FMLD
FEDERAL MINISTRY OF LIVESTOCK DEVELOPMENT

FEDERAL MINISTRY OF LIVESTOCK DEVELOPMENT (FMLD)

NATIONAL ANTIMICROBIAL STEWARDSHIP

STRATEGY AND GUIDELINES IN ANIMAL HEALTH

November 2024

National Antimicrobial Stewardship Strategy and Guidelines in Animal Health
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About the Ministry

The Federal Ministry of Livestock Development (FMLD) was established on July 9, 2024, by President Bola Ahmed Tinubu to transform Nigeria's livestock sector into a sustainable and globally competitive industry. With a mandate to enhance livestock productivity, ensure food security, and drive economic growth, the Ministry is committed to addressing key challenges such as poor infrastructure and conflicts between farmers and herders. FMLD is structured into 17 departments, focusing on areas like livestock breeding, ranch development, pest control, and veterinary public health. Through strategic policies, research, and private-sector engagement, the Ministry aims to modernize livestock farming, create jobs, and boost Nigeria's economy.

Our Mandate

According to a circular issued by the Secretary to the Government of the Federation (SGF), Sen. George Akume, CON, on September 12, 2024, with Ref. No. SGF/OP//S3/X11/218, the Ministry is mandated to "develop the policies and programmes needed to transform the livestock sector into a vibrant, sustainable, as well as globally competitive industry, ensuring food security, economic growth, improved livelihoods for farmers, and maintenance of social harmony."

Our Vision

To build a resilient, sustainable, and inclusive livestock sector that drives economic growth, ensures food security, and improves livelihoods.

Our Structure

The Federal Ministry of Livestock Development is responsible for formulating and implementing policies to enhance livestock productivity, sustainability, and economic growth. The Ministry operates through 13 specialized departments, including seven (7) technical departments and six (6) common services departments, alongside a Special Duties Office, three (3) units, and seven (7) parastatals/agencies.

I. **Ruminants and Monogastric Department:** The Department functions in the formation and implementation of policy that enhances the productivity and sustainability of dairy, beef, sheep, cattle, goats, pig, poultry, and other micro livestock sectors. It focuses on improving breeding, managing, practicing, processing, and marketing livestock products for economic growth.

II. **Ranch and Pastoral Resources Development:** The Department formulates and implements policies for the development and sustainable management of grazing reserves, ranches, and stock routes. It also develops strategies to promote efficient land use within grazing reserves, improving livestock productivity and reducing conflicts between farmers and pastoralists.

III. **Pest Control Services:** This Department formulates and implements policies for preventing and controlling transboundary pests and vectors of economic and public health importance. It is also responsible for sensitization, advocacy, and monitoring of pesticides used in livestock production.

IV. **Quality Assurance & Certification:** The Department initiates policy direction on safety guidelines for livestock products to protect animal and public health. It also issues International Veterinary Certificates (export and import permits) in compliance with the World Organization for Animal Health (WOAH).

V. **Veterinary Public Health and Epidemiology:** This Department formulates policies and regulations on veterinary public health, ensuring good hygienic animal processing practices and safe delivery of animal products to consumers. It aims to protect public health from animal-borne diseases.

VI. **Livestock Extension & Business Development:** This Department develops policies and strategies to promote livestock extension services and business development for farmers, contributing to national food security and economic growth.

VII. **Human Resources Management:** Responsible for providing administrative guidelines to maximize productivity by optimizing employee effectiveness. It handles recruitment, training, staff performance evaluation, workplace culture, dispute resolution, and wellness programs.

VIII. **Planning, Research & Statistics:** This Department oversees corporate and strategic planning, research activities, and statistical data collection. It supports livestock sector development through research on new technologies and breeding processes.

IX. **Finance & Accounts:** Responsible for financial planning, budgeting, and fund management. It ensures financial stability, transparency, and fraud prevention while supporting management in financial decision-making.

X. **General Services:** Manages the Ministry's facilities, transportation, logistics, and workplace safety, ensuring smooth operational services.

XI. **Procurement:** Oversees negotiation, purchasing, and stock management of goods and services. It ensures quality, cost efficiency, and adherence to legal and ethical procurement standards.

XII. **Special Duties Office:** Handles urgent issues, unforeseen situations, and strategic tasks requiring special attention. It also manages special projects and acts as a bridge between departments.

XIII. **Reform Coordination & Innovation Service:** Drives policy reforms and innovative initiatives, ensuring continuous improvement, modernization, and efficiency within the Ministry.

XIV. **Press and Public Relations Unit:** Disseminates accurate information about government policies and programs related to the livestock sector. It handles media relations, press releases, social media engagement, and public awareness campaigns.

XV. **Internal Audit:** Ensures accountability, financial discipline, and compliance with regulations by identifying risks, detecting irregularities, and recommending corrective actions to safeguard public funds.

XVI. **Legal Unit:** Provides expert legal guidance, ensuring all Ministry activities align with national laws. It advises on contracts, agreements, and legislation affecting the livestock sector while ensuring regulatory compliance.

Our Function

The core responsibilities of the Ministry include the following:

i. Facilitate the expeditious resolution of farmers/herders conflicts.

ii. Increase the productivity and resilience of livestock systems to ensure long-term sustainability.

iii. Improve animal health systems to minimize the impact of livestock diseases on productivity and public health.

iv. Promote climate-smart livestock production to enhance sustainability in the face of

climate change.

v. Encourage innovation, technology adoption, and entrepreneurship among livestock value chain actors.

vi. Create enabling conditions and incentives to attract private-sector investments across the livestock value chain.

vii. Enhance market access and value addition through strategic marketing initiatives, infrastructure development, and compliance with global standards.

viii. Provide incentives for youth and women participation in the livestock sector as a means of job creation, improved livelihoods, and wealth generation.

FOREWORD

Antimicrobial resistance (AMR) continues to be a pressing global health concern, threatening both human and animal health. The inappropriate and excessive use of antimicrobials in the animal health sector contributes significantly to the emergence and spread of resistant pathogens. Addressing this challenge requires a well-structured antimicrobial stewardship (AMS) framework that promotes the responsible use of antimicrobials while safeguarding public health, animal welfare, and ensuring environmental sustainability.

The **National Antimicrobial Stewardship Strategy and Guidelines in Animal Health** has been developed to provide a clear roadmap to develop antimicrobial stewardship programs in Nigeria's animal health sector. This document aligns with the **One Health** approach and serves as a comprehensive guide for veterinarians, livestock farmers, policymakers, and regulatory agencies on best practices for antimicrobial use.

Through this strategy, Nigeria reaffirms its commitment to combatting AMR by strengthening regulatory frameworks, enhancing veterinary oversight, promoting responsible antimicrobial use, and improving infection prevention measures. This initiative complements ongoing national and international efforts to address AMR and supports the implementation of the **National Action Plan on Antimicrobial Resistance (NAP 2.0)**.

We urge all stakeholders to embrace and implement this stewardship strategy diligently. By fostering responsible antimicrobial use and enhancing collaboration across sectors, we can mitigate the threat of AMR, improve animal health outcomes, strengthen one-health and contribute to global health security.

Alh. Idi Mukhtar Maiha
Honourable Minister of Livestock Development

ACKNOWLEDGEMENT

The **National Antimicrobial Stewardship Strategy and Guidelines in Animal Health** was developed through a collaborative effort of dedicated experts, policymakers, partners, and key stakeholders from the One-health sectors, leveraging on the experience and strides from the existing AMS programs in the human health sector and international best practices.

Aptly, we acknowledge the leadership and teams of the **Federal Ministry of Agriculture and Food Security, Federal Ministry of Livestock Development; Federal Ministry of Environment;** the **Federal Ministry of Health and Social Welfare,** and the **National AMR Coordinating Committee (AMRCC) domiciled in the Nigeria Centre for Disease Control and Prevention (NCDC)**, for their commitment to advancing AMS in the animal health sector.

Importantly, we appreciate the team at **Management Sciences for Health (MSH)**, who as country grantee for the **UKAID's Fleming fund Phase II grant**, supported the entire process from drafting to completion of the strategy.

We also appreciate the **Food and Agriculture Organization (FAO),** and other development partners, including the **World Health Organization (WHO), World Organisation for Animal Health (WOAH), and the United Nations Environment Programme (UNEP)**, for their technical support.

We acknowledge the expertise and input of the team of consultants and subsequent expert reviewers from research institutions and the academia for making quality contribution and improvements to the strategy. The valuable insights provided by **academic institutions, veterinary professionals, livestock farmers, private sector partners, and civil society organizations** have ensured that this strategy is both practical and effective in promoting responsible antimicrobial use.

Furthermore, we are thankful to the members of the **Veterinary Council of Nigeria (VCN), Nigerian Veterinary Medical Association (NVMA), and National Veterinary Research Institute (NVRI),** for their technical guidance and commitment to improving antimicrobial stewardship across Nigeria's animal health sector.

Finally, we appreciate the hard work and dedication of CVON's AMR team and all other individuals and organizations involved in this process. The successful implementation of this strategy will be key in reducing AMR risks, improving animal health systems, and ensuring sustainable agricultural practices in Nigeria.

Dr. Samuel Akawu Anzaku
Director/Chief Veterinary Officer, Veterinary Public Health and Epidemiology

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ABBREVIATIONS

AGF: Attorney General of the Federation

AMC: Antimicrobial Consumption

AMR: Antimicrobial Resistance

AMRCC: Antimicrobial Resistance Coordinating Committee

AMS: Antimicrobial stewardship

AMU: Antimicrobial Usage

ARB: Antimicrobial-Resistant Bacteria

ARCN: Agricultural Research Council of Nigeria

ASP: Antimicrobial Stewardship Programmes

AST: Antimicrobial Sensitivity Test

ATC: Anatomic Therapeutic Chemical

AU-IBAR: African Union-Inter-African Bureau for Animal Resources

AWaRe: Access, Watch, Reserve

CDC: Center for Disease Control and Prevention

CDSS: Clinical Decision Support System

DDD: Defined Daily Dose

DVS: Director of Veterinary Services

ECOWA: Economic Community of West African States

EVML: Essential Veterinary Medicines List

FAO: Food and Agriculture Organization

FIPAN: Feed Industry Professional Association of Nigeria

FMAFS: Federal Ministry of Agriculture & Food Security

FMARD-FDVPCS: Federal Ministry of Agriculture and Rural Development-Federal Department of Veterinary and Pest Control Services

FMOH: Federal Ministry of Health

FMLD: Federal Ministry of Livestock Development

EHR: Electronic Health Records

IEC: Information, Education and Communication

IPC: Infection, Prevention and Control

KPIs: Key Performance Indicators

LGA: Local Government Area

MACBAN: Miyetti Allah Cattle Breeders Association of Nigeria

MAN: Manufacturers Association of Nigeria

MSH: Management Sciences for Health

NAAT: National Association of Academic Technologist

NAAHHT: National Association of Animal Health and Husbandry Technologists

NADIS: National Animal Disease Information System

NAFDAC: National Agency for Food and Drug Administration and Control

NAMR-TWG: National AMR Technical Working Group

NAP: National Action Plan

NAPRI: National Animal Production Research Institute

NAQS: Nigeria Agricultural Quarantine Service

NCDC: Nigeria Centre for Disease Control and Prevention

NGO: Non-governmental Organization

NIOMR: Nigerian Institute for Oceanography and Marine Research

NITR: Nigerian Institute of Trypansomiasis Research

NOHSC: National One Health Steering Committee

NUC: National Universities Commission

NVMA: Nigerian Veterinary Medical Association

NVRI: National Veterinary Research Institute

PAN: Poultry Association of Nigeria

SAVAN: Small Animal Veterinary Association of Nigeria (

SOP: Standard Operating Procedures

TOR: Terms of Reference

TWG: Technical Working Group (National AMR)

UKAID: The United Kingdom Department for International Development

UTI Urinary Tract Infection

VCN: Veterinary Council of Nigeria

VCN CE Veterinary Council of Nigeria Continuing Education

VMP: Veterinary Medicinal Products

VTH: Veterinary Teaching Hospital

WASH: Water, Sanitation and Hygiene

EML: Essential Medicines List

WHO: World Health Organization

WOAH: World Organization for Animal Health

1. INTRODUCTION

Antimicrobials include antibiotics, antivirals, antifungals and antiparasitic agents that prevent and treat infections in humans, animals and plants. Access to high-quality and affordable antimicrobials to combat infectious diseases is a challenge in many settings affecting the quality of animal health care. On the other hand, inappropriate use of antimicrobial agents across human, animal and environmental sectors is among the main drivers of antimicrobial resistance (AMR) (1). AMR occurs when bacteria, viruses, fungi and parasites change over time and no longer respond to medicines, making infections harder to treat and increasing the risk of disease spread, severe illness and death. AMR also makes lifesaving medical procedures riskier to perform and has a broader societal and economic impact. Tackling AMR requires a comprehensive set of interventions. Simple measures to prevent infections such as vaccinations, promoting good animal husbandry practices and biosecurity in animal healthcare facilities will reduce the risk of death and decrease the health burden of AMR by half (2). Optimizing the use of antimicrobials across human, animal, and plant health is a cornerstone of the Global Action Plan for Antimicrobial Resistance (2). Similarly, integrated delivery of policies that promote hospital hygiene, antimicrobial stewardship (AMS), and the use of diagnostic tests to differentiate bacterial versus. viral infections and mass media campaigns could significantly reduce the burden of drug-resistant infections.

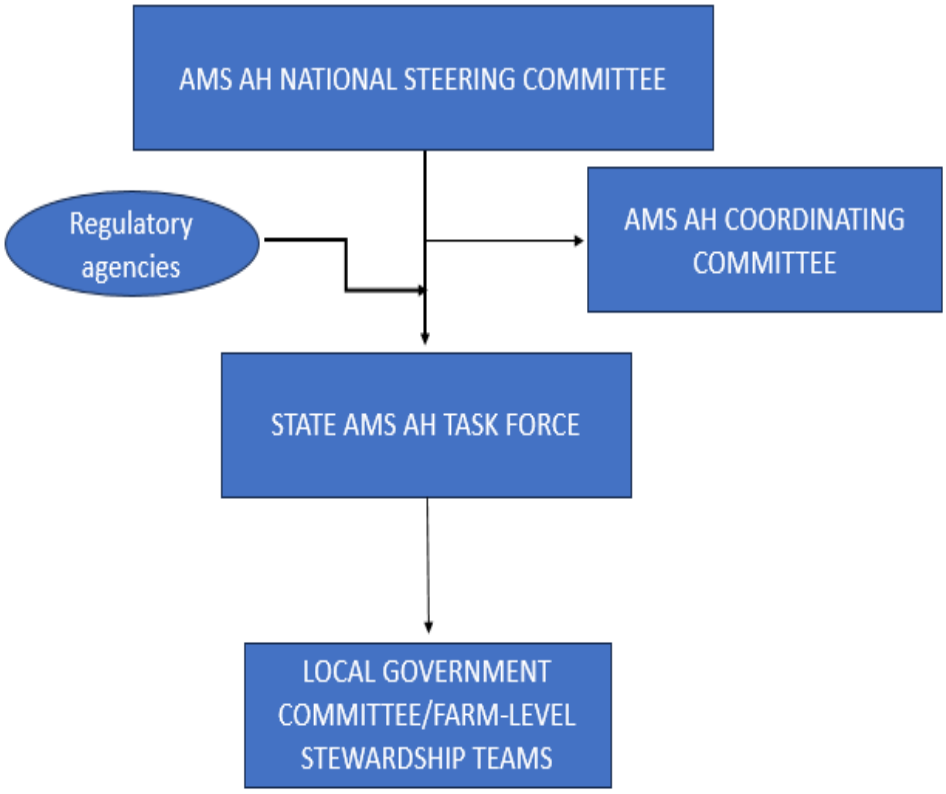
The World Health Organization (WHO) defines AMS as a coherent set of integrated actions that promote the responsible and appropriate use of antimicrobials to help improve patient outcomes across the continuum of care. Responsible and appropriate use of antimicrobials includes prescribing only when needed, selection of the optimal drug regimen, drug dosing, route of administration and duration of treatment following proper and optimized diagnosis. In veterinary medicine, antimicrobial stewardship refers to the series of actions veterinarians, veterinary paraprofessionals and livestock, poultry, aquaculture farmers as well as wildlife, small and companion animal owners take individually and as professionals to preserve the effectiveness and availability of antimicrobials through conscientious oversight and responsible medical decision-making while safeguarding animal, public, and environmental health. Veterinary and human medicine share the responsibility of preserving the efficacy of antimicrobials and preventing the spread of antimicrobial resistance (AMR). To a large extent, the classes of antimicrobial drugs that are used in animals are the same as those in human settings and resistant bacteria can be transferred between animals, the environment and humans through different routes of transmission (3-6) This renders AMR a One Health issue requiring multi-sectoral collaborations (6-8).

The animal health (AH) sector is highly heterogeneous and complex. Veterinarians can work in private or public sectors. They deal with different animal species including companion animals, food-producing animals, and wildlife. In the AH sector antimicrobials are used for various purposes, including treatment, metaphylaxis (administration of a drug to a group of clinically healthy animals in contact with diseased animals) (9), disease prevention and growth promotion for individual animals or groups of animals (9-11). Access to antimicrobials also differs greatly between countries (12-14) and is sometimes readily available without any prescription to farmers or pet owners (15-17) leading to further difficulties in controlling antimicrobial usage (AMU). Antimicrobial stewardship is captured as one of the pillars of Nigeria's One Health National Action Plan (NAP 2.0) on Antimicrobial Resistance. However, there is no policy document(s) on antimicrobial stewardship in the animal health sector at all levels of the governance structure (Federal, States and Local Government Areas). Hence, there is an urgent need to develop an Antimicrobial Stewardship strategy and guidelines for Nigeria's AH sector to improve the health of animals, enhance livestock production, as well as safeguard the health of the public, and improve the environment.

2. INSTITUTIONS AND ANTIMICROBIAL RESISTANCE GOVERNANCE STRUCTURE IN NIGERIA

The Nigeria National AMR Coordinating Body was established in 2016 and is domiciled at the Nigeria Centre for Disease Control (NCDC). After this, a National AMR Technical Working Group(TWG) was formed comprising stakeholders from human health, animal health, and environmental sectors. A situation analysis of AMR was conducted by this working group. This led to the development of the first National Action Plan (NAP) for Antimicrobial Resistance (2017-2022). The AMR governance structure in Nigeria is based on the One Health approach and comprises the National One Health Steering Committee (NOHSC), National One Health Technical Committee (NOHTC), Antimicrobial Resistance Coordinating Committee (AMRCC) and National AMR Technical Working Group (NAMR-TWG). Their mandate is focused on five strategic areas (Awareness and Education, Surveillance, Stewardship, Infection Prevention and Control/Biosecurity, and Research). The coordinating centre is at the NCDC. The NOHSC is the highest policy and governance body responsible for all activities related to One Health and AMR in Nigeria. The purpose of the AMRCC is to guide, oversee, and monitor AMR-related activities in all sectors to ensure a systematic and comprehensive implementation (National Antimicrobial Stewardship Plan for Nigeria (2022-2026).

3. THE AMS GOVERNANCE STRUCTURE



The governance structure for antimicrobial stewardship (AMS) in Animal Health involves a multi-tiered approach that integrates various stakeholders, including veterinary professionals, farmers, regulatory bodies, and public health officials. Below is an overview of the governance structure for AMS AH:

ANTIMICROBIAL STEWARDSHIP GOVERNANCE STRUCTURE

i. **National Level**

- **Regulatory Authority**
    - Oversees the implementation of AMS policies and regulations.
    - Sets guidelines for antimicrobial use in livestock sector.
- **National AMS Committee**
    - Composed of representatives from veterinary Department, Animal health sector, public health, environmental health,

Veterinary Medical laboratory, law enforcement agencies, Veterinary Council of Nigeria, Nigerian Veterinary Medical Association (NVMA), Veterinary Teaching Hospitals, Federal Veterinary Medical Centre and academia.

- Responsible for developing national strategies, monitoring compliance, and promoting research.

ii. **State Level**

- **State AMS Task Force**
    - Tailored to local livestock practices and public health needs.
    - Works on education, outreach, and implementation of AMS programs at the State level.
- **Veterinary and Animal Health Agencies**

  The team shall comprise of representatives from the State Veterinary Services, private veterinarians, NVMA State chapter, Animal Health and Husbandry Technologists, Collages of Agriculture, Colleges of Animal health and production technology, public health officers and law enforcement agencies
    - Provide support and resources for farmers and veterinarians.
    - Facilitate training and workshops on best practices for antimicrobial use.
    - Ensure compliance with guidelines and standards

iii. **Local Government Level**

- **Veterinary Practices**
    - Implement AMS protocols in clinical settings.
    - Educate clients (farmers and pet owners) on responsible antimicrobial use.
- **Farm-Level Stewardship Teams and champions**
    - Composed of farm managers, public and private veterinarians, community based animal health workers, public health officers, community leaders and law enforcement agencies
    - Develop and enforce AMS plans tailored to specific operations.

4. THE ANIMAL HEALTH SECTOR IN NIGERIA

In Nigeria, the animal health sector consists of the following :

Livestock and Poultry Farms – may be classified as subsistence, small, medium, and large farms based on the number of animals in the farm. Herders or traditional pastoralists are included in this group. They may be classified as high-risk areas characterized by unrestricted and indiscriminate use of antimicrobials with/without prescription, even as they move from one place to another. Also, use of animal dungs-containing antimicrobials, as manure could contaminate vegetables and may be a source of public health worry and environmental contamination.

Aquaculture (fish farms across the country) – small, medium, and large sizes – high risk of unrestricted and indiscriminate use of antimicrobials and a major source of environmental contamination as they dispose of the antimicrobial-contaminated water from the ponds.

Feed mills - of various sizes are located in the rural areas and townships. They are also a high-risk areas because they incorporate antimicrobials in the feed as feed additives and growth promoters.

Private Veterinary Clinics/Hospitals/Laboratories of various sizes in rural areas and townships are owned by veterinarians who use antimicrobial agents with or without proper prescription and stipulated guidelines.

Public Veterinary Clinics and Hospitals in the states and Local Government Areas.

Research Institutes – National Veterinary Research Institute (NVRI), Vom, National Animal Production Research Institute (NAPRI), Zaria, Nigerian Institute for Trypanosomiasis Research (NITR).

Veterinary Pharmacy and drug stores.

Slaughterhouses and slabs - across the country are associated with poor management of animal wastes laden with antimicrobial residues, which may have a negative environmental impact.

Veterinary Teaching Hospitals (VTHs) in Veterinary Faculties/Colleges in Universities across the country, where antimicrobials are prescribed and administered for the clinical management of animal diseases.

5. PURPOSES

To develop policy guidance on the National AMS generic document for the Animal Health sector to include AMS activities and implementation in an integrated and programmatic approach.

This policy guidance is anchored on the stakeholders in the animal health sector in Nigeria. It aims to provide a set of evidence-based and pragmatic recommendations to drive comprehensive and integrated AMS activities under the purview of a central national coordination unit, National AMR steering or coordinating committees, and the AMS Sub TWG. The document will complement the Global Action Plan, the WHO practical toolkit for AMS programmes in animal health care in Nigeria, using WHO Policy Guidelines on Integrated Antimicrobial Stewardship Activities, International and National Policy Documents and published works on AMS.

6. SCOPE

The scope of antimicrobial stewardship (AMS) in Nigeria's animal health sector is broad and intricate, shaped by the diversity of animal species—ranging from companion animals (horses, cats, dogs) to food-producing animals (Ruminant, swine, poultry, fish) and wildlife. This diversity necessitates AMS strategies that consider the unique needs and practices associated with each animal group. AMS implementation in Nigeria spans multiple settings, from local, rural communities, states, federal and even multinational platforms, integrating efforts across diverse livestock production systems and geographical locations. Such a wide-reaching approach requires alignment with international guidelines while adapting to local contexts to effectively tackle antimicrobial resistance (AMR).

A significant challenge within this scope is the unregulated access to antimicrobials. In parts of Nigeria, antimicrobial agents, including those used in human medicine, are readily accessible without prescriptions, leading to abuse and misuse among livestock, poultry and aquaculture farmers as well as companion animal owners. This widespread and unregulated use of antimicrobials increases the risk of resistance development, undermining both animal and public health efforts. Another critical issue is the environmental impact of antimicrobial misuse, particularly in slaughterhouses, slaughter slabs, live bird and livestock markets. These facilities often lack proper waste management systems, resulting in the discharge of untreated wastes containing resistant microorganisms and residual antimicrobials. This improper disposal contaminates the environment and contributes to the spread of AMR, as resistant genes can be transferred to other bacteria in the environment, exacerbating the problem.

Overall, the AMS scope in Nigeria involves a multifaceted approach that addresses species diversity, varied access to antimicrobials, and environmental impacts, aiming to reduce antimicrobial misuse, enhance monitoring, and promote responsible antimicrobial use across all animal health sectors. Effective

implementation requires robust regulatory frameworks, stakeholder engagement, and continuous capacity-building to align with global AMR control strategies.

7. TARGET AUDIENCE

The primary target audiences of this guidance are National policy-makers at the Federal Ministry of Agriculture and Food Security (FMAFS), Veterinary Council of Nigeria (VCN), National AMR coordinating bodies such as national AMR steering or coordinating committees in NCDC. National Agency for Food and Drug Administration and Control (NAFDAC), National Veterinary Research Institute (NVRI), Environmental Agencies, State Ministries in charge of Animal Health , Universities, Veterinary Teaching Hospitals (VTHs) public and private veterinary clinics and hospitals, feed millers and crop farmers and other Agro-allied businesses. The following category of stakeholders are involved: Veterinarians, Veterinary Laboratory technologists, Animal Health Technologists , public health officers, feed millers, environmentalists, Federal Ministry of Livestock Development (FMLD), Community Animal Health workers.

8. PRINCIPLES OF INTEGRATED AMS ACTIVITIES

The policy promotes an integrated approach to preserve antimicrobials. It seeks synergy and efficiency for the implementation of comprehensive interventions across essential areas of the animal health sector at all levels.

The following are the guiding principles:

- Give due considerations to the national and local context and the structure of the animal health system in carrying out AMS activities.
- Focus on prioritizing implementation of activities that are likely to provide the greatest benefits based on national and facility needs assessment.
- Strengthen and use existing Federal, State and Local Government platforms and coordinating mechanisms and resources to implement integrated AMS activities.
- Ensure strong and effective linkages and synergies between the relevant organisations, disciplines and stakeholders such as the Department of Veterinary and Pest Control Services , National Veterinary Research Institute, Universities offering Veterinary Medicine, Veterinary Teaching Hospitals, designated National Laboratories (NVRI, Animal Health AMR surveillance Sentinel laboratories), Veterinary Council of Nigeria (VCN), Medical and Dental Council of Nigeria (MDCN), National Agency of Food and Drug Administration and Control (NAFDAC), Agriculture Research Council of Nigeria (ARCN),

Nigerian Institute of Animal Science (NIAS), Federal Ministry of Environment, Nigerian Institute for Trypanosomiasis Research (NITR) etc.

9. SITUATIONAL AND SWOT ANALYSES OF ANTIMICROBIAL STEWARDSHIP IN ANIMAL HEALTH IN NIGERIA

Antimicrobial agents play significant roles in the animal health sector as they are used for the treatment of infectious diseases and ensure animal welfare. However, antimicrobial use (AMU) and misuse in both human and animal settings have contributed to the emergence and spread of antimicrobial-resistant (AMR) pathogens (18). The world is currently grappling with a formidable challenge, known as antimicrobial resistance (AMR), which threatens the effectiveness of antimicrobials and poses an escalating threat to public health worldwide (19). Unfortunately, AMR has already taken a considerable toll, with an estimated 1.27 million human fatalities attributed to it in 2019 (20). More disturbing are projections indicating that by 2050, the annual death toll due to AMR may surge to a staggering 10 million and AMR is expected to cost the world $100 trillion in lost revenue if immediate and concerted global precautionary measures are not taken (21). With this in mind, it is important to acknowledge that the burden of AMR-related mortality will be disproportionately borne by low- and-middle-income countries (LMICs) (22). These nations, grappling with a higher prevalence of infectious diseases, continue to confront a substantial share of preventable deaths stemming from infectious diseases (21). Recent estimates show that the western sub-Saharan African region has the highest AMR burden, with 27.3 deaths attributable to AMR per 100,000 overall deaths (23).

Nigeria is number 19 of 204 countries with the highest age-standardised mortality rate per 100,000 population associated with AMR (21). In 2019, there were 64,500 deaths attributable to AMR and 263,400 deaths associated with AMR, making the number of AMR deaths in Nigeria higher than those from enteric infections, respiratory infections and tuberculosis, maternal and neonatal disorders, neglected tropical diseases and malaria, and cardiovascular diseases (21) Furthermore, the study identified five pathogens, along with their associated AMR-related deaths: *Streptococcus pneumoniae* (54,300), *Klebsiella pneumoniae* (44,300), *Escherichia coli* (38,200), *Staphylococcus aureus* (32,300), and Group B *Streptococcus* (16,600). These pathogens are frequently implicated in lower respiratory infections, as well as other infections affecting the thorax, meningitis, bacterial central nervous system infections, bloodstream infections, and peritoneal and intra-abdominal infections (21). Amid the AMR crisis lies the pervasive issue of selective pressure from antimicrobial overuse and misuse, a phenomenon intrinsically intertwined with

the emergence of antimicrobial resistance (24). However, this is likely underestimated considering the gaps that exist in national AMR surveillance. In addition to the impact on mortality, loss of gross domestic product (GDP) attributable to AMR in developing countries like Nigeria has been forecast to reach 5 - 7% by 2050 (23)

In Nigeria, AMU in livestock production and aquaculture, primarily for disease prevention and growth promotion, is a common practice. This practice has raised concerns over the potential spread of antimicrobial-resistant bacteria (ARB) to humans and the environment. To appraise the situation of AMU and AMR in the context of antimicrobial stewardship (AMS) in the animal health sector in Nigeria, data from diverse sources including government documents and reports, peer-reviewed literature and key relevant stakeholder interviews were conducted.

About 89% of veterinarians surveyed in Abuja, Nigeria believed that overuse of antimicrobials was the major contributor toward AMR (19, 25). In the same study, 67.4% of the veterinarians prescribed antimicrobials based on observation and experience; however, 31.3% indicated that they sent samples to the laboratory for microbiological analysis to guide the choice of antimicrobials for therapy. A nationwide study by Adekaye *et al*., (20, 26) revealed that 89 (36.9%) of the 241 veterinarians surveyed have heard of the term "antimicrobial stewardship" and 61 (25.3%) of veterinarians could correctly define it. This proportion of veterinarians with knowledge of AMS is similar to the 21.4% reported for practicing veterinarians in Enugu State, Nigeria (21, 27). These observations are indicative of the poor knowledge of the concept of antimicrobial stewardship among practicing veterinarians in Nigeria. Inappropriate antibiotic practices observed among practicing veterinarians in Enugu State, Nigeria included antibiotic prescription: without the animal being seen or examined, for any suspected infection, broad-spectrum antimicrobials, and concurrent prescription of antimicrobials belonging to different classes or overdosing to ensure therapeutic efficacy (21, 27). Sixty percent of veterinarians and Veterinary paraprofessionals reported that they had recommended antibiotic treatment for suspected viral, helminths, and fungal infections (22, 28). While only 20% of veterinarians indicated that they performed AST before antibiotic administration (ref 3?), 30% (6) and 32% (5) never conducted AST before antibiotic prescription. Despite these inappropriate antibiotic prescribing practices, some veterinarians in other parts of Nigeria indicated that excessive use of antimicrobials in livestock (83.8%) and underdosing (78.8%) were the most important drivers of AMR while 97.5% agreed that unnecessary antibiotic prescription was professionally unethical (20, 26). Veterinarians indicated that the limited availability of laboratory diagnostic services (82.2%) and the inability of animal owners to pay (71.8%) were barriers to AST (20, 26). Limited access to laboratory diagnostic facilities contributes to inappropriate

AMU as it encourages the prescription/administration of broad-spectrum antimicrobials; in some cases the antimicrobials are unnecessary.

Inappropriate use of antimicrobial agents is not limited to veterinarians and veterinary paraprofessionals. Livestock farmers often use antimicrobials not only for therapeutic purposes but also as growth promoters. In Oyo and Plateau States, 98% of poultry farmers were reported to have administered antimicrobials as prophylaxis to day-old chicks (23, 29). Unregulated access to antimicrobial agents is a common practice in Nigeria and this unwholesome practice poses further risks of AMR. Some preparations containing cocktail of up to six different antibiotic classes were used in poultry farms in Oyo and Plateau States (23, 29). A study on antibiotic use among small-scale poultry farmers in Enugu State, Nigeria showed that all the poultry farmers studied used antimicrobials for growth promotion, disease prevention, and treatment (24, 30). The study further revealed that 48 % and 70.5 % of the respondents had good knowledge of AMU and AMR, respectively, while 83 % of them used antimicrobials inappropriately. However, farmers with good knowledge of AMU and AMR were more likely to misuse antimicrobials than those with poor knowledge (24, 30).

The reported antimicrobial agents prescribed or used in the animal sector in Nigeria varied among the regions; however, the most frequently prescribed or used agents belonged to the following classes: tetracycline, penicillin/beta-lactam, aminoglycoside, polypeptide and fluoroquinolone (23, 29,; 25, 31,; 26, 32). Neoceryl^{R}, a commercial broad-spectrum antimicrobials cocktail containing neomycin, erythromycin, oxytetracycline, streptomycin and colistin, was among the antimicrobials commonly used in poultry production in Ogun State, Nigeria (26, 32). Colistin, a polypeptide antimicrobial agent, is a last resort drug for the treatment of infections in humans caused by multi-drug resistant Gram-negative bacteria. The National Agency for Food and Drug Administration and Control (NAFDAC) has prohibited the importation, sale, and use of colistin and colistin sulfate in livestock. Other antimicrobial agents that are banned in Nigeria include chloramphenicol, furazolidone, metronidazole and nitrofuran (27, 33). Despite the ban, these antimicrobial agents are freely imported, distributed, and used in animal health sector in Nigeria indicating inadequate enforcement of existing regulations.

The SWOT analysis of Antimicrobial Stewardship in Animal Health in Nigeria is presented in Table 1.

Table 1: SWOT analysis of Antimicrobial Stewardship in Animal Health in Nigeria

STRENGTHS	**WEAKNESSES**
1. Growing awareness of the importance of antimicrobial stewardship (AMS) among veterinary professionals and the agricultural sector. 2. Strong regulatory support through government guidelines promoting responsible antimicrobial use in animal and aquatic health. 3. Availability of research and educational resources aimed at enhancing antimicrobial use practices. 4. Availability of human resources for AMS activities 5. Effective collaboration between veterinarians, farmers, environmental and public health officials to promote best practices.	1. High cost of diagnostic rapid tests to guide treatment 2. Cultural and traditional practices may resist the adoption of new stewardship protocols 3. Difficulty enforcing AMS practices at the farm level due to varying understanding and resources 4. Financial constraints hinder animal owners and handlers from adopting alternative health management practices that reduce reliance on antimicrobials 5. Poor compliance to drug withdrawal periods 6. Insufficient data on antimicrobial use and resistance in animal health limits informed decision-making
OPPORTUNITIES	**THREATS**
1. Political will to address AMR issues 2. Development and promotion of alternative therapies and management practices can reduce antimicrobial use 3. Increasing adoption of good agricultural practices 4. Enhancement of biosecurity 5. Leveraging technology enhances health monitoring and decision-making 6. Growing consumer demand for responsibly produced products can drive AMS initiatives 7. International collaboration offers opportunities to share AMR strategies and best practices	1. The rise of AMR threatens both animal and human health. 2. Market competition pressures producers to use antimicrobials for productivity. 3. Negative public perception of antimicrobial use in agriculture may lead to stricter regulations. 4. Emerging resistant pathogens can undermine current AMS efforts. 5. Residue of antimicrobials in food producing animal products 6. Unrestricted access to antimicrobials 7. Inaccessibility of some livestock producing areas 8. Infiltration of adulterated drugs across borders 9. Impact of climate change on animal production 10. Undocumented trade of livestock and livestock products

10. STAKEHOLDERS AND STAKESHOLDERS MAPPING

Stakeholders involved in animal Health antimicrobial stewardship in Nigeria include:

A. Ministries, Departments and Agencies (MDAs)

- Federal Ministry of Livestock Development
- Federal Ministry of Agriculture and Food Security (FMAFS)
- Federal Ministry of Health and Social Welfare (FMOHSW)
- National Agency for Food and Drug Administration and Control (NAFDAC)
- Nigeria Agricultural Quarantine Service (NAQS)
- Nigeria Centre for Disease Control and Prevention (NCDC)
- Veterinary Council of Nigeria (VCN)
- State Ministries in charge of Animal Health

B. Professional Bodies and Associations

- Nigerian Veterinary Medical Association (NVMA)
- National Association of Animal Health and Husbandry Technologists (NAAHHT)
- Association of Veterinary and Allied Industry
- Association of poultry Veterinarians in Nigeria
- Association of Equine Veterinarians
- Association of ruminant veterinarians in Nigeria
- Association of Veterinary and Allied industry
- Wildlife Association of Nigeria
- Association of Aquatic Veterinarians of Nigeria
- Small Animal Veterinary Association of Nigeria (SAVAN)
- Poultry Association of Nigeria (PAN)
- Feed Industry Professionals Association of Nigeria(FIPAN)
- Livestock Farmers Association (Miyetti Allah Cattle Breeders Association of Nigeria MACBAN, National Sheep and Goat Association of Nigeria).

C. Aquaculture farmers

- Fish Farmers Association
- National Association of Crayfish and shrimps farmers
- National Fish Association of Nigeria
- Fisheries Society of Nigeria
- Fisheries Cooperative Federation of Nigeria.

D. Academic and Research Institutions

- Universities and and Colleges of Agriculture

- Veterinary Schools
- Veterinary teaching Hospitals (VTHs)
- Research Institutes; (NVRI,NAPRI, NITR, NIOMR)

E. Private Sectors and Industries

- Pharmaceutical Companies
- Veterinary Medicinal and Allied Products Marketers
- Livestock iindustries
- Animal Feed Manufacturers

F. Development Partners

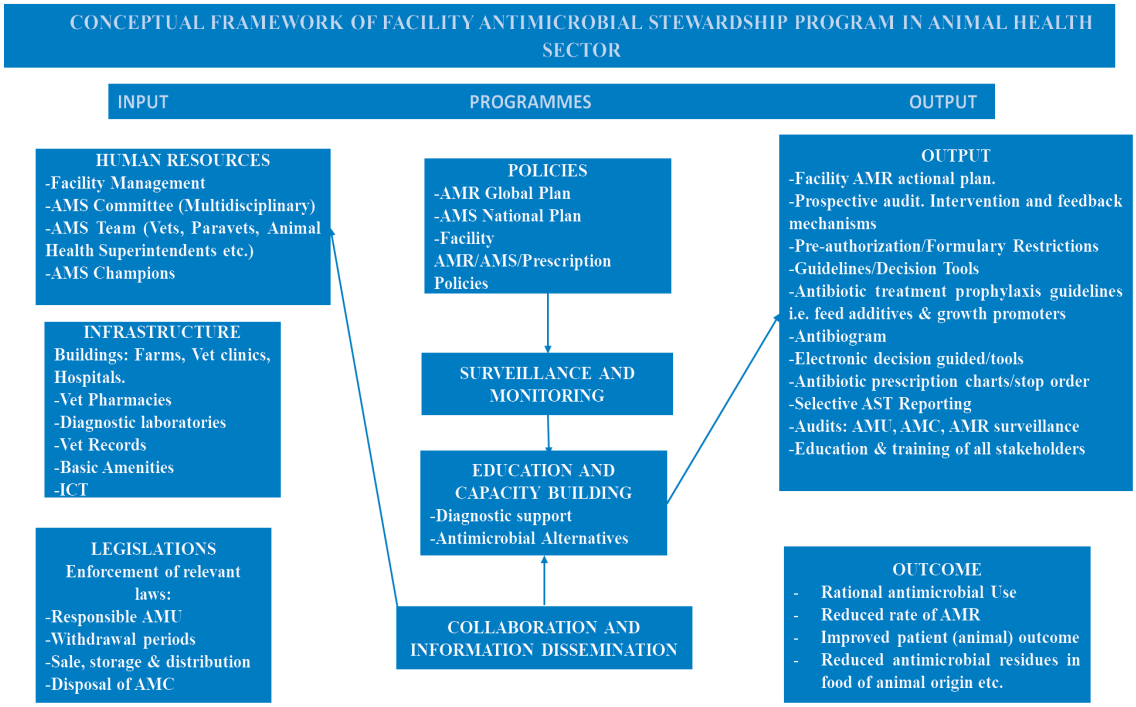
- World Organisation for Animal Health (WOAH)
- Food and Agriculture Organization of the United Nations (FAO)
- African Union -Inter African Bureau for Animal Resources (AU-IBAR)
- World Health Organization (WHO)
- Economic Community of West African States (ECOWAS)
- Foreign Commonwealth and Development Office (FCDO)
- Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ)
- Centre for Disease Control and Prevention (CDC)
- United States AID (USAID)
- Canadian International Development Agency (CIDA)
- PROPCOM MAIKARFI
- International Committee of the Red Cross (ICRC)

G. Others

- Public Health Professionals
- Veterinary Extension Workers
- Security Agencies
- Sales Representatives/Drug distributors
- Veterinary products and agro-allied shops
- Petty traders and hawkers of veterinary drugs in open markets.
- Mass Media
- General Public

Find attached Stakeholders mapping (Appendix II)

11. CONCEPTUAL FRAMEWORK OF FACILITY FOR ANTIMICROBIAL STEWARDSHIPPROGRAMME



A. PROGRAMME DESCRIPTION

i. Policies

- Developing policies and guidelines for antimicrobial use in animal health, livestock production, aquaculture and wildlife based on scientific evidence and best practices.

- Establishing protocols for responsible antimicrobial use, dosage, duration, administration routes and disposal.

a. AMR Global plan, AMR National Action Plan
b. AMR/AMS prescription policies
c. AMU Templates
d. FMAFS-FDVPCS National Guidelines for use of Antimicrobials etc.

ii. Surveillance and Monitoring:

- Antimicrobial Resistance Monitoring: Regular monitoring of antimicrobial resistance patterns in animal pathogens to inform treatment decisions and assess the impact of antimicrobial use.

- Routine monitoring and surveillance of poultry, livestock and aquaculture for the presence of antimicrobial residues pre- and post-slaughter,

- Antimicrobial Use Reporting: develop and Implement systems for monitoring antimicrobial use in animals. Track and report antimicrobial use in animals to monitor trends and identify opportunities for improvement.

- Collect, collate and analyse data on antimicrobial consumption and resistance to track trends and inform decision-making.

iii. Education and Capacity Building

- Providing training to veterinarians, animal health professionals, and farmers on antimicrobial stewardship principles, infection prevention, and control practices.

- create awareness among animal health and production service providers, stakeholders and general public about the importance of preserving the effectiveness of antimicrobials.

- Quality control and Assurance measures: Implement quality control and assurance measures to assess and improve the effectiveness of antimicrobial stewardship and interventions at critical control points.

iv. Diagnostic and Treatment Support:

- Antimicrobial treatment should be based on accurate diagnosis through appropriate diagnostic technique , including culture isolation, identification and antimicrobial susceptibility testing.

-Treatment Guidelines: Use antimicrobials at the recommended dose, duration, and administration route as recommended by the national guidelines for the use of antimicrobials in animals.

-First-Line Therapy: Preferentially use first-line antimicrobial agents before resorting to broad-spectrum antimicrobials.

-Therapeutic Monitoring: Monitor the response to treatment and consider adjustments based on clinical response and follow-up testing

-Promote the use of rapid diagnostic tools to guide targeted antimicrobial therapy and avoid unnecessary use.

-Support the development of diagnostics to identify pathogens and resistance mechanisms in animal health.

v. Antimicrobial Alternatives/ prevention strategy

- Exploring and promoting alternatives to antimicrobials by Implementing preventive measures such as vaccines, probiotics, phage therapy, biosecurity protocols, good Management and hygiene practices, to reduce the need for antimicrobial treatment.

-Enhance animal welfare, nutrition, and housing conditions to promote overall health and reduce the risk of infections

- Encouraging research and innovation in developing effective ethnoveterinary medicines and other non-antimicrobial solutions to prevent and treat animal diseases.

vi. Collaboration and Information :

- Fostering collaboration between veterinarians, livestock producers, and relevant stakeholders to implement stewardship practices towards a one health approach.

- Enhancing communication channels to share information, best practices, and research findings.

By implementing a comprehensive antimicrobial stewardship program in the animal health sector, stakeholders can work together to address antimicrobial resistance, safeguard animal health and welfare, as well as protect public health from the risks associated with drug-resistant infections. Collaboration, education, surveillance, and policy development are essential elements of a successful framework for antimicrobial stewardship in animal health.

Collaborative Networks

- **Public-Private Partnerships**
    - Collaborate between government entities, industry stakeholders (private veterinary practitioners), and non-profits organizations (NGO)
    - Share resources, data, and best practices for AMS.
- **Research Institutions**
    - Conduct studies on antimicrobial resistance and effectiveness of AMS interventions.
    - Provide evidence-based recommendations for practice.

Monitoring and Evaluation

- **Data Collection and Surveillance**
    - Establish systems for monitoring antimicrobial use and resistance patterns.
    - Regularly assess the effectiveness of AMS strategies and make adjustments as necessary.
- **Feedback Mechanisms**
    - Create channels for stakeholders to report challenges and successes in AMS implementation.
    - Use feedback to continuously improve governance and policy framework
    -

A. INPUTS

a. Human resources

Facility Management: Well laid out animal hospital buildings, laboratory facilities, slaughterhouses & slabs, Farm buildings, and feed mills with well laid out facilities with proper management should be encouraged. Water and power supply and sewage management systems should be top-notch.

i. **AMS Committee.** It should be multidisciplinary. A stewardship committee is fundamental to any stewardship scheme as it will provide the strategic direction, guidance, manpower, intelligence, resources, etc for any stewardship activities. It may be a stand-alone group or in subcommittees. If it is a stand-alone group, it should be integrated into the governance structure of the organization so that it is accountable. Therefore, National AMS committee should consist of AMS National Coordinator, AMS, Chief Veterinary Officer Nigeria, FMAFS, Directors of Veterinary Service (DVS) in the 36 states and Federal Capital Territory (FCT), Directors of Veterinary Teaching Hospitals (VTH), Permanent Secretaries or representatives of Federal Ministries of Livestock Development, Agriculture and Food Security, Environment, and Health, Director, Nigeria Agricultural Quarantine Service (NAQS), Representative of the Attorney General of the Federation (AGF), Director or representative of National Agency for Food and Drug Administration and Control (NAFDAC). Manufacturers Association of Nigeria (Drug section) (MAN), President or Representative of Veterinary Council of Nigeria (VCN), President or Representative of Animal Science Council of Nigeria, President or Representative of Medical Laboratory Council of Nigeria, and National President or Representative of Nigeria Veterinary Medical Association (NVMA), and other stakeholders.

ii. **AMS Team**: States, LGAs, and VTHs should set up their AMS teams made up of Veterinarian, Animal Health Superintendents, Veterinary Pharmacist/Pharmacologist, Microbiologists Laboratory scientists, Representative of Nigerian Veterinary Medical Association (NVMA) state chapter, Representative of livestock farmers associations (Poultry Association of Nigeria, Fish Farmers Association of Nigeria).

iii. **AMS Champions:** Farmers, Feed millers, Market (meat and egg) associations, social media influencers, young people, teachers and educators, journalists and communication experts, community and religious leaders, and all animal health workers as well as stakeholders and service providers in animal health and agriculture, such as veterinarians, farmers, consumers, and professionals in environmental sciences.

Animal health AMS Champion is a trustworthy person of societal influence who is passionate, committed and with good understanding of responsible use of antimicrobials. He/she is preferably community and /or facility based.

Criteria for selection of AMS champion.

This individual shall possess the following Qualities:

- Ability to demonstrate commitment to antimicrobial stewardship.
- Can provide leadership and guidance to stakeholders on AMS principles and practices.
- Can lead others to ensure enforcement of evidence-based protocols for antimicrobial use.
- Ability to Work with team members to share knowledge, and raise awareness about AMS
- Ready to develop capacity and stay current with emerging trends and research in AMS
- Readiness to collaborate with other stakeholders to implement AMS activities
- Be a strong advocate for AMS implementation
- Possess good communication skills for effective delivery of behavioural change messages .
- He/she should be friendly and have persuasive approach to issues.

b. Infrastructure

a) Farms (different sizes - subsistence, small, medium, large), veterinary clinics (private, Local government, State), veterinary hospitals with provision of boarding facilities (Private or State specialist veterinary hospitals and Veterinary Teaching hospitals, pharmacies and drug sellers.

b) Diagnostic units (private and public diagnostic laboratories like NVRI, VTH labs, AMR Sentinel labs, other designated private labs, etc

c) Veterinary records in the State Veterinary headquarters, Federal Ministry of Agriculture and Food Safety, VTH records, Fleming sentinel AMR lab records(electronic), etc

d) Basic amenities: water supplies from the public water supply (State), the university works and services department (VTHs), private water boreholes (private entities like livestock farms, veterinary clinics, slaughterhouses, etc) Power supply from national power grid, renewable power supply system (solar Power), Disposal and sewage facilities in the farms including aquaculture, VTHs, meat markets, slaughterhouses, meat processing outlets etc.

e) ICT facilities - computer with relevant software and accessories, internet, phone, social media/Blogs, etc.

c. Legislation

Enforcement of legislation on responsible use, prescription, withdrawal period, sales storage, distribution and disposal of antimicrobial agents

B. OUTPUT/IMPACT

i. Output

a) Development of AMS Action plan.
b) Real time AMR reporting
c) Compliance and appropriate use of antimicrobial agents
d) Prospective audit, interventions, and feedback mechanisms
e) Pre-authorization/Formulary restriction
f) Guidelines/Decision tools
g) Antibiotic treatment and prophylaxis guidelines i.e. as feed additives and growth promoters
h) Antibiogram
i) Electronic decision guides/tools
j) Antimicrobials prescription charts/stop orders
k) Selective AST reporting
l) Audits: AMU, AMC, AMR Surveillance

m) Education and Training of all stakeholders

ii. Outcome

a) Enhanced Awareness on AMR
b) Rational antimicrobial use
c) Reduced rate of AMR
d) The improved patient (animal) outcome, improved livestock production (meat, milk and egg products), reduced antimicrobials in meat & meat products, milk, animal dungs, environment - plant, water table and water fauna, etc
e) Reduced cost of care and production using robust biosecurity and vaccination programmes.
f) Enhanced political will for AMR activities
g) Enhanced AMR data collection and analysis
h) Clearer understanding of the trends and patterns of AMR.
i) Developed ethnoveterinary and other non-antimicrobial alternatives.
j) Enhanced biosecurity measures and personal hygiene

iii. Education and Capacity Building:

Basic concepts of AMS should be included in the academic curriculum of Faculties of Veterinary Medicine by the Veterinary Council of Nigeria (VCN), National Universities Commission (NUC), and Colleges of Agriculture by National Board of Technical Education (NBTE) and Veterinary Council of Nigeria (VCN).

i. Develop or adapt training packages and conduct training to build capacity for all stakeholders on the policy and its intended outcomes.

ii. Conduct training of trainers to assist the nationwide scale-up of implementation of the policy. This could be done in collaboration with professional societies.

iii. Develop and encourage robust supervision, coaching, or mentoring efforts to support capacity building across multiple levels and cadres of health workers using existing platforms and synergies.

iv. Pre-qualification/induction/in-service training programmes.

v.

iv. Advocacy and Awareness:

i. Develop information , Education and Communication (EIC) materials and Social Behavioural Change (SBC) tools

ii. Conduct advocacy and awareness activities to disseminate the new policy and implementation plan at all levels to all stakeholders through various

platforms, such as workshops, meeting training sessions, social media and the Internet.

iii. Develop a shared vision and goals with stakeholders, including professional societies, civil society and local AMS steward/champions, which is necessary for successful implementation of the policy.

iv. Conduct advocacy explicitly for political leaders, professional societies, and other stakeholders to garner support for the policy and its implementation, through availing sustainable human and financial resources.

v. Integrated AMS advocacy activities should be jointly planned with the relevant stakeholders to ensure coherence and consistency between messages targeted at key stakeholders and value chain operators.

n) Biohavioural change interventions
o) Reports Facility management, National.

12. CORE ELEMENTS FOR AMS:

Antimicrobial resistance (AMR) is a serious global health issue that compromises the effectiveness of antimicrobials used in the treatment of infections in humans, animals and as disinfectants in the environment . The overuse and misuse of antimicrobials, especially in food-producing animals, are major contributors to the development and spread of AMR. Antimicrobial stewardship (AMS) in the animal health sector plays a crucial role in addressing these challenges by ensuring the responsible use of antimicrobials, ultimately preserving their efficacy. Effective AMS programmes focus on optimizing antimicrobial use to protect animal, humans and the environment. This involves establishing guidelines for the appropriate use of antimicrobials, including access, when and how they should be administered, and promoting practices that prevent infections, such as improved biosecurity, vaccination, and better animal husbandry practices. Surveillance systems are also vital for monitoring antibiotic use and the emergence of resistance, enabling timely interventions.

To further curb the spread of AMR, the 5Rs - **R**esponsible use, **R**eduction in unnecessary use, **R**efinement of practices, **R**eplacement with alternatives, and **R**eview of antimicrobial use - serve as key pillars of containment. These principles emphasize the need for veterinarians, farmers, and other stakeholders to prioritize animal health through preventive measures and rational antimicrobial use, thereby reducing reliance on these agents while maintaining productivity. Additionally, the WASH (Water, Sanitation, and Hygiene) framework complements AMS efforts by promoting hygiene practices that reduce the risk of infections and, consequently, the need for antimicrobial

treatments. By preventing the spread of disease through proper sanitation, the demand for antimicrobials can be significantly reduced.

The Centre for Disease Control and Prevention's core elements of a hospital AMS as Leadership commitment, Accountability and Responsibility, veterinary Medicinal Products expertise, Action, Tracking, Reporting, and Education and Training. These core elements are essential to ensure the responsible use of antimicrobials in the health care facility, including the animal health sector.

i. Leadership commitment:

A successful AMS programme requires strong leadership and governance structures. Leadership commitment involves clear policy directions from national authorities, regulatory bodies, and veterinary organizations that prioritize AMR containment and the promotion of responsible antimicrobial use. Leaders at animal health facilities, such as veterinary hospitals or clinics and animal farms, must demonstrate a commitment to AMS by allocating resources, setting goals, and ensuring that AMS is integrated into the facility's core operations. The One Health National Action Plan (NAP) 2.0 on AMR has been developed to serve as a framework, providing strategic directions for the implementation of AMS in the animal health sector. Governance mechanisms ensure that policies and guidelines on antimicrobial use are developed, disseminated, and enforced. Stakeholders such as government agencies, veterinary professional bodies (Veterinary Council of Nigeria and Nigerian Veterinary Medical Association), and agricultural organizations must collaborate to establish legal frameworks that regulate access to veterinary antimicrobials. Governance also encompasses creating multi-sectoral task forces that include animal health, public health, agriculture, and environment experts to coordinate AMS efforts in a One Health approach as enshrined in the AMR and AMU One Health governance manual (2021). The role of law enforcement agencies and media should not be overlooked.

ii. Accountability and Responsibilities

Accountability and clear delineation of responsibilities are critical for the success of antimicrobial stewardship (AMS) programmes in the animal health sector. To ensure the effective implementation of AMS, various stakeholders like governments, veterinarians, farmers, and the veterinary medicinal products manufacturers must be accountable for their roles in promoting the responsible use of antimicrobials.

Veterinarians play a central role in AMS as they are primarily responsible for diagnosing animal diseases and prescribing antimicrobials. They should adhere to evidence-based guidelines, ensure proper dosing, and limit the use of critically important antimicrobials for human health. Veterinarians are also responsible for educating farmers about the risks of antimicrobial misuse and

promoting alternative disease prevention strategies, such as vaccines, improved biosecurity measures and adequate nutrition.

Farmers and livestock producers are accountable for the appropriate administration of antimicrobials under veterinary guidance. They should ensure that prescribed antimicrobials are used only when necessary, adhere to treatment regimens, and maintain accurate records of antimicrobial use on their farms. Additionally, farmers are responsible for implementing good husbandry practices and infection control measures to reduce the need for antimicrobials.

Government and regulatory authorities have the responsibility to establish and enforce regulations governing importation, manufacture, distribution, sale and use of veterinary antimicrobials. They should ensure that antimicrobials are available only by veterinary prescription and oversee compliance through regular inspections and penalties for non-compliance. Governments at all levels also plays a crucial role in supporting surveillance systems to monitor antimicrobial use and resistance trends.

The Veterinary Medicinal Products manufacturers have a responsibility to adhere to guidelines governing the manufacture of antimicrobials ensure quality assured and ethical marketing of antimicrobial products and support the development of alternatives to these agents , such as probiotics and vaccines. Collaboration across all sectors is necessary to strengthen AMS efforts and create a culture of accountability that mitigates the risk of antimicrobial resistance.

The Director of the Veterinary Teaching Hospital has a responsibility to ensure that a multidisciplinary AMS team is put in place to implement the day-to-day AMS activities in the hospital. The team may include veterinarians, clinical pharmacologists, microbiologists, veterinary epidemiologists, laboratory scientists and other relevant professionals. The directors of veterinary teaching hospitals must ensure the availability of treatment guidelines and adherence to AMS policies in the facility.

Other animal healthcare facilities such as state, Local Government Areas, and private veterinary clinics should have an AMS champion with the responsibility of driving AMS activities in that facility.

iii. Veterinary medicinal product experts

In the Nigerian animal health sector, veterinary surgeons currently take on multiple roles in diagnosing and prescribing antimicrobials. However, the involvement of veterinary medicinal products experts including veterinary pharmacologists,and microbiologists is essential for the effective implementation of antimicrobial stewardship (AMS) programmes. Their

specialized knowledge of antimicrobials, resistance mechanisms, and veterinary pharmacology is crucial for promoting responsible antimicrobial use and developing effective stewardship strategies.

Veterinary pharmacologists are vital in advising on the appropriate selection, dosage, and administration of antimicrobials. They assess pharmacokinetic and pharmacodynamic data to ensure that treatments are effective and minimize the risk of resistance. They provide advice on drug interactions, adverse effects, and optimal dosing schedules to ensure antimicrobial safety and efficacy. This expertise enables veterinarians to make informed decisions regarding antimicrobials prescriptions, especially in complex cases involving resistance.

Microbiologists contribute significantly to AMS efforts through their work in diagnostic laboratories. They perform microbial culture and sensitivity testing, identifying pathogens responsible for infections and determining the most effective antimicrobials. This targeted approach reduces the unnecessary use of broad-spectrum antibiotics and promotes evidence-based antimicrobial application. Additionally, microbiologists monitor trends in antimicrobial resistance, helping track and respond to emerging resistance patterns in animal populations.

Veterinary Medicinal Products Manufacturers also play a crucial role in developing and marketing veterinary antimicrobials in an ethical manner. They focus on creating alternatives to antimicrobials, such as vaccines, prebiotics probiotics, and immunomodulators, which help decrease reliance on antimicrobial therapies.

Together, these experts provide a scientific foundation for AMS programs, optimizing antimicrobial use in animals to protect their health while minimizing resistance risks. Their contributions are vital for shaping policies, developing guidelines, and educating veterinarians and farmers on best practices for antimicrobial use.

Actions/Interventions: (a) Before or at the time of Prescription (b) After Prescription. Effective antimicrobial stewardship (AMS) in the animal health sector requires a multifaceted approach that encompasses actions both before and after the prescription of antimicrobials. Interventions that can enhance AMS efforts in veterinary practice include:

(a) Actions Before or at the time of Prescription

i. Veterinarian Education

Continuous education for veterinarians is crucial in updating their knowledge about antimicrobial resistance (AMR), pharmacology, and best practices for antimicrobial use. Training programs can enhance understanding of local resistance patterns and the importance of adhering to treatment guidelines, ultimately improving decision-making when prescribing antimicrobials.

ii. Client education and public awareness creation

Educating clients about the responsible use of antimicrobials is vital. Awareness campaigns can inform animal owners about the risks of AMR, the importance of following veterinary prescriptions, and alternative practices to minimize the need for antimicrobials. Providing resources and training for clients fosters a culture of responsible antimicrobial use and encourages them to seek veterinary guidance.

iii. Antimicrobial Use (AMU) surveillance in facilities for baseline and follow-up assessments

Conducting AMU surveillance in veterinary facilities provides baseline data on antimicrobial use and helps identify areas needing improvement. Regular follow-up assessments can track progress, inform intervention strategies, and measure the impact of AMS initiatives.

iv. Diagnostic Stewardship for improved laboratory diagnosis in Animal Health

Implementing diagnostic stewardship improves laboratory diagnosis in animal health. By ensuring accurate and timely diagnoses, veterinarians can prescribe the appropriate antimicrobials based on specific pathogens, reducing the reliance on broad-spectrum antimicrobials.

v. Development of Facility Antibiograms (cumulative antibiograms)

Creating cumulative antibiograms for veterinary facilities allows veterinarians to understand local resistance patterns. These antibiograms summarize the susceptibility of bacteria isolates to various antimicrobials, guiding veterinarians in selecting effective treatments based on empirical data, this can also support the review treatment guidelines.

vi. Development and Use of appropriate antimicrobials treatment guidelines

Establishing evidence-based antimicrobials treatment guidelines tailored to specific animal populations and diseases promotes standardized, appropriate use of antimicrobials. These guidelines should be regularly updated to reflect current research and resistance patterns.

vii. Development and Use of appropriate guidelines for antimicrobial prophylaxis

Guidelines that outline appropriate scenarios for antimicrobial prophylaxis can help reduce unnecessary antimicrobial use in surgical or high-risk situations. These guidelines should focus on indications, timing, and duration of prophylactic treatments.

viii. Antimicrobial De-escalation (and/or Escalation) Approach

When initial empirical treatment is commenced, having a protocol for de-escalation based on culture results and clinical response can minimize the use of broad-spectrum antimicrobials. Conversely, escalation may be warranted if treatment fails and resistance is detected.

ix. Approach to ensuring the right doses, Start and Stop dates for prescriptions (antimicrobial treatment duration)

Establishing protocols for prescribing the correct doses and determining start and stop dates for antimicrobials therapies helps ensure that antimicrobials are used effectively. Providing clear guidance on treatment duration is essential to prevent underdose or overdose

x. Review of Veterinary Formulary

Reviewing the veterinary formulary of recommended antimicrobials based on efficacy, safety, and resistance patterns can streamline the prescription process. This formulary should include first-line agents and reserve antimicrobials for specific, justified cases to reduce the likelihood of resistance development. This formulary should be consulted at the time of prescription to ensure that critically important antimicrobials for humans are preserved.

(b) Actions After Prescription

i. Continuous Quality Improvement (CQI) approach

Implementing a CQI approach using the Plan, Do, Study, Act (PDSA) model allows for iterative evaluation and improvement of AMS programmes. By systematically assessing the effectiveness of interventions, facilities can adjust their practices based on data-driven insights and feedback.

ii. Prescription audits (prospective audits and feedback)

Conducting prospective audits of antimicrobial prescriptions and providing feedback to veterinarians can identify inappropriate prescription patterns and facilitate improvements. These audits should review adherence to treatment guidelines, appropriateness of antimicrobial choice, dosing, and duration. By

regularly evaluating and discussing findings, veterinary teams can refine their practices and enhance AMS efforts.

iii. Tracking/Monitoring (Assessing AMS programmes using structural measures/ indicators; process measures/indicators; outcome measures/indicators)

Tracking and monitoring are critical components of antimicrobial stewardship (AMS) programmes in the animal health sector. Effective AMS relies on the assessment of various measures and indicators that can provide insights into the efficacy and impact of interventions. By systematically evaluating structural, process, and outcome measures, veterinary practices and organizations can identify areas for improvement and ensure that their AMS efforts are contributing to the reduction of antimicrobial resistance (AMR).

iv. Structural Measures/Indicators

Structural measures serve as the foundational framework for AMS programmes. These indicators assess the resources, facilities, and protocols in place to support responsible antimicrobial use. Examples include the presence of AMS guidelines, the availability of trained personnel, and the existence of a formulary that restricts certain antimicrobials to specific conditions. Tracking these indicators helps ensure that veterinary practices have the necessary infrastructure to implement effective AMS strategies. Facilities lacking these structural elements may struggle to achieve desired outcomes in their AMS efforts.

v. Process Measures/Indicators

Process measures focus on the actions taken within the AMS framework. They evaluate the appropriateness of antimicrobial prescribing practices, adherence to established treatment guidelines, and the implementation of diagnostic stewardship practices. Indicators such as the percentage of veterinary prescriptions that comply with antimicrobials treatment guidelines, the rate of culture and sensitivity testing performed before prescribing, and the documentation of treatment duration are crucial for understanding the effectiveness of AMS initiatives. By regularly monitoring these processes, veterinarians can identify trends and areas needing improvement, ensuring that antimicrobials are used judiciously and effectively.

vi. Outcome Measures/Indicators

Outcome measures assess the actual impacts of AMS programmes on animal health and the prevalence of AMR. Key indicators include changes in antimicrobial usage rates, incidence of AMR in clinical isolates, and clinical outcomes, such as treatment success rates and rates of adverse effects from

antimicrobials. Additionally, tracking the overall health and productivity of animal populations can provide valuable context for assessing the effectiveness of AMS initiatives. By analyzing these outcome measures, veterinary practices can determine whether their stewardship efforts are achieving the desired effects in both reducing antimicrobial use and controlling AMR.

vii. Reporting and feedback

Reporting and feedback mechanisms are fundamental components of effective antimicrobial stewardship (AMS) in the animal health sector. These processes not only promote accountability but also enhance the continuous improvement of antimicrobial use practices, contributing to better health outcomes for animals and, by extension, public health.

A structured reporting system allows for the systematic collection and analysis of data related to antimicrobial use (AMU) and resistance patterns. This data serves multiple purposes: it enables veterinary practitioners to monitor their antimicrobial prescription habits, identifies trends in resistance, and provides a foundation for evidence-based decision-making. By establishing a centralized reporting system, veterinarians and stakeholders can gain insights into which antimicrobials are used, the reasons for their use, and the associated outcomes. Reporting also facilitates benchmarking against national or international standards. By comparing local practices with established guidelines and best practices, veterinary professionals can identify areas for improvement. Benchmarking encourages practices to strive for excellence in AMS, helping to standardize care across the sector.

Feedback is critical for reinforcing positive behaviors and correcting practices that may contribute to antimicrobial resistance. Effective feedback loops can be established through regular audits of antimicrobial prescriptions, where data collected is analyzed and communicated back to veterinarians. This can involve assessing adherence to guidelines, the appropriateness of prescribed antimicrobials, and outcomes associated with those prescriptions. By providing constructive feedback, veterinarians can be encouraged to refine their prescribing habits and adopt evidence-based practices.

The reporting and feedback process is integral to the continuous quality improvement (CQI) approach in AMS. It enables veterinary practices to assess the impact of their stewardship efforts over time, making necessary adjustments to strategies based on real-world outcomes. This interactive process fosters a culture of learning and adaptation, essential for addressing the dynamic nature of antimicrobial resistance.

Collaboration among veterinarians, Government and regulatory authorities is enhanced through effective reporting and feedback. Sharing data on antimicrobial use and resistance fosters transparency, allowing stakeholders to work together towards common goals in AMS. This collaborative approach can also lead to the development of regional or national AMS initiatives, where shared resources and information can further enhance efforts to combat AMR.

viii. Education and capacity building

Education and capacity building are critical components of antimicrobial stewardship (AMS) in the animal health sector. As antimicrobial resistance (AMR) poses significant challenges to veterinary medicine, enhancing the knowledge and skills of veterinarians, animal health professionals, and other stakeholders is essential for promoting responsible antimicrobial use. A well-structured education and training framework fosters a culture of stewardship, ensuring that all parties involved are equipped to make informed decisions regarding antimicrobial therapies.

Veterinarian Education: Continuous professional development is crucial for veterinarians, who must stay informed about the latest research, resistance patterns and treatment guidelines. Regular workshops, seminars, and training sessions should focus on topics such as the pharmacology of antimicrobials, AMR, principles of infection prevention and control/biosecurity, and the importance of diagnostics in guiding treatment decisions. Incorporating case-based learning and practical applications into training programs allows veterinarians to apply their knowledge to real-world scenarios, enhancing their competence and confidence in managing infections.

Client Education: In addition to training veterinarians, educating clients—animal owners—is vital for effective AMS. Clients must understand the implications of AMR and the importance of adhering to prescribed treatment regimens. Educational initiatives can include informational materials, workshops, and on-farm training sessions that address responsible antimicrobial use, biosecurity measures, and alternatives to antimicrobials, such as vaccination and improved husbandry practices. Engaging clients fosters a collaborative approach to AMS, empowering them to take an active role in minimizing antimicrobial use.

Interdisciplinary Collaboration: Capacity building should extend beyond veterinary professionals to include collaboration with other sectors, such as public health, agriculture, and environmental management. Interdisciplinary training programmes can facilitate a comprehensive understanding of AMR's complex nature, promoting a One Health approach that considers the interconnectedness of human, animal, and environmental health. This

collaboration encourages the sharing of knowledge and resources, leading to more effective AMS strategies across various domains.

Surveillance and Research Training: Developing skills in surveillance and research methodologies is essential for monitoring antimicrobial use and resistance trends. Training programmes that focus on data collection, analysis, and interpretation empower veterinarians and other animal health professionals to contribute to the development of facility antibiograms and local resistance profiles. This knowledge is invaluable for guiding empirical treatment decisions and formulating targeted AMS interventions.

13. COMPONENT OF INTEGRATED AMS ACTIVITIES

The implementation of integrated AMS interventions and activities requires a programmatic approach anchored in animal and public health principles. The following 12 interventions and activities organized in five components represent the key package that needs to be considered to commence and implement comprehensive and integrated AMS activities in animal health sector.

Integrated AMS activities

COMPONENT 1: Develop guidelines and Terms of Reference (TOR) to establish and develop National Coordination mechanisms for antimicrobial stewardship.

1. Establish and maintain a national coordinating mechanism for AMS that is functional at federal, state and local government levels.

2. Implement national treatment and stewardship guidelines, standards and tools.

COMPONENT 2: Ensure access to and regulation of antimicrobials

1. Regulate and improve access to essential, quality-assured, safe, effective and affordable antimicrobials.
2. Regulate social triggers and remuneration policies that promote responsible antimicrobial prescription and dispensing practices.
3. Legislate and regulate responsible and appropriate use and disposal of antimicrobials.

COMPONENT 3: Improve awareness, education and training

1. Improve awareness and engagement to support behavioural change of antimicrobials use.
2. Strengthen animal health worker's capacity based on need.

COMPONENT 4: Antimicrobial alternatives/ prevention strategies

1. Implement robust and comprehensive bio-security measures, good animal husbandry and hygienic practices. .
2. Implement disease preventive measures such as vaccinations, use of probiotics, antimicrobial peptides, ethno-medicinal plants, ozone therapy, nanobiotics and phage therapy in animal health facilities.

COMPONENT 5: Surveillance, monitoring and evaluation of AMR, AMU/C

1. Surveillance of antimicrobial use and consumption.
2. Surveillance of AMR.
3. Monitoring and evaluation of AMS activities.

DETAILS OF THE ACTIVITIES

1. Establish and develop national coordination mechanisms for AMS and develop guidelines

a. ***Establish and maintain a national coordinating mechanism for AMS that is functional at federal, state and local government levels.***

Implementing national action plans on AMR, including integrated AMS activities, requires partnering with stakeholders within the animal, human and environmental health sectors and other sectors, including private profit and non-profit organizations such as professional societies and cross border collaboration. Coordination is essential for establishing and sustaining an enabling environment to scale up the implementation of integrated AMS activities. These activities should be coordinated by a central national coordination unit i.e. Department of Veterinary and Pest Control Services of Federal Ministries of Livestock Development, Agriculture and Food Security and Environment or its equivalent at the Ministry of Health or in any other designated national agency with sustainable and adequate funding, with technically competent human resources and accountability mechanisms. The shape and structure of such a unit will depend on the national context and the structure of the animal health system and could be embedded within existing functional national AMR coordinating mechanisms adopting One Health principles.

Actions and considerations:

Establish and maintain a central national coordination unit at the Federal Ministry of Agriculture and Food Security(FMA&FS) or in any other designated national agency with its own sustainable and adequate funding, with technically competent human resources and accountability mechanisms. The units will function at all administrative levels to coordinate the design, implementation and monitoring of integrated AMS activities. The central national coordination unit should establish a specific national AMS coordinating mechanism for integrated AMS activities with diverse membership, including representatives from relevant national programs and departments, the private profit and non-profit sector, professional societies, non-governmental organizations (NGOs), regulatory bodies, academia and researchers, representatives working with community groups and animal owners, and representatives from other relevant One Health sectors and national mechanisms. There is also a need to facilitate the establishment and functionality of the AMS coordinating mechanism at federal, state local government and facilities-based levels depending on the local context and needs.

The terms of reference (TOR) of the central national coordination unit at the Ministry of Agriculture and Food Security or in any other designated national agency should include:

i. Providing strategic and programmatic leadership on activities under the national action plan on AMR related to optimizing antimicrobial use, including development of AMS implementation plans aligned with national action plans with well-defined goals and indicators.
ii. Providing guidance on gap analysis and prioritization to help define a starting point based on available capacities and resources.
iii. Enhancing integration of AMS activities across multiple levels of the animal health sector, including federal, state, local government, facility and community levels.
iv. Coordinating the development and dissemination of guidelines for optimized diagnosis and treatment of infectious diseases, clinical decision support tools, standard operating procedures and implementation tools.
v. Facilitating the review of guidelines for management of infectious diseases, including emerging and re-emerging animal diseases, to incorporate AMS activities based on surveillance and other data generated in collaboration with those responsible for prescription and administration of veterinary medicinal products.
vi. Mobilizing resources dedicated to AMS activities, including through integration into national animal health sector plans and budgets at all levels.
vii. Creating synergies and mainstreaming AMS activities into public health programmes.

viii. Facilitating cooperation and mechanisms between public, profit and non-profit animal health sector stakeholders to support uptake of AMS activities and policy recommendations.
ix. Supporting implementation research, knowledge management and establishing evidence and learning platforms for locally tailored best practices and experiences of successful AMS activity implementation.
x. Incorporating AMS into relevant pre- and in-service training curricula for all animal health professionals.
xi. Developing and implementing a monitoring and evaluation framework and national targets for AMS activities based on nationally and internationally agreed indicators, guidelines and tools (28, 34).

b. Implementation of national guidelines for use of Antimicrobial treatment and stewardship

Proper diagnosis and treatment of infectious diseases of animals with appropriate therapeutic agents, facilitated by the existence of diagnostic capacity to rapidly and reliably detect specific pathogens and their antimicrobial susceptibilities, is critical to improve animal health. National treatment guidelines on infections and infectious diseases should be based on local and global evidence and guidelines, including diagnosis, selection of the optimal drug regimen, dosing, duration and route of administration, and are critical elements of AMS activities. National operational guidelines, standard operating procedures and implementation tools based on internationally and nationally recommended, evidence-based policies and guidelines will facilitate the scale-up of integrated stewardship activities. The availability of proper and optimized diagnosis, including timely and accurate microbiological tests, will help to reduce inappropriate use of antimicrobials and improve animal health outcomes. The principles in the WHO Model List of Essential Medicines (EML), WOAH list of Essential Medicines, Access, Watch, Reserve (AWaRe) classification and the WHO handbook (29, 35) on the use of antibiotics for common bacterial infections including drug resistance, can be used to inform the development of national guidelines. The current Veterinary Formulary by Veterinary Council of Nigeria (VCN) has a section for Essential Veterinary Drugs which may be helpful. The overall goal of these efforts should be to reduce unnecessary use of antimicrobials, including the inappropriate use of Watch group and Reserve group antibiotics (the antibiotics most crucial for human medicine and at higher risk of resistance), and to increase the use of Access antibiotics where appropriate

Actions and considerations:

i. Develop or adapt and monitor implementation of standard diagnosis and treatment guidelines for infections and infectious diseases of public health depending on local epidemiology and resistance patterns and informed by

principles of internationally agreed guidelines or the rigorous assessment of the evidence and in collaboration with professional societies and other relevant in-country stakeholders, including endorsement of the guidelines.

ii. Advocate and coordinate the availability of affordable and appropriate microbiological diagnostics to facilitate proper and optimized diagnosis where appropriate to guide therapeutic decisions and improve patient care and outcomes.

iii. Design easy, scalable, sustainable and context-specific standard operating procedures (SOPs) and standards for AMS activities for animal health-care facilities (e.g. animal hospitals, clinics, farms, feed mills) and community settings (e.g. for community-based animal health workers) with inbuilt continuous quality improvement concepts.

iv. Incorporate continuous quality improvement concepts into AMS activities to ensure that the interventions and activities are sustainable.

v. Establish structures and systems for effective linkage and engagement of different departments to support integrated AMS activities.

vi. Facilitate the development and use of electronic platforms and applications to populate AMS guidelines, standards and implementation tools and other relevant information and for sharing experiences, best practices and information on implementation of AMS activities.

vii. Establish mechanisms and activities for the dissemination of guidelines, standards and implementation tools on AMS activities.

2. Ensure access to and regulation of antimicrobials

a. Regulate and improve access to essential, quality-assured, safe, effective and affordable antimicrobials

Equitable and affordable access to quality-assured, safe and effective antimicrobial medicines and their appropriate use (30, 36). In some parts of the world, huge economic loss due to high mortality of livestock is caused by lack of access to antimicrobials than drug-resistant infections. The WOAH and WHO Essential Medicine List *(EML)* and Access, Watch and Reserve (AWaRe) classification (31, 37*)* provide a selection framework to develop and or update the national EMLs and relevant efforts to strengthen national pharmaceutical supply chains, financing and reimbursement mechanisms and pharmaceutical information management systems that will ensure availability of affordable and culturally acceptable antimicrobial medicines at all levels of care. National diagnosis and treatment guidelines for infections and infectious diseases, as well as federal, state, local government and district level microbiological data (where it exists), can also inform the prioritization of antimicrobial medicines that require access and affordability. Shortage, inaccessibility or unavailability of the first-line treatment often leads to the misuse of broad-spectrum antibiotics and other

antimicrobials, contributing to the development of AMR. Tackling substandard and falsified medical products is an important component of ensuring access to quality-assured antimicrobials and NAFDAC should be actively involved.

Actions and considerations:

i. Incorporate the WOAH and WHO EML (where applicable) and AWaRe system into national EMLs, Veterinary Formulary, national and health-care facility treatment guidelines to guide AMS actions.
ii. Ensure the treatment guidelines and formularies are linked to the updated national EML where applicable.
iii. Establish effective federal, state and local government level antimicrobial (antibiotic, antifungal, antiviral and antiparasitic) demand forecasting depending on local epidemiology and public health priorities.
iv. Establish a robust supply chain and pharmacy information system with capacity to provide advanced notice of possible shortages and stock-outs of antimicrobial medicines to allow rapid action and reduce importation of substandard antimicrobial drugs.
v. Leverage pooled procurement mechanisms to ensure the supply of quality-assured medicines, with predictability of demand for manufacturers and promoting sustainable procurement practices.
vi. Simplify the process, requirements and costs of the national drug registration for antimicrobials with integrated measures of AMS and quality assurance mechanisms.
vii. Encourage regulatory agencies to publish the active pharmaceutical ingredients source of registered antimicrobial medicines for transparency and to enable countries to design solutions to maintain predictable supply and mitigate against drug shortages.
viii. Ensure that integrated AMS activities are prioritized within existing structures and mechanisms at national and facility levels such as veterinary pharmacy boards or drugs and therapeutic committees.
ix. Ensure availability and affordability of antimicrobial agents based on animal health priorities, epidemiology and resistance patterns in both the public and private sector through appropriate regulations, policies, measures and mechanisms.
x. Develop evidence-based policies, measures and mechanisms to enhance access to alternative therapeutics, repurposed and new antimicrobial medicines.
xi. Strengthen national procurement and supply chain management for quality and effective antimicrobials, including new antibiotics.

b. Regulate social triggers and remuneration policies that promote responsible antimicrobial prescription and dispensing practices

Animal health workers' antimicrobial prescribing and dispensing practices can often be determined or influenced by systemic factors that may be outside the immediate control of the animal health worker. These can range from how animal health workers are remunerated to promotion of antimicrobial products by veterinary medicinal products manufacturing companies. At institutional and facility levels, mechanisms are needed to reduce the number of antimicrobials being inappropriately prescribed, dispensed or administered. Pay-for-performance initiatives (in developed countries) showed that they helped in some settings to reduce the prescription of broad-spectrum antibiotics by animal health workers (32, 38 33, 39). However, these initiatives are not a silver bullet and can potentially be harmful when the incentives are not right (34, 40 35, 41).

Actions and considerations:

i. Understand and incorporate animal health workers behavioural change principles in policies to address optimal diagnostic processes, antimicrobial prescription, dispensing and administration as part of national institute incentives and policies to address social and economic factors that drive the inappropriate prescription and use of antimicrobials as part of national AMR plans and standard operating procedures.
ii. Strengthen national regulations that promote prescription of antimicrobials using International Non-proprietary Names (36, 42) (generic names) to mitigate undue influence of marketing activities on prescribers.
iii. Encourage and empower individual champions, institutions and facilities to implement innovative measures or rewards (as appropriate for the local context) to reduce the inappropriate diagnosis of infectious disease as well as the inappropriate prescription, dispensing, administration and use of antimicrobials.
iv. Acknowledge and empower individual and institutional champions and motivate appropriate stewardship activities.

c. Legislate and regulate responsible and appropriate use and disposal of antimicrobials

Enforced legal and regulatory instruments, frameworks and oversights at every step in the life cycle of antimicrobials constitute critical steps in ensuring effective AMS activities. The life cycle of antimicrobials includes research and development; production; marketing authorization and registration; selection, procurement and supply; prescribing, dispensing and administration; responsible and appropriate use; post-marketing surveillance; and appropriate disposal. The process of implementing integrated AMS activities should entail a comprehensive review of the needs for legal and regulatory systems, where the National Assembly will play a pivotal role. The gaps in existing legal and regulatory instruments and

frameworks should be identified and addressed. New regulations should be developed and enforced. These steps require developing an enabling environment through liaising with stakeholders involved in the development, production, marketing, prescription, sale and use of antimicrobials, including in the human, animal and plant sectors, to harmonize rules and regulation to preserve antimicrobials of animal health importance. The National Assembly will play a key role for the passage of antimicrobial-related bills submitted to them.

Proper regulatory oversight requires enforcement mechanisms by VCN, NAFDAC and other stakeholders.

Actions and considerations:

i. Develop and enact efficient regulatory systems to provide oversight of the development, production, marketing, importation, supply, prescribing, dispensing, administration and disposal of quality-assured antimicrobials.
ii. Enact and enforce regulations to restrict over-the-counter and internet or online sale of antibiotics and other antimicrobials intended for use without a prescription from a qualified and registered veterinary surgeons .
iii. Enact and enforce regulations to promote regulatory requirements for prescribers and dispensers as well as advertisers of antimicrobial agents.
iv. Establish and implement robust and effective post-market surveillance and pharmacovigilance systems to ensure quality-assured and safe antimicrobials are available.
v. Establish regulatory mechanisms and enforce their implementation through VCN and NAFDAC to stem the sale and distribution of substandard and falsified drugs in close consultation with professional associations.
vi. VCN in collaboration with NAFDAC, develop and enact legal and regulatory frameworks to preserve medically important antimicrobials for human medicine (37) from inappropriate use in the animal and plant sectors.
vii. Design an enabling environment to engage professional societies and the private sector to support responsible use of antimicrobials as well as enforcement of legal and regulatory instruments and frameworks.
viii. Develop context-specific national accreditation programmes with AMS standards that could be used for relevant levers such as inspection, quality assurance and improvement frameworks for animal health-care facilities across all levels as feasible and appropriate.
ix. Develop standards and criteria for responsible manufacturing and disposal of antimicrobial drugs in procurement and import frameworks in close collaboration with NAFDAC and other stakeholders.

3. Improve awareness, education and training

a) Improve awareness and engagement to support behavioural change of antimicrobials use

Improving awareness and understanding of AMR through effective communication, education and training is an important component of the Global Action Plan. National authorities like Federal Ministry of Livestock Development, FMA&FS, VCN, NAFDAC, VTHs, need to prioritize measures that are useful to raise awareness of AMR and the appropriate use of antimicrobials and promote change of behaviour. Tailored public communication activities that target different audiences using communication and behaviour change strategies are important. Audiences may include the general public, young people, teachers and educators, journalists and communication experts, social media influencers, community and religious leaders, and all animal health workers as well as stakeholders and service providers in animal health and agriculture, such as veterinarians, farmers and consumers, and professionals in environmental sciences etc.

To promote better understanding and awareness of the AMR among the public, it is important to include within schools' curricula the appropriate use of antimicrobial agents, Biosecurity practices and drug-resistant infections from an early age.

Actions and considerations:

i. Support the design and implementation of studies to understand level of awareness and determinants of behaviour to drive change in animal health professionals, the general public, consumers and other stakeholders.
ii. Conduct regular and continuous awareness and engagement creation campaigns on threat of drug-resistant infections and measures to contain them using data generated and taking into consideration local contexts and language barriers. Campaigns should in particular include preventive actions such as biosecurity measures, good animal nutrition and vaccinations, discourage self-medication and promote responsible and appropriate use of antimicrobials as well as the importance of proper and optimized diagnosis.
iii. Organize and coordinate highly visible and regular national, state and local advocacy activities, such as during World Antimicrobial Awareness Week (WAAW), to raise the political and public profile of AMS and encourage best practices among the general public, animal health workers and policy-makers to prevent the emergence and spread of drug-resistant infections and scale up integrated AMS activities.
iv. Integrate tailored AMS messages into broader national and international animal health promotion, prevention, treatment and rehabilitation initiatives such as World Veterinary Day, World Water Day, World AMR Awareness Week, World One Health Day etc.

v. Develop tools and conduct regular assessment and evaluation of the impact of education and awareness campaigns on knowledge, attitudes and behaviours of animal health workers and the general public.

vi. Establish and maintain a national knowledge management hub as appropriate for AMR to support continuous information generation and dissemination across all levels, through cooperation with the ministries of education, animal health and other relevant government agencies and stakeholder groups, including civil society organizations.

vii. Develop or tailor an educational tool kits and materials to national and local contexts to provide effective models to improve knowledge and practice among the general population and all animal health workers (e.g. in VTHs, Veterinary Clinics, Farms, Feed mills etc.) working in the public and private sectors, and to enhance community engagement.

viii. Develop joint communication strategies with stakeholders in humans, agriculture and environmental sectors to raise the awareness of antimicrobial use and resistance from a One Health approach.

ix. Produce documentaries, testimonials and impact stories based on individuals affected by drug-resistant infections using a One Health approach in collaboration with relevant bodies for dissemination through local, print and social media.

x. Conduct regular surveys and analysis to understand knowledge, attitudes and behaviour towards antimicrobial use and resistance of health workers, general public, consumers and other stakeholders to define the best methods and areas for communication and behaviour change strategies, and also to employ a baseline data set for monitoring of progress and impact.

b) Strengthen animal health workers capacity through the provision of tailored education and training packages according to animal health worker roles and functions

To ensure full understanding and awareness among animal health workers, it is also important to make AMR a core component of undergraduate and postgraduate professional education, in-service trainings and certifications, and other continuing education programmes in the animal health (Annual VCN Continuing Education programmes), veterinary and agricultural practice sectors. Animal health-care workers should undergo competency-based training in AMS tailored to their local context and needs. Trainings can take different forms, including through case-based learning modules with multiple points of departure, allowing for tailored, experiential learning cycles and inter-professional networking experiences. This provides for the foundation for a strong and effective animal health workforce able to respond to the relevant needs (37, 43*)*. In human medicine, WHO's *Health workers' education and training on AMR: curricula guide* (39, 44*)* and the AMS core competency course (40, 45) for health-care providers, among other tools and

resources, provide overarching guidance for the development and implementation of educational programmes for animal health workers. Such instrument should be developed for animal health practitioners and workers. These tools incorporate the linkages between AMS principles and treatment algorithms, ensuring an intricate and comprehensive approach to stewarding antimicrobials. Basic principles of antimicrobial use and Infection, Preventions and Control (IPC; Biosecurity, vaccination, use of probiotics) should be included for animal health workers alongside communication skills. Managing patient outcome on antimicrobial prescriptions is a key challenge that animal health workers face, and they must be fully supported to undertake this task, including the availability of functional laboratories to investigate infections. Competency-based training in AMS requires effective engagement of students, active professionals, decision makers and other professional groups from academic and research institutions; professional associations; certification bodies; NGOs; domestic and international partner organizations; the private sector; civil society; mass media; and federal Ministries of Livestock Development, Education, Health, Agriculture and Environment. Finally, educational interventions, when provided, should be sustainable, timely, cost-effective, efficient, pragmatic, high quality and should address the needs of recipient health workers according to federal, state and local government contexts.

Actions and Considerations:

i. Integrate AMS principles, including appropriate antimicrobial use, quality improvement cycle, AMS activities/interventions and biosecurity, vaccination and probiotics use into pre- and in-service training of all animal healthcare workers' groups.
ii. Develop or adapt facility-based training materials and standard operating procedures on AMS activities based on national and internationally recommended tools and adapted to the local context for use by animal health workers.
iii. Develop or adapt in-service training packages for policy-makers and animal health services managers to improve their understanding and strengthen their decision-making roles in implementing AMS activities.
iv. Integrate AMS concepts and principles within the university curricula and other complementary disciplines, for example the curriculum for IPC (41, 46).
v. Train and deploy appropriate human resources to support implementation of integrated AMS activities with expert-level skills and accountability.

4. **Antimicrobial alternatives/ prevention Strategies to explore, promote and strengthen alternatives to antimicrobials**

   a) **Implement robust and comprehensive biosecurity measures, good animal health husbandry and hygienic practices**

   Biosecurity measures are critical in controlling the spread of infections among terrestrial and aquatic animals and hence reducing the need for chemotherapeutic use of antimicrobials in animal agriculture. The importance of biosecurity in reducing AMR is applicable in the following areas: infection control, by implementing biosecurity measures helps in minimizing the introduction and spread of pathogens, which reduces the need for antimicrobials; protection from external threats because biosecurity practices safeguard farms from external disease threats, ensuring a healthier animal population (42, 47); and environmental impact as proper biosecurity reduces environmental contamination with resistant pathogens, protecting public health (43, 48). Proper nutrition strengthens the immune system, making animals less susceptible to infections. A robust immune response can reduce the need for antimicrobials, which are often used to treat bacterial infections (44, 49). Similarly, a balanced diet supports a healthy gut microbiome. A diverse and stable microbiome can out-compete pathogenic bacteria, reducing the chances of infections that require antimicrobials treatment. Also, good nutrition can help minimize stress in animals. Stress can compromise immune function, making animals more vulnerable to infections. Less reliance on antimicrobials in stress-free animals contributes to lower AMR rates. Phage therapy represents a novel and promising strategy for combating bacterial infections, particularly in the face of rising antibiotic resistance. While still in the developmental stage in many developed countries, ongoing research may expand its applications and establish it as a mainstream therapeutic option in the future (45, 50).

   Actions and Considerations.

   Effective biosecurity practices that can be explored, improved and strengthened include:

   i. Farm Hygiene: Regular cleaning and disinfection of facilities, equipment, and vehicles, including fallowing can significantly reduce pathogen load (46, 51).

   ii. Controlled Animal Movements: Limiting the movement of animals in and out of farms prevents the spread of diseases (47, 52). In addition restrict of movement of visitors and elimination of formites should be encouraged.

   iii. Monitoring and Surveillance: Establishing surveillance systems to detect and respond to disease outbreaks promptly can help manage potential AMR risks (48, 53).

   iv. Enhanced immune function, improved gut health and reduced stress; as a result of good animal nutrition should be encouraged.

v. The leadership of animal health sector should strengthen governance and investment in good nutrition for animals, promotion of good health, and enhanced immune response; which can significantly contribute to tackling this global challenge.

b) **Implement disease control measures such as vaccination, the use of prebiotics and probiotics and phage therapy in animal health facilities**

Vaccination is a preventive measure that can reduce the incidence of diseases, thereby minimizing the need for antimicrobials. Vaccines help in preventing infections that could otherwise require antimicrobial treatment. For instance, vaccines against Newcastle disease in poultry and foot-and-mouth disease in cattle have been shown to reduce the incidence of these diseases, thereby decreasing antimicrobial reliance (49, 54). Similarly, vaccination can lead to herd immunity, reducing the overall disease burden within a population. This effect lowers the chance of outbreaks that necessitate antimicrobial use (50, 55). Other disease preventive measures include the use of probiotics and prebiotics, and phage therapy, which are known to prevent animal diseases before they occur, thereby decreasing the need for antimicrobial treatments.

Actions and Considerations:

i. Encourage regular and routine vaccination procedures in all species of animals, wildlife and aquaculture.
ii. Develop simple and cost effective animal disease preventive measures to optimize growth and production and encouraged other sustainable practices.
iii. Local production of affordable animal vaccines, prebiotics and probiotics should be encouraged at the highest level of the leadership of animal health sector..
iv. Research to come up with the novel alternatives to antimicrobials such as phage therapy, Ethnoveterinary medicine, and antimicrobial peptides etc. in the reduction of AMR in animals should be encouraged and supported.

5. **Surveillance, monitoring and evaluation**

a) **Surveillance of antimicrobial use and consumption**

Documentation and reporting of antimicrobial use and consumption have multiple uses: helping to relate the exposure to antimicrobials with the development of AMR; identifying and providing early warning of problems relating to the pharmaceutical market, access to effective treatment, exposure to and utilization of antimicrobials and developing interventions to address problems identified; monitoring shortage or stock-outs of antimicrobials, and monitoring the outcomes of interventions aimed at changing behaviour;

assessing quality of prescribing against practice guidelines; and raising awareness among animal health professionals, consumers and policy-makers about AMR and the contribution of inappropriate use of antimicrobials animals (51, 56). Generation of good-quality evidence and awareness of the magnitude of the problem takes time. The methodologies for monitoring antimicrobial use and consumption vary according to the monitoring objectives and the maturity of the surveillance systems. Collected data on consumption and use each serve specific purposes and complement rather than replace each other. Antimicrobial use data refer to estimates derived from patient-level data, mostly collected by surveys and audits but also through reimbursement processes. These data may allow dis-aggregation of data based on animal's characteristics, or indication for which the medicine is being used. Depending on the source of information, it may be possible to determine the patients' symptoms, veterinarian's diagnoses and medications ordered. Such patient-level data will facilitate assessment of patient treatments, compliance of clinical practice with agreed protocols and treatment guidelines, identify animal and human populations at risk, inform policy-making and stewardship strategies towards more optimal antimicrobial use and assess the effect of targeted interventions.

Antimicrobial consumption refers to estimates derived from aggregated data sources such as import, production or wholesaler data, or aggregated livestock farm data in a specific setting (country, state, animal health facility). As such these consumption data are a proxy for actual use at patient level. Consumption data do not provide information on the patients who are receiving the medicines or why the antimicrobials are being used. Rather, the antimicrobial consumption data provide information on the types and quantities of consumed antimicrobials and are often used to inform routine surveillance and AMS programmes. Regular measurement and sharing of consumption information to prescribers and policy-makers are a first step in increasing the awareness and importance of optimal antimicrobial use. Over time, such aggregated data on the volume and pattern of antimicrobial consumption provide a more complete picture of the trends in antimicrobials use. The aggregated consumption data could also help to identify areas that could be investigated further, and therefore devise ways to increase access to antimicrobials where needed, including policy decisions regarding investment in surveillance, antimicrobial licensing, selection and supply, reimbursement, prescribing guidelines and formularies. The consumption data could also be used to monitor the impact of such decisions and follow-up interventions. These activities on surveillance of use and consumption of antimicrobials should be adapted to the objectives and target audience who will use these data for action.

Actions and Considerations:

i. Establish or enhance national surveillance programmes for antimicrobial use and consumption with defined structures, governance and work objectives (i.e. data collection, validation, analysis, reporting and data sharing with all stakeholders).
ii. Develop national, state, local government and facility level antimicrobial use and consumption surveillance methodology based on standardized international methodologies, including the WOAH, WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS) (52, 57 53, 58) and the ATC/DDD (Anatomic Therapeutic Chemical/Defined Daily Dose) system (54, 59).
iii. Develop or adapt tools to support a standardized and harmonized national system for documenting and reporting use of antimicrobials intended for use in accordance with internationally agreed guidelines, data sets, data sources in both primary and secondary care settings and use the information to inform integrated AMS activities.
iv. Introduce and use the antimicrobial consumption tool (AMC Tool) (55, 60) (an open-source program to calculate antimicrobial consumption) to compute antimicrobial consumption from packages data into DDDs.
v. Conduct surveys of antimicrobial use in health-care facilities in animal health and hospitals) based on internationally agreed guidelines, including WOAH/WHO Point Prevalence Survey methodology (56, 61), and enhance the utility of the data to inform programmatic decisions in integrated AMS activities locally and nationally.
vi. Promote and facilitate data sharing to optimize antimicrobial use and establish a system for routine support supervision, audit, and feedback of prescribing and dispensing practices based on antimicrobial use data.
vii. Include a periodic identification of the percentage of animal health-care facilities that have a core set of relevant antimicrobials available and affordable on a sustainable basis (57, 62).

b) **Surveillance of AMR**

Drug resistance surveillance is essential to inform the planning and implementation of integrated AMS activities. National authorities may fulfil this requirement through building laboratory capacity, standardization of methodology and operating procedures, internal and external quality assurance, and participation in NADIS, INFARM and AMRIS, and other established surveillance systems. Quality and representative data on both the aetiology of infections and the AMR profile should be collected routinely or periodically and utilized to inform AMS activity implementation and progress. Laboratory strengthening efforts should ensure that there is adequate infrastructure for conducting quality microbiological practices, including isolation, identification and susceptibility testing.

Actions and Considerations:

i. Conduct and facilitate national surveillance of antimicrobial consumption and use and AMR to inform the planning, implementation and monitoring of progress of integrated AMS activities and for better patient outcomes. The surveillance strategies to obtain quality and representative data to inform empiric treatment and the integrated AMS activities should be designed by the responsible national body for AMR surveillance.
ii. Strengthen laboratory capacities, processes and procedures to optimize diagnosis of infectious diseases and to improve pathogen identification and antimicrobial susceptibility testing.
iii. Facilitate the linkage of surveillance data on AMR, antimicrobial use and consumption with similar surveillance data in the human and environmental sectors to inform relevant policy decisions to contain AMR.

c) **Monitoring and evaluation of AMS activities**

Regular monitoring and evaluation help to assess the quality, effectiveness, coverage and delivery of integrated AMS activities and to make the necessary adjustment following a continuing quality improvement cycle. It promotes a learning culture within and across the programmes and ensures continuous quality improvement of individual and joint activities of AMS. Implementing internationally agreed standardized indicators for AMS activities and establishing standardized national reporting and recording formats to capture these indicators are essential.

The following are internationally agreed indicators for integrated AMS activities in animal health, which can be used to define core indicators and targets depending on the national context (58, 63):

- total animal consumption of antibiotics for systemic use (ATC J01) in DDDs per 1000 population of animals per day;
- proportion of Access antibiotics for systemic use, relative to total antibiotic consumption in DDDs;
- percentages of animal health facilities that have a core set of relevant essential antibiotics available and affordable on a sustainable basis;
- percentage of inpatient surgical procedures with appropriate timing and duration of surgical antimicrobial prophylaxis; and
- presence of legislation or regulation requiring that antimicrobials are only dispensed with a prescription from an authorized health worker.

National authorities should avail resources and evaluate the capacity in implementing these indicators and also introducing other optional process and outcome indicators based on the development of the health infrastructure and their national context to facilitate the implementation, monitoring and evaluation of integrated AMS activities. This can be facilitated by applying the

WHO AMS assessment tools at the federal, state, local government and animal health-care facility level.

Actions and Considerations:

i. Establish a national monitoring and evaluation framework, including internationally agreed core indicators for integrated AMS activities in animal health (59, 64). Other optional process and outcome indicator can be included based on national context. The national monitoring and evaluation framework should also define mechanisms to:
   a. use federal, state, local government and facility AMR and antimicrobial use and consumption data for continuous improvement of integrated AMS activities;
   b. ensure accountability procedures are put in place at the federal, state, local government and facility levels and facilitative supervision is promoted and local leadership and best practices recognized;
   c. undertakes a baseline assessment of federal, state, local government and facility AMS activities;
   d. integrates AMS monitoring and evaluation activities with monitoring of IPC and WASH indicators;
   e. Identify risks and enablers to the implementation process and propose appropriate actions, including through implementation science, behaviour change and continuous quality improvement principles.

ii. Develop federal, state, local government quality-of-care measures using integrated surveillance data to demonstrate change in patient management and outcomes as a result of implementation of stewardship activities, including antibiograms and locally tailored AMS plans.

iii. Consider conducting periodic post-market surveillance for antimicrobial agents for quality assurance.

14. STRATEGY AND TOOLS FOR AMS IN ANIMAL HEALTH

This section provides information describing the practical methods to bring the principles of AMS to the point of antimicrobial prescription. This represents a combination of strategies involving restriction, persuasion and enablement, which finally influence prescription decision behaviour.

i. **Restrictive** strategies require the prescriber to adhere to a set of rules as described by the veterinary formulary and prevents the prescribers from gaining access to certain antimicrobial agents unless criteria are met and formal approval is granted. This may occur before the prescription is written or at a decided time after the prescription has been filled as part of the post-prescription review.

ii. **Persuasive** strategies aim to improve prescriber's knowledge and change of attitudes and beliefs about prescribing through review and feedback.

iii. **Enablement** strategies make it easier for the prescribers to gain access to the information they need to prescribe appropriately.

Persuasive strategies are more widely practiced and more readily accepted by clinicians and provide greater opportunity to educate prescribers than restrictive strategies. Several leading guidelines on AMS endorse the use of a combination of restrictive, persuasive and enablement strategies to enable comprehensive stewardship in animal health facilities.

These strategies, the guidance to support them, and the practical tools that enable their implementation are summarized in Table 2.

Table 2: Strategies, rules, and tools for antimicrobial stewardship programmes

Strategy	Rules	Tools
Implementing clinical guidelines/SOPs consistent with prescription guidelines : antimicrobials that take into account local micro biota and antimicrobial susceptibility patterns	Prescribers prescribe according to current evidence-based guidelines. Prescribers are encouraged to follow care bundles in veterinary practice.	● Easy access to the current versions of AMU guidelines, including prescription standards and policies antimicrobial endorsement of evidence-based guidelines by the qualified registered veterinarians AMS champions. ● Barriers to guideline implementation- should be analyzed, discussed and mitigated . ● Advocacy support for political will for the implementation of the new guidelines. ● Creating awareness and communication activities about guidelines and care bundles in animal health. ● Regular Monitoring and evaluation of AMS activities. ● Institutionalization of AMS for sustainability
Implementing formulary restriction and approval systems that include restricting broad-spectrum and later-generation antimicrobials to patients in whom their use is clinically justified	prescribe according to the veterinary formulary. Approval is required for all highly restricted antimicrobials before use; an approval system must be used to register the indication for use of all restricted antimicrobials, and further approval sought if use exceeds 5 -7 days (Depending on the Antimicrobials, Animal species and clinical condition)	● Develop IECs tool (posters, fliers, handbills and web pages etc) that make the formulary rules explicit to all prescribers ● A formalized approval system should be in place (fax, phone, or electronic)
Reviewing antimicrobial prescribing, with intervention and	AMS teams are expected to review all patients receiving highly restricted	● AMS team to provide a regular individualized prescription review

Strategy	Rules	Tools
direct feedback to the prescriber	antimicrobials, or courses of restricted antimicrobials for more than five days (Depending on the Antimicrobials Animal species and clinical condition)	● Electronic tools may help prompt review and triage patients

The antimicrobial stewardship tools that are essential for optimizing the use of antimicrobials and reducing the spread of antimicrobial resistance are listed below:

1. Guidelines and Protocols

Clinical Guidelines: Evidence-based guidelines for appropriate antimicrobial prescription.

Empiric Therapy Protocols: Recommendations for initial treatment based on local resistance patterns.

2. Antimicrobials Order Forms

Pre-authorization Forms: Require justification for certain categories antimicrobials- as-recommended by veterinary regulatory authority before they can be prescribed.

Standardized Order Sets: Pre-defined sets of orders for common infections to streamline appropriate evidence based prescription.

3. Decision Support Tools

Clinical Decision Support Systems (CDSS): Tools integrated into electronic health records (EHR), like NADIS which provide real-time guidance on antimicrobial selection and dosage.

Alerts and Reminders: Automated notifications for prescribers about potential antimicrobial interactions, allergies, or appropriate alternatives.

4. Education and Capacity Building Programs

Training Programs: Educational sessions for animal health providers on the principles of antimicrobial stewardship.

Animal owners /Education: Informing clients about the appropriate use of antimicrobials the dangers of misuse.

5. Monitoring , Evaluations and Feedback

Antimicrobial Use Monitoring: Develop feasible and implementable indicators for regular review of antimicrobial prescription patterns using data analytics.

Feedback Reports: Providing prescribers with information on their antimicrobial prescribing compared to peers.

6. Infection Prevention and Control (IPC) Measures

Surveillance Programs: Tracking and reporting infection rates and resistance patterns.

Hand Hygiene Initiatives: Promoting practices that prevent the spread of infections.

7. Multidisciplinary Teams

Stewardship Committees: Involvement of one health team in the stewardship program.

Regular Meetings: Collaborative discussions to review cases and strategies for improvement.

8. **Research, Development and Quality Control Improvement**

To conduct needs-based research on AMR, AMU and AMS activities

To conduct clinical trials to Investigate new approaches to antimicrobial use and resistance.

Quality control Improvement Initiatives: Implementing changes based on feedback, on proper implementation of the SOPs and outcomes of ~~to~~ improve stewardship practices.

9. Public Awareness Campaigns

Test IECs and SBC tools and deploy for community outreaches

Community Outreach: Create awareness about antimicrobial resistance and appropriate antimicrobial use in the community.

Implementing these tools effectively can help healthcare institutions manage antibiotic use more responsibly and combat the growing threat of antimicrobial resistance.

10. **Impact Assessment of education and Capacity building**

Continually conduct impact assessment of education and capacity building on the effectiveness of the implementation of AMS using focus group discussion and linking it with the outcomes of monitoring and evaluation, thereafter, provide feedback to facilitators on outcomes.

15. AMS CAPACITY BUILDING MODULES

Antimicrobial Stewardship (AMS) training modules for the animal health sector are designed to educate animal healthcare professionals about the principles and practices of effective antibiotic use and resistance management. Some common topics and components that can be included in AMS training modules:

1. Introduction to Antimicrobial Stewardship
   - Definition and importance of AMS programme. Overview of antimicrobial resistance (AMR) and its global impact.
   - Understanding the National Structure of AMS.
2. Introduction to General Veterinary Microbiology
   - Understanding bacteria, viruses, fungi, and parasites.
   - Mechanisms of action of antimicrobials.
   - Resistance mechanisms and how they develop.
3. Guidelines for Appropriate Antimicrobial Use
   - Risk factors responsible (drivers) for development of Antimicrobial Resistance
   - Evidence-based prescription practices.
   - Indications for antibiotic therapy.
   - Duration of therapy and de-escalation strategies.
4. Laboratory Diagnosis and AST
   - Importance of microbiological testing (Isolation, identification and antimicrobial sensitivity testing (AST)).
   - Sample Collection, Handling and Submission

5. Overview of how veterinary medicinal products work
   - Basic principles of how antimicrobials work in animal body.
   - Dosing strategies and considerations for different animal species.Introduction to National Guidelines for the use of Antimicrobial Drugs in Animals
   - Introduction to Essential Veterinary Medicine Lists
   - Introduction to National Veterinary Formulary
   - Management of common infections
   - Local resistance patterns and their implications for prescription.
6. Monitoring and Evaluation of Antimicrobial Use
   - Methods for tracking antimicrobial prescription patterns.
   - Interpreting institution/facility AST and AMU data to inform practice.

7. Communication
   - Awareness creation
   - Advocacy
   - Sensitization
   - Research

- Economic impact of antimicrobial resistance
- Data collection

- Strategies for discussing antimicrobial use with clients.
- Educating the end-users about the risks associated with antimicrobial misuse.
- Communicating AST and AMU data to relevant stakeholders

8. Alternatives to antimicrobials
   Water Sanitation and Hygiene (WASH), Biosecurity, Vaccination, Nanotherapy, Ethnoveterinary medicine, Prebiotics and probiotics, Phage therapy, Ozone therapy.
9. One health Collaboration
   - Importance of collaboration among animal, human healthcare and environment professionals.
   - Capacity building on one health collaboration
   - Roles of veterinary pharmacists, clinicians and microbiologists in AMS.
10. Case Studies
    - Case studies to apply knowledge.
    - Challenges and solutions in implementing AMS.
11. Ethical and Legal Considerations
    - Understanding the ethical implications of antimicrobial prescription.
    - Understanding Prescription standards.
12. Evaluation and Continuous Improvement
    - Assessing the effectiveness of AMS initiatives.
    - Strategies for ongoing education and training.
13. AMS Leadership and Governance Structure at the Facility Level
    - Understanding the Leadership and Governance Structure for a Successful Antimicrobial Stewardship.
    - Understanding the different roles of AMS Committee and Team members..
    - Highlight Attributes and Qualifications of Potential AMS Leaders in a Health Facility.
14. Conceptual Framework of AMS Programme
    - Understanding the organizational framework of a facility AMS programme
    - Understanding the Structures and Resources needed for the AMS Programme
    - Understanding the Inter-relatedness of ASP with other Hospital Programmes
    - Understanding the Primary and Secondary Outcomes of an AMS programme and associated key performance indicators (KPIs).
15. AMS Intervention
16. Understanding core and supplementary AMS activities.
17. Understanding the how-to of prospective audit and feedback.
18. Understanding the how-to of pre-authorization and formulary restriction.
19. Understanding the limitations/challenges with each intervention.

20. Explore possible interventions at different levels of care.

21. Drivers and Barriers to AMS Programme in Animal Health Facilities

- How to identify drivers and barriers of AMS Programmes
- Optimizing drivers of AMS Programmes
- Mitigating barriers of AMS Programmes.

Delivery Method

- E-Learning Modules: Online courses that allow for self-paced learning.
- Workshops and Seminars: In-person or virtual sessions for interactive learning.
- Webinars: Short, focused presentations on specific topics.
- Simulation Exercises: Role-playing scenarios to practice decision-making.

Certification and Continuing Education

Many AMS training programs offer certification or Continuing Education (VCN CE) credits units to encourage participation and enhance professional development (Not less than 6 Credit Unit). Implementing these training modules can help animal healthcare teams improve their understanding of AMS, leading to better patient outcomes, reduced tissue residues of antimicrobials, and reduced antimicrobial resistance.

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APPENDIX I: STAKEHOLDERS MAPPING ON ANTIMICROBIAL STEWARDSHIP

S/N	Stakeholder	Influence	Interest
1	Federal Ministry of Livestock Development (FMLD)	High	High
2	Federal Ministry of Agriculture and Food Security (FMAFS)	High	High
3	Federal Ministry of Health and Social Welfare (FMSW)	High	High
4	National Agency for Food and Drug Administration and Control (NAFDAC)	High	Low
5	Nigeria Agricultural Quarantine Service (NAQS)	High	High
6	Nigeria Centre for Disease Control and Prevention (NCDC)	High	High
7	Veterinary Council of Nigeria (VCN)	High	High
8	State Ministries in-charge of Animal Health	High	High
9	Veterinary Teaching Hospitals (VTHs)	High	High
10	Nigerian Veterinary Medical Association (NVMA)	High	Low
11	Poultry Association of Nigeria (PAN)	High	Low
12	Livestock Farmers Association (MACBAN, National Sheep and Goat Association of Nigeria)	High	Low
13	Aquaculture farmers (Fish farmers Association, National Association of Crayfish & Shrimps farmers)	Low	High
15	Feed Industry Professional Association of Nigeria (FIPAN)	High	High
16	Small Animal Veterinary Association of Nigeria (SAVAN)	High	High
17	Association of Poultry Veterinarians in Nigeria	High	High
18	National Association of Academic Technologist (NAAT)	High	Low
19	Universities and Colleges of Agriculture	High	High
20	Veterinary Schools	High	High
21	Research Institutes (NVRI, NAPRI, NITR, NIOMR)	High	High
22	Pharmaceutical Companies and Veterinary and Allied Drug Marketers	High	Low
23	Mott McDonald	High	High
24	Livestock Industries; and Animal Feed Manufacturers	High	Low
25	Fleming Fund	High	High

26	World Organisation for Animal Health (WOAH)	High	High
27	Food and Agriculture Organization (FAO) of the United Nation	High	High
28	World Health Organization (WHO)	High	High
29	African Union-Inter-African Bureau for Animal Resources (AU-IBAR)	High	High
30	ECOWAS	High	High
31	UKAID	High	High
32	Management Sciences for Health (MSH)	High	High
33	Centre for Disease Control and Prevention (CDC)	High	High
34	Veterinary Extension Officers	Low	High
35	Security Agencies	High	Low
36	General Public	Low	Low
37	Sales Representatives/Drug distributors	Low	Low
38	Veterinary shop owners	High	Low
39	Petty traders and hawkers of veterinary drugs in open markets	High	Low
40	Livestock Marketers	Low	Low
41	Live bird Marketers	Low	Low
42	Public Health Professionals	Low	High