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Prioritizing Animal Care: A key to Sustainable Animal Husbandry and Antibiotic Resistance Control

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Abstract
Animal husbandry constitutes a very vital stake in the production proteins human and animal care however adequate management practices remain the mainframe of the animal husbandry. Antibiotics have extensively utilized in the management of animals for healthy living and growth promotion which has led emergence of antibiotic resistance in bacteria. The emergence of this resistance is responsible for the difficult in disease treatment which adversely leads high mortality rate among the livestock. Human infections by antibiotic resistant organisms from animal sources is aftermath effect of the abuse of antibiotics in the rearing of animal. Evidence of unmetabolised antibiotics in the animal products is also certain which leads to antibiotic residue in animal meat, egg or milk. The desire to control antibiotic use especially as growth promoter and/or prophylaxis, un-prescribed as well as inadequate doses in animal husbandry is expected to be the focus of government agencies and veterinarians.

Keywords: Un-metabolised, Prophylaxis, Mortality, Veterinarians, Government agencies

Introduction
Antibiotics are essential in the management of livestock thereby become essential medicines veterinary practices to treat bacterial-caused diseases, when administered at therapeutical concentration and can also targeted growth promotion when administered at sub-therapeutic concentrations. The common methods of antibiotic administration in animal management are mainly oral by incorporating antibiotics into feed and/or drinking water, parenterally and through injection. Antibiotics have been ranked importance for veterinary (Adesokan *et al.,* 2015) and human medicine (Barton, 2001). In some conditions where the similar classes of antibiotics such as: generations of cephalosporins (third and fourth) and fluroquinolones, is critically essential to manage both human and animal sectors, instructions for animal use has carefully been highlighted by the World Health Organisation for Animal Health (OIE) based on the followings, namely: i) such class of antibiotics should not be employed for metaphylaxis that is prevention of diseases; ii) such antibiotics are not advised to be used as a first line of treatment except there is a convincing evidence in term of infection severity and adequately directed using antibiotic susceptibility testing; iii) off label administration should not be allowed and such antibiotics should be reserved for situation when there is no alternatives antibiotics.; and finally iv) Use of antibiotics growth stimulants should not be allowed (WHO, 2019).

The major objective in the fight against antibiotic resistance (AMR) in many countries action plans is to enforce careful use of antibiotic, which is linked to the patterns of the antibiotic consumption and justifying the reasons for the use. These countries action plans are anchored on three international strategic plans which includes: the strategy of the OIE's (WHO, 2019), the action plan of Food and Agriculture Organization under United Nations (FAO) (FAO, 2016), as well as the WHO's AMR global action plan (WHO, 2019). Developed countries especially high-income countries, e.g Europe and North America. Such countries have integral monitoring schemes that involve prescription of antibiotics along with animal species stratification, age and disease indication (Landers *et al*., 2012). This valuable information is vital in identifying targeted areas of interventions, and evaluation of the impact of AMU/AMR reducing interventions (Klein *et al*., 2018). Significantly, it is about 6% of low- and middle-income countries (LMICs) that check AMU during care for the animals (Landers *et al*., 2012) as there are limited awareness and techniques to establish and sustainable surveillance system. Generally, there is a paucity of data on the quantity of antibiotics usage. The global AMU in livestock management has been estimated to be 73% especially in LMIC. Similarly, in a recent research report of antimicrobial consumption from 41 nations across the regions of the world gives a projection of an increase in AMU by 11.5% from 2017 to 2030, particularly in Asia (NethMap, 2018). This rise in percentage of AMU is caused by strictness on the adequate livestock management so as to scale up production that can meet up or bypass the demand of animal protein. The increased AMU in LMICs is as result of poor regulation and irrational use of antimicrobial to recompense for inadequate and poor animal management (NethMap, 2018). In LMICs, other issues include free access to antimicrobials and lagging in the drug quality.

Antibiotics Use and Antibiotic Resistance

The antibiotic use for animal rearing has continuously been observed to be a key determinant to the occurrence of antibiotic resistance that could be responsible for the disease-severity in humans (Lee *et al*., 2001). Magnitude of the antibiotic that is use in food for animals as well as respective clinical evidence remains a serious matter (Tang *et al*., 2019). The use of antibiotic in animal care commenced briefly after the use of antibiotics for prevention and treatment of diseases in humans (Gustafson, 1993). Antibiotics are mostly used in animal management for the prevention and treatment of diseases as well as increasing productivity. This practice has been reported to contribute greatly to the spread of bacteria that are resistance to antibiotics which contribute public health threat to both humans and animals resulting to diseases that are difficult to treat (Martin *et al*., 2015). However, the rate novel antibiotic discovery is slower than development of antibiotic resistance (Silver, 2011) thereby bringing global health early days when bacterial infections constituted a huge problem (Jackson *et al*., 2018; Mantravadi *et al*., 2019). The antibiotic resistance pull in the animal husbandry has placed embargo on food from animal sources which account for the spread of resistant bacteria and resistant genes in humans and animal population (Aarestrup *et al*., 2001). The use of antibiotics in animal management either prophylaxis or therapeutic can have effects on humans either directly or indirectly through consumption of animal food products.

The direct effects of the bacteria with antibiotic resistance is through the consumption of food from animals; while the indirect effects occur through the contact with resistant organisms from the environment after it has been transferred to the constituents of the ecosystem (Landers *et al*., 2012). Multiple reasons could account to the ways by which antibiotics use as supplement in the animal feed can cause a threat to global health. Fundamentally, the desire for the incorporation of antibiotics into animal husbandry management is generally high like as growth factors or prophylaxis instead of primary function of treating bacterial diseases. Similarly, poor knowledge about antibiotics mandate among livestock farmers as well as the poor veterinary health system of the developing and underdeveloped countries. (Ayukekbong *et al*., 2017).

Common Practices among Livestock Farmers

The goal of any investor is to make gain which accounts for the desire of farmers to ensure that their livestock grow and produce maximally. Some of the practices in the developing and under-develop countries, especially where there is absence of well-coordinated antibiotic management strategies and poor legislation and policies. These frequent practices foster the prevalence and transmission of antibiotic resistance (Podolsky, 2018). Different ways through which antibiotic use in livestock management could account for the challenges of antibiotic resistance are:

Self-prescription by Farmers

Many farmers tend to diagnose diseases affecting their animals by themselves and this leads to prescription by themselves which is a critical drive of abuse of the antibiotic, especially in developing and underdeveloped countries where veterinary policies is poorly embraced (Harbarth and Samore 2005). Lack of information by the livestock farmers plays a fundamental function in the aspect of uncontrolled antibiotics utilization. In fact, some of these local farmers do not know that there are veterinary antibiotics therefore purchase on-the-counter antibiotics specifically for humans. This is common in developing and underdeveloped countries. Some of these livestock farmers may not be capable of employing the services of a well-informed extension officers or veterinarian therefore settle for their instinct to address the infections affecting their livestock (Ezenduka *et al*., 2011). Some of the regularly employed antibiotics for therapeutic purposes in livestock including aminoglycosides, penicillins, lincosamides, cephalosporins, sulphonamides, pleuromutilins, tetracyclines and macrolides (Lee *et al*., 2001) however, the commonest one belong to class tetracyclines among poultry farmers in Africa especially Nigeria (Emmanue *et al*., 2009; Ezenduka *et al*., 2011). Considering European countries, the predominantly utilized antibiotics includes streptomycin, sulphonamides, neomycin, tetracyclines, chloramphenicol, ampicillin and gentamicin (Wray and Gnanou, 2000). European countries are having strict rules that enforce antibiotics prescription to reduce if not eliminating the non-prescription antibiotic sales. In the United States, this measure has reduced sales of antibiotics by more than 40% (Bavestrello *et al*., 2002). Government authorities concern with health in Nigeria which includes Federal Ministry of Agriculture and National Agency for Food and Drug Administration and Control (NAFDAC) should embrace concerted effort to make farmers to be well informed about livestock management on the adequate animal keeping strategies and proper antibiotic use for adequate benefits of the animals and consumers of animal products (NAFDAC, 2019). Enforcement should be well embraced because there has been the reports of continuous use of selected drugs such as Nitrofurantoin by farmers despite it has been banned by NAFDAC (Ezenduka *et al*., 2011).

Antibiotics as Agents Promoters for Animal Production

From the inception of the antibiotics, the primary aim of using antibiotics was for the treatment and possible prevention of diseases. However, in the recent times, several works have reported antibiotics being majorly used as animal growth promoter by incorporating them into animal feeds. (Darwish *et al*., 2013; Van *et al*., 2020). The concept of animal growth promoter might have been considered to be useful way of maximizing animal production and enhancement of profit, especially in the period of rising consumption of animal protein. This possibility has given rise to continuous utilization of antibiotics in animal husbandry especially poultry to prevent diseases and promote animal growth (Olayiwola and Adedokun, 2019; Abiala *et al.,* 2016; Khachatourians, 1998). Now, there is a close link between the spread of antibiotics resistance and the desire for animal protein by humans for nutritional and industrial purposes. With teeming population of human being, there is need to increase animal production to meet the demand for the animal proteins however, it should not be at the expense of increasing rate of antibiotic resistance (Van Boeckel *et al*., 2015). Fundamental research is required in boosting animal production by concentrating on good breeds and improved animals feed composition. (Van *et al*., 2020).

In Europe like United States where data is widely available and functional, about 50% of the antibiotics used in animal husbandry are mostly penicillin and tetracycline. From this finding, it is observed that only 10 % is used for disease treatment while the remaining proportion (40%) are utilized for disease prevention (prophylaxis) and growth promotion (Landers *et al*., 2012). This practice tends which involves antibiotic use without prescriptions and use of antibiotics in doses below expected level for a long time will result in antibiotic residues which will eventually moves into the food chain (Darwish *et al*., 2013). The careless use of medicines designated for veterinary use is the serious point of reference when addressing issue of antibiotic accumulation and deposition in the animal tissue and related products such as milk, eggs, and meat (Emmanue *et al*., 2009; Ezenduka *et al*., 2011; Martin *et al*., 2015; Okocha *et al*., 2018).

Antibiotic Administration in Animal Husbandry

Therapeutic administration of the antibiotics ought to be treatment of selected animals suspected to be infected however this is difficult in the animal husbandry as some animal may be difficult to be isolated (Darwish *et al*., 2013). In animal care, this is contributive factor to the pressure of antibiotic resistance. In the case of animal that may be difficult to isolate when infected (e.g fish) group medication may be inevitable but should be guided by veterinarian (McEwen and Fedorka-Cray, 2002).

Apart from spread through resistance genes (either vertical or horizontal transmission), the major factors for antibiotic resistance are wrong and unfollowed dosage use of antibiotics, lack of adequate knowledge on the overuse or misuse of antibiotics, poor sanitation and hygiene in livestock management, excretion of unmetabolized antibiotics into the environment or bioaccumulation antibiotic residues in the tissues of animal and their products (e.g egg, milk and meat). All these dangers are precipitated by use of antibiotics in poultry and other livestock as growth promoters rather than disease control agents (Aswin *et al.,* 2025).

Non-adherence to Prescriptions

There are antibiotics recommended for the use of animal with distinct instruction and direction for use therefore it is expected that livestock farmers should contact veterinarian for the right choice of drug required for the treatment of diseases. However, it is part of common practice in livestock management that livestock farmers tend to use antibiotics indiscriminately at sub-therapeutic levels to prevent animal infections (Barton, 2001). Similarly, antibiotics do have instructions for use and withdrawal period for meat, egg or milk. It is vital to stress that the loss especially when animal products like milk or egg is involved will not permit farmers to adhere to withdrawal times therefore account for antibiotic residues animal-derived products (Okocha *et al*., 2018). Based on the manufacturer, farmers will have ensured the complete degradation of antibiotics in the animal body before withdrawal period is allowed. This could enhance safety and wholesomeness of the animal products (McEwen and Fedorka-Cray, 2002). So, it is crucial to educate the farmers on the danger of antibiotic usage and government constant support for farmers. Adequate information through antibiotic usage and uses of logbook by the farmers to record antibiotic usage will help in monitoring possibility antibiotic resistance (Silley *et al*., 2012).

Bioaccumulation of Antibiotics and Antibiotic-Resistant Bacterial Metabolites by Animals.

Basically, the presence of drug deposit in the food of animal origin is directly similar to the intensity of the appraisal of use, control and residue of antibiotics (Kabir *et al*., 2004). Also, when animal and/or animal products like eggs are collected within the unsafe period for withdrawal either for eat or any other products, there is tendency for drugs deposit in the body of livestock and produce (Anadón *et al*., 1994) obtain from such animal. This antibiotic deposit is generally called residues which are sometimes found to be undegraded in the animal body and later consumed by human being. The unmetabolized antibiotics in the animal tissue and animal products (e.g egg, milk) have been claimed to responsible for the cause of several health-related complications in humans (Okocha *et al*., 2018). The global health implications of this scenario is crucial because a lot of disease conditions in human are defying medical treatment. The prevalence of the antibiotic resistance across the globe is now serious and control is look into human, animal and environment which is being referred to as one health (Lee *et al*., 2001). Antibiotics has been employed indiscriminately as drugs of choice require to treat bacteria associated diseases or as growth promoters for poultry and other animals in several parts of the globe (Darwish *et al*., 2013). Antibiotic residue has been reported in a study where assessment of undegraded antibiotic in the broiler meat was observed to be a consequence of careless use of antibiotic in poultry feed formulation in Bangladesh (Khan *et al*., 2019). The antibiotic depositions have been found in the animal tissues and products from many African countries which includes Egypt, Kenya, Ethiopia, Nigeria, Tanzania, Sudan and Ghana (Darwish *et al*., 2013). In Nigeria, poultry products which are meat and eggs remain valuable sources of animal protein. The required number of poultry farmers across Nigeria to satisfy local demand for animal proteins is on the risen side.

Fluoroquinolone class of the antibiotics is one of the most used antibiotics in some farms engaging in poultry activity (Kabir *et al*., 2004; Persoons *et al*., 2012) and several works have shown that products from poultry possess deposit of antibiotics (Ezenduka *et al*., 2011). Fluoroquinolones, tetracyclines and beta-lactam antibiotics which happened to be mostly used in the bacterial disease treatment in animal husbandry in Northern (Kabir *et al*., 2004) and Southwestern part of Nigeria (Adesokan *et al*., 2015). According to a particular study in Egypt about the occurrence of tetracycline deposits in the fresh chicken samples mainly meat and liver, it was observed that there were tetracycline residues in some of the fresh chicken samples (Salama *et al*., 2011). In many developing and under-developed countries of the world like Nigeria, there are poor monitoring programs to ascertain drug residue at the point of animal slaughtering therefore there is little or no data on antibiotic residues from animal flesh and related products. (Cannavan and Elliott, 2004). Some of the techniques such as Enzyme-Linked immunosorbent Assay (ELISA) and Chromatography methods (e.g gas, liquid and paper chromatography) are not available in most our research institutes (Nisha, 2008). This constraint along with poor data set and lack of surveillance for drug residues constitute limiting factors to combat indiscriminate antibiotic use for livestock by the farmers in the developing and under-developed countries. The climax of the issue is the lack of legislation and enforcement on the acceptable limits antibiotic residues in the animal meat and other products (Kabir *et al*., 2004).

Antimicrobial Use (AMU) and Monitoring

There has been a copious effort to get a updated and coherent data on global AMU in animal feed and health management. There have been efforts to assemble AMU data from OIE member countries yearly since 2015. Moreover, standards to monitor AMU and investigate AMR in livestock management has been developed by OIE (OIE, 2019). European Union in 2006 has suggested a regulatory factors towards the AMU and some of the factors includes the suspension of sub-therapeutic antimicrobials use as growth promoters, improved biosecurity, vaccinations, adequate disease diagnosis etc. This measure has resulted into 20% reduction in the consumption of antimicrobial between 2011 and 2016 (WHO, 2020). Data from United States of America in 2017 revealed 33% drop in antibiotic sales when restriction was placed on the use of antimicrobials as growth promoters. Also, the antibiotics use was only allowed under adequate monitoring by a veterinarian (FAO, 2018). In the same manner, LMICs like Indonesia, Bangladesh, Thailand and India have clear cut rules and regulations on the ban of antibiotic as growth promoters (FAO, 2018), however, the issue of enforcement of the policies remains a serious task. Similarly, there are no data on the impact this ban economically in the context of livestock production in the LMICs. This data could have served as supporting tool for the livestock farmers as the economic goal of any investor is to make gain even though third sustainable goal is good health and wellness. Additionally, the gap created when ban is placed on sub-therapeutic antibiotic use is that there should be sustainable, dependable cost-efficient alternatives for maintenance of animal growth and good health (Van Boeckel *et al.,* 2017). Some studies have recommended increased biosecurity and better herd management as alternatives to antibiotic use either therapeutically without prescription or sub-therapeutically as growth promoters (Tiseo *et al.,* 2020). To corroborate AMR global action plan championed by the Tripartite which are FAO, OIE and WHO, the individual organisation strategizes national action plans to address AMR through surveillance. Global Antimicrobial Resistance Surveillance System under WHO deals with AMR data collection while addressing AMR in human, investigated bacteria indicator and their resistance patterns to estimate the global burden of AMR (WHO, 2020). Conversely, this kind of global system does not occur in the observation of antibiotic resistance in animals across Africa countries and Asia.

In Europe, there are available data on AMR in zoonosis and bacteria indicators from meat and other products from animal origin which are sampled annually for investigation by countries with emphasis on the species of animal and age range. Reports from 2017 – 2018 revealed some promising trends in food from animal sources which includes: lower prevalence of *Escherichia coli* with extended spectrum beta-lactamase (ESBL)-/AmpC genes; marked increase in the percentage of fully susceptible *E. coli* with average 25% among selected member states of the Europe; resistance to colistin was rare; however, carbapenemaseproducing *E. coli* has not yet been reported in poultry (ESAF, 2020). In North America, the same observation of AMR in animals has been reported however, in LMICs, only few of the member countries (10%) reported monitoring AMR in animals (WHO, 2020) therefore limiting the standard of the food from animal sources from these countries. From the limited availability data on AMR in LMICs, Van Boekel *et al*. (2017) presented point prevalence evaluations of AMR in animals and animal related food products placing details on four bacterial species which are *Campylobacter* spp., *E. coli, Staphylococcus aureus* and non-typhoidal *Salmonella* spp. between 2000 and 2018. Other major findings from this report were geographic difference according to the number of studies carried out with fewer research in Africa compared to Asia countries; overall prevalence in AMR rates over certain period from varieties of livestock commodities; and lastly variation geographic locations influenced AMR rates and resistance patterns which appeared to be connected to the regional antimicrobial use patterns.

Antimicrobial Resistance Impact

The effects of AMR on well-being of the animal have been receiving far less attention compared to that of human wellness. Like in humans, antibiotic resistance in animals will result into persistent infections that would not have occurred under normal circumstances, increased rate of treatment frustrations, and heightened infections severity (Sara *et al.,* 2024). This consequence of AMR will adversely affect animal health and wellness and will responsible for economic losses to the livestock farmers either increasing mortality rate directly or reducing production and poor growth condition indirectly. Infections by antibiotic resistant organisms have been reported to responsible for the reduction in feed conversion during digestion, and untimely culling of breeding but poorly producing animals when production has become unsatisfactory. The overall effects of this AMR menace in the animal husbandry sector may lead to high price of the animal products that are obtain from animal production by the consumer (Sirwan *et al.,* 2024).

Food and food products from animal sources are traded worldwide and thus, resistant bacteria are selected based on antimicrobial usage in a particular country which may cause challenges in other countries where the food or its products sold. This trade link through food and food products from animal sources may cause pandemic of AMR strains. There has been the report of the spread of *E. coli* resistance to cephalosporin from broiler parent stock where it was found in the broiler meat (Tang *et al.,* 2017). Livestock output, trade and production are seriously vulnerable to the effect of AMR due to AMU/AMR. In the 2017, livestock production will go down from 8% to 3% each year globally due to AMR according to World Bank leading serious effect by 2050. The AMR impact on livestock production will leads to approximately 11% loss by the farmers in low-income countries by 2050 (WHO, 2020). System of animal husbandry which are small and medium scale in nature are commonly found in LMICs, where livestock are usually found to be frequently in close contact with humans without establishing adequate biosecurity which place farmers at high risk of contracting AMR strains from livestock (Tang *et al.,* 2017). Inability to combat AMR is due to poor methods of AMR surveillance and less/unenforced regulation of antimicrobial use which further exacerbate the negative effect of AMR in these countries (Tang *et al.,* 2017).

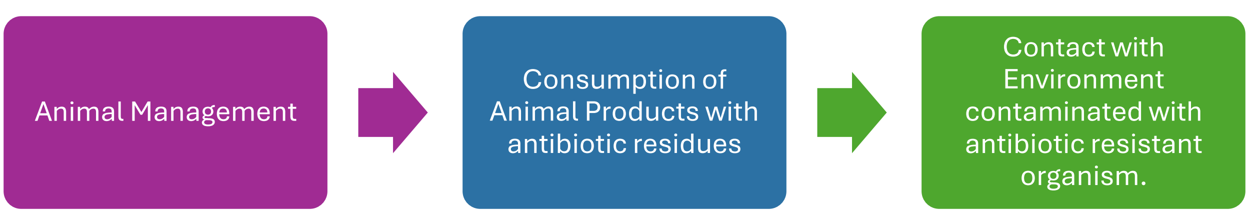

Fig. 1: The flow of Antibiotic Resistant Organisms in the Ecosystem.

Effects of antimicrobial resistance from One Health perspective

There are scientific evidences on the infections with antibiotic resistant pathogens affecting humans due to AMU in animal husbandry management (Hoelzer *et al.,* 2017). It fundamental to mention that contact with farm animals colonized with antibiotic resistant organisms, or ingesting animal food that contain antibiotic residue may stimulate infection by AMR organisms in human (Catry *et al.,* 2010, Tang *et al.,* 2017) (Fig. 1). Similarly, antibiotic resistant organisms found in thses animals can also spread into the environment through animal waste by excreting unmetabolised antibiotic product. This animal waste can also be converted to manure as fertilisers for crop production which also leads to the flow of antibiotic residues in the plants (Rushton, 2015). Antimicrobial resistance has been found to be increasingly contributing to serious health threat account for the difficulty in attaining the first three Sustainable Development Goals (Wu, 2019). This difficulty also attributed to the widening of the inequity gap within and between countries.

Conclusion

The need for antibiotics in the management of livestock is vital however antibiotic consumption by farm animals has to be minimised by concentrating on improving the general farm animal management and promptly applying good hygiene as a key to disease prevention in animal care. This is possible by increasing the level of hygiene in the livestock management. These applications have been carefully demonstrated in developed countries where use of antibiotics for growth promotion or as prophylaxis were phased out many decades ago. In the developing and under-developing countries, phasing out AMU must be done carefully while placing appropriate animal management measures to ensure good animal health and adequate growth. Some measures could be incorporated into animal husbandry to ensure healthy animal care and these measures can be summarized as follows; The firstly measure is the adequate animal husbandry practices which includes sufficient access to quality and safe water, nutritious and healthy feed, appropriate and well-ventilated housing, good hygiene practices by the farmers etc., The second measure is the sufficient and efficient biosecurity which will protect the animals from any kind of infections. Some of the biosecurity practice includes proper isolation of infected animals, minimizing humans entering into the farm-houses (which is external biosecurity) and restrictions of long stay of animals and personnel (which is internal biosecurity). The third measure is the involvement of relevant vaccination schemes into farm animal management against specific infectious diseases.

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Conflict of Interest

All the authors declare that there was no conflict of interest as regards the list and arrangement of the authors.

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Data Availability

All references were obtained from open-access journals and conference proceedings, so data can be assessed from the literature online.

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