<br>[ ]<br>[ ]<br>[ ]<br>[ ]<br>[ ] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 8. Sulfonamides e.g. sulphur drugs<br>9. Tetracyclines e.g. oxytetracycline<br>10. Others | | | | [ ]<br>[ ] | |
| 35 | How often do you use the medicines? | 1. Every day<br>2. Every week<br>3. Every two weeks<br>4. Every month<br>5. Between 1 - 6 months<br>6. Between 7 - 12 months<br>7. From 1 - 2 years<br>8. From 2-5 years<br>9. Less than every 5 years | | | | | |
| | **Hint**: Put out the frequently used medicines in front of the respondent. Resort recognized medicines into two piles (used preventatively, and all other frequently used medicines) | | | | | | |
| 36 | Which, if any, of these frequently used antibiotics do you use in anticipation of sickness – without the animal becoming sick yet? **Tick all options that apply** | 1. Aminoglycosides e.g. gentamycin, streptomycin<br>2. Penicillins e.g. amoxicillin<br>3. Cephalosporins e.g. cefotaxime<br>4. Polymyxins e.g. colistin<br>5. Lincosamides e.g. lincomycin<br>6. Macrolides e.g. erythromycin, tylosin<br>7. Quinolones e.g. flouroquinolones<br>8. Sulfonamides e.g. sulphur drugs<br>9. Tetracyclines e.g. oxytetracycline<br>10. Others | | | | | |
| | **Hint**: Bring back all recognized medicines and put them in front of the respondent. Resort recognized medicines into two piles (medicines that could not be accessed, and all other recognized) | | | | | | |
| 37 | Of the recognized antibiotics, kindly rank levels of accessibility. (**Please don't select more than one answer per row)** | ***Very Easy*** | ***Easy*** | ***Neutral*** | ***Difficult*** | ***Very Difficult*** | |
| | Aminoglycosides | | | | | | |
| | Penicillins | | | | | | |
| | Cephalosporins | | | | | | |
| | Polymyxins | | | | | | |
| | Lincosamides | | | | | | |
| | Macrolides | | | | | | |
| | Quinolones | | | | | | |
| | Sulfonamides | | | | | | |
| | Tetracyclines | | | | | | |
| | Others | | | | | | |
| 38 | Why was it easy to access antibiotics? Tick all options that apply | 1. Ability to buy without prescription<br>2. Affordable<br>3. Efficacy (achieve results)<br>4. Reliable supply<br>5. Nearness to source (supplier)<br>6. Others (Specify) | | | | | |

| | | |
|---|---|---|
| 39 | Why was it difficult to access the antibiotics? **Tick all options that apply** | 1. Unable to buy without prescription<br>2. Expensive<br>3. Poor Quality of antibiotics<br>4. Unreliable supply<br>5. Source of antibiotics is further away<br>6. Others (Specify) |
| **SECTION 6: ANTIBIOTIC USE** | | |
| 40 | Have you used antibiotics on your farm during the periods below?<br>1. Last 3 months<br>2. last 6 months<br>3. last year<br>4. Two years and above | **Yes** \| **No** |
| 41 | Who prescribes or recommend antibiotic use on the farm? **Tick all options that apply** | 1. Vet/Vet Technical Officer<br>2. Extension Officer<br>3. Colleague farmer<br>4. Self -medication |
| 42 | Purpose for antibiotic use on the farm **Tick all options that apply** | 1. Treatment of diseases<br>2. Prevention of illness<br>3. Routine feeding practice or growth promoters |
| 43 | Where do you buy your antibiotics for use? **Tick all options that apply** | 1. Pharmacy<br>2. Drug Store<br>3. Agro vet Shop<br>4. Veterinary / Agricultural officer<br>5. Other farmers<br>6. Imported<br>7. Others (specify) |
| 44 | What type of information do you receive on the antibiotics you buy for use? (**Tick as apply)** | 1. Dosage<br>2. Number of days to be administered<br>3. Withdrawal period<br>4. Disposal of waste or expired medicines<br>5. Other (specify) |
| 45 | Who is responsible for administering the antibiotics on the farm (**Tick all options that apply)** | 1. Farm owner<br>2. Farm manager<br>3. Other farm hands<br>4. Vet/ Vet Technical Officer<br>5. Extension Officer<br>6. Others (specify) |
| 46 | If the antibiotics are self -administered,(farm owner, manager and other hand) , is the process supervised by a competent professional (Vet/Vet Technical Officer/Extension Officer)? | 1. Yes<br>2. No |
| 47 | What informs the choice of antibiotics use on the farm? **Tick all options that apply** | 1. Results from laboratory test<br>2. Signs and symptoms of illness<br>3. Abnormal mortalities<br>4. Farm routine / practice<br>5. Others (specify) |
| 48 | What is the frequently used route of administration? **Tick all options that apply** | 1. Injection<br>2. Oral (mouth)<br>3. On the skin<br>4. In feed |
| 49 | Do you keep records on antibiotic use on farm? **Tick all options that apply** | 1. Yes<br>2. No |

| | | |
|---|---|---|
| | | 3. Sometimes |
| 50 | Where do you store antibiotics for use in farm? **Tick all options that apply** | 1. Farmhouse shelf /cupboard<br>2. Refrigerator in residence<br>3. Refrigerator in farm<br>4. Others (specify) |
| 51 | How do you dispose of expired drugs and empty drug containers ? | 1. Burying in the ground<br>2. Burning<br>3. Disposal at public refuse dump<br>4. Others (specify) |
| 52 | Please tell us about your most recent experience using antibiotics to manage illnesses in the birds? | |
| 53 | Can you show any medicines that you keep for poultry or domestic animals? **(Take a photo and record the name)** | |

## Appendix 2: Sources of water

| | Frequency | Percent |
|---|---|---|
| Borehole | 79 | 49.1 |
| Borehole & Harvested rain | 3 | 1.9 |
| Borehole & Others | 2 | 1.2 |
| Borehole & pipe-borne | 3 | 1.9 |
| Borehole, pipe-borne & harvested rain | 1 | .6 |
| Borehole & well | 3 | 1.9 |
| Borehole, well & pipe-borne | 1 | .6 |
| Pipe-borne | 24 | 14.9 |
| Stream/river | 1 | .6 |
| Well | 43 | 26.7 |
| Well & harvested rain | 1 | .6 |
| Total | 161 | 100.0 |

## Appendix 3: Whom to contact when birds are sick

| | Frequency | Percent |
|---|---|---|
| Extension Officer | 1 | 0.6 |
| Extension Officer & self-medication | 1 | 0.6 |
| Self-medication | 55 | 34.2 |
| Self-medication & Others specify | 1 | 0.6 |
| Other farmers for help | 10 | 6.2 |
| Other farmers for help & self-medication | 1 | 0.6 |
| Others specify | 7 | 4.3 |
| Vet/vet tech officer | 47 | 29.2 |
| Vet/vet tech officer & self-medication | 23 | 14.3 |
| Vet/vet tech officer & Other farmers for help | 6 | 3.7 |
| Vet/vet tech officer Other farmers for help & No one (self-medication) | 7 | 4.3 |
| Vet/vet tech officer & Others specify | 2 | 1.2 |
| Total | 161 | 100.0 |

## Appendix 4. Means to contact officers for help when birds are sick

| | Frequency | Percent |
|---|---|---|
| N/a | 53 | 32.9 |
| No response | 1 | .6 |
| Others specify | 2 | 1.2 |
| Phone calls | 65 | 40.4 |
| Phone calls & Visit vet | 15 | 9.3 |
| Phone calls & Visit vet shop | 6 | 3.7 |
| Phone calls, Visit vet shop & Visit vet | 10 | 6.2 |
| SMS | 1 | .6 |
| Visit vet | 5 | 3.1 |
| Visit vet shop | 3 | 1.9 |
| Total | 161 | 100.0 |

## Appendix 5. What informed the choice of antibiotics use by farmers

| | Frequency | Percent |
|---|---|---|
| N/a | 33 | 20.5 |
| Farm routine / practice | 1 | .6 |
| Results from laboratory test Signs and symptoms of illness | 2 | 1.2 |
| Results from laboratory test Signs and symptoms of illness and abnormal mortalities | 1 | .6 |
| Results from laboratory test signs and symptoms of illness, abnormal mortalities and farm routine / practice | 4 | 2.5 |
| Results from laboratory test signs and symptoms of illness & Farm routine / practice | 13 | 8.1 |
| Signs and symptoms of illness | 18 | 11.2 |
| Signs and symptoms of illness & Abnormal mortalities | 18 | 11.2 |
| Signs and symptoms of illness, abnormal mortalities & Farm routine / practice | 48 | 29.8 |
| Signs and symptoms of illness & Farm routine / practice | 21 | 13.0 |
| Signs and symptoms of illness & Others (specify) | 1 | .6 |
| Symptoms of illness | 1 | .6 |
| **Total** | **161** | **100.0** |

## Appendix 6. Experience (range) in poultry farming

| Production scale | | Frequency | Percent |
|---|---|---|---|
| Backyard below 200 | 1-3 | 7 | 17.1 |
| | 4-6 | 9 | 22.0 |
| | 7-9 | 2 | 4.9 |
| | 10-12 | 7 | 17.1 |
| | 13-15 | 7 | 17.1 |
| | 16-18 | 1 | 2.4 |
| | 19-21 | 2 | 4.9 |
| | 22-24 | 2 | 4.9 |
| | 28-30 | 1 | 2.4 |
| | 34-36 | 1 | 2.4 |
| | 37-39 | 2 | 4.9 |
| | Total | 41 | 100.0 |
| Small=200-1,000 | 1-3 | 11 | 42.3 |
| | 4-6 | 4 | 15.4 |
| | 7-9 | 3 | 11.5 |
| | 10-12 | 4 | 15.4 |
| | 13-15 | 1 | 3.8 |
| | 16-18 | 1 | 3.8 |
| | 22-24 | 1 | 3.8 |
| | Total | 25 | 96.2 |
| | No response | 1 | 3.8 |
| Medium=1001-10,000 | 1-3 | 15 | 25.0 |
| | 4-6 | 8 | 13.3 |
| | 7-9 | 8 | 13.3 |
| | 10-12 | 11 | 18.3 |
| | 13-15 | 5 | 8.3 |
| | 16-18 | 3 | 5.0 |
| | 19-21 | 7 | 11.7 |
| | 22-24 | 1 | 1.7 |
| | No response | 2 | 3.3 |
| | | 60 | 100.0 |
| Large > 10,000 | 1-3 | 3 | 8.8 |
| | 4-6 | 4 | 11.8 |
| | 7-9 | 4 | 11.8 |
| | 10-12 | 8 | 23.5 |
| | 13-15 | 6 | 17.6 |
| | 16-18 | 1 | 2.9 |
| | 19-21 | 6 | 17.6 |
| | 25-27 | 1 | 2.9 |
| | 28-30 | 1 | 2.9 |
| | Total | 34 | 100.0 |

## Appendix 7. Experience and whether respondents had been trained on farm biosecurity

| | | Training on farm biosecurity | | Total |
|---|---|---|---|---|
| | | No | Yes | |
| Experience | 1-3 | 30 (83.3%) | 6 (16.7%) | 36 (100.0%) |
| | 4-6 | 16 (64.0%) | 9 (36.0%) | 25 (100.0%) |
| | 7-9 | 12 (70.6%) | 5 (29.4%) | 17 (100.0%) |
| | 10-12 | 16 (53.3%) | 14 (46.7%) | 30 (100.0%) |
| | 13-15 | 14 (73.7%) | 5 (26.3%) | 19 (100.0%) |
| | 16-18 | 3 (50.0%) | 3 (50.0%) | 6 (100.0%) |
| | 19-21 | 6 (40.0%) | 9 (60.0%) | 15 (100.0%) |
| | 22-24 | 2 (50.0%) | 2 (50.0%) | 4 (100.0%) |
| | 25-27 | 1 (100.0%) | 0 (0.0%) | 1 (100.0%) |
| | 28-30 | 2 (100.0%) | 0 (0.0%) | 2 (100.0%) |
| | 34-36 | 1 (100.0%) | 0 (0.0%) | 1 (100.0%) |
| | 37-39 | 2 (100.0%) | 0 (0.0%) | 2 (100.0%) |
| Total | | 105 (66.5%) | 53 (33.5%) | 158 (100.0%) |

## Appendix 8. Source of training of poultry farmers on farm biosecurity

| | Poultry farmers Assoc. | Gov. Agency | Drug Manufacturing companies/dealers | Feed manufacturing | Project | NGOs | Others |
|---|---|---|---|---|---|---|---|
| 1-3 | 4 (11.1%) | 0 (0.0%) | 2 (5.6%) | 1 (2.8%) | 0 (0.0%) | 0 (0.0%) | 1 (2.8%) |
| 4-6 | 3 (12.0%) | 5 (20.0%) | 3 (12.0%) | 0 (0.0%) | 1 (4.0%) | 2 (8.0%) | 0 (0.0%) |
| 7-9 | 1 (5.9%) | 1 (5.9%) | 2 (6.7%) | 3 (17.6%) | 0 (0.0%) | 3 (17.6%) | 0 (0.0%) |
| 10-12 | 5 (16.7%) | 2 (6.7%) | 3 (15.8%) | 2 (6.7%) | 3 (10.0%) | 3 (10.0%) | 2 (6.7%) |
| 13-15 | 4 (21.1%) | 3 (15.8%) | 1(16.7%) | 2 (10.5%) | 2 (10.5%) | 0 (0.0%) | 0 (0.0%) |
| 16-18 | 2 (33.3%) | 2 (33.3%) | 1 (6.7%) | 2 (33.3%) | 1 (16.7%) | 0 (0.0%) | 1(16.7%) |
| 19-21 | 6 (40.0%) | 3 (20.0%) | 0 (0.0%) | 3 (20.0%) | 1 (6.7%) | 1 (6.7%) | 2 (13.3%) |
| 22-24 | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 1 (25.5%) | 1 (25.0%) | 0 (0.0%) |
| 25-27 | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) |
| 28-30 | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) |
| 34-36 | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) |
| 37-39 | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) |
| Total | 25 (15.8%) | 16 (10.0%) | 14 (8.9%) | 13 (8.2%) | 9 (5.7%) | 10 (6.3%) | 6 (3.8%) |

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