Title:

Antimicrobial Use/Consumption Surveillance in Zimbabwe: Desk Review Report

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Abbreviations

AAS	Annual Agricultural Survey
ADCD	Animal Defined Course Dose
DDD	Animal Defined Daily Dose
AGISAR	Advisory Group for Integrated Surveillance for Antimicrobial Resistance
AGRITEX	Department of Agricultural Extension
AHI	Animal Health Inspector
AHMC	Animal Health Management Centre
AMC	Antimicrobial Consumption
AMR	Antimicrobial Resistance
AMU	Antimicrobial Use
APHIS	Animal and Plant Health Inspection Service
ARF	Agricultural Revolving Fund
AST	Antimicrobial Susceptibility Testing
AWT	Average Weights at Treatment
CDDEP	Center for Disease Dynamics, Economics and Policy
CIPARS	Canada Integrated Program for Antimicrobial Resistance Surveillance
CVL	Central Veterinary Laboratory
CVM	Centre for Veterinary Medicine
DCDvet	Defined Course Dose for Animals
DDDA	Defined Daily Dose for Animals
DDDvet	Defined Daily dose for animals
DVFS	Division of Veterinary Field Services
DVO	District Veterinary Officer
DVTS	Division of Veterinary Technical Services
DVS	Department of Veterinary Services
EEA	European Economic Area
EMA	European Medicines Agency
ESBL	Extended Spectrum Beta-Lactamase
ESVAC	European Surveillance for Veterinary Antimicrobial Consumption
EU	European Union
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Statistical Databases
FDA	Food and Drug Administration
GAP	Global Action Plan for Antimicrobial Resistance
GDP	Gross Domestic Product

GLASS	Global Antimicrobial Resistance and Use Surveillance System
LMIC	Low and Middle Income Countries
MCAZ	Medicines Control Authority of Zimbabwe
MoHCC	Ministry of Health and Child Care
NAHMS	National Animal Health Monitoring System
ODK	Open Data Kit
PCU	Population Correction Unit
PVO	Provincial Veterinary Officer
PVS	Performance of Veterinary Services
TI	Treatment Incidence
USDA	United States Department of Agriculture
UBOS	Uganda Bureau of Statistics
UK	United Kingdom
US	United States
USA	United States of America
VARSS	Veterinary Antimicrobial Resistance and Sales Surveillance
VASR	Veterinary Antimicrobial Sales Reporting
VES	Veterinary Extension Supervisor
VEW	Veterinary Extension Worker
VPH	Veterinary Public Health
VPHO	Veterinary Public Health Officer
WAHIS	World Animal Health Information System
WHO	World Health Organization
WOAH	World Organization for Animal Health (ex OIE - Office International des Epizooties)

EXECUTIVE SUMMARY

Antimicrobial Resistance (AMR) now poses a significant global threat to animal and human health, and over the years, inappropriate antimicrobial use (AMU), both in animals and humans, has been identified as the most significant driver of AMR. Recognizing the urgent need to tackle AMR, in 2015, the WHO, WOAH and FAO endorsed a Global Action Plan (GAP) on AMR, which includes five strategic objectives targeted at curbing AMR development. Amongst these objectives is the need to "strengthen knowledge through surveillance and research". Zimbabwe, being one of many countries in Africa experiencing challenges arising from AMR in both the animal and human health sectors, needs to map a way forward to address this critical challenge.

The objectives of this report were firstly to determine the current status of antimicrobial use or consumption (AMU/C) surveillance in Zimbabwe in the animal sector and identify gaps in knowledge. Secondly, to explore AMU/C surveillance strategies in food-producing animals in other countries, including data collection methods, data entry platforms, data analysis and reporting. Finally, to provide a situational analysis of existing systems, plans, software platforms and human and physical resources in relevant institutions in Zimbabwe with the view of identifying potential strategies for implementing AMU/C surveillance in the country.

Methods

The objectives were addressed through various methods, including key informant interviews of personnel in key government institutions such as the Department of Veterinary Services (DVS) and the Medicines Control Authority of Zimbabwe (MCAZ), among others. Information was also derived from relevant publications searched from scientific databases, including PubMed and PLOS.

Key findings

The first part of the report describes the situation analysis of Zimbabwe, which details the country's animal production sector and the Department of Veterinary Services (DVS), and AMR & AMU/C surveillance initiatives in the country, including the reporting of AMU/C data to the WOAH. The second part of the report reviews global standards and methods for AMU/C in animals, including the WOAH standards for AMC data collection. Also included in this section are the AMU/C surveillance strategies in food-producing animals in Low-and Middle-Income Countries (LMICs) and high-income countries (HICs). The report also includes a brief on the different types of antimicrobial use metrics and indicators used in AMU/C surveillance in food-producing animals, as well as their advantages and disadvantages. The last section of the report includes proposals for implementing AMU/C surveillance in Zimbabwe and a feasibility assessment for each proposal.

Conclusion and recommendations

Zimbabwe generally has adequate human resource capacity to implement AMU/C surveillance in food-producing animals. The key personnel to perform these activities will need to be identified and adequately capacitated through training and provision of other key resources. To coordinate the AMU/C surveillance activities, the relevant institutions, the DVS and MCAZ, will need to collaborate closely to conduct the process activities efficiently. Of paramount importance is that the two government institutions will also need to establish funding mechanisms for AMU/C surveillance in food-producing animals in order to make it sustainable.

1 Introduction

Antimicrobials are used worldwide, both in humans and in animals, for the prevention and treatment of infectious diseases and as growth promoters in animal farming in some countries (McEwen and Ferdoka-Cray., 2002). However, the development of antimicrobial resistance (AMR) threatens to undermine decades of progress in the treatment of infectious diseases and hence, become a serious threat to global health (Jasovsky., 2016). 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 (WHO, 2020). A correlation between antimicrobial resistance (AMR) and antimicrobial use (AMU) in animal production has been firmly established from observational studies (Burow *et al*., 2014 and Simoneit *et al*., 2014), country AMU/AMR surveillance data (Asai *et al*., 2005 and Chantziaras *et al*., 2005), and statistical meta-analyses (Bell *et al*., 2014). This development of AMR has been attributed to the selective pressure exerted on microorganisms (bacteria, fungi, viruses and parasites) by the widespread use and misuse of antimicrobials (Van Boeckel et al., 2015).

With the apparently ever-increasing global demand for animal source nutrition, livestock production systems in low-to-middle-income countries (LMICs) will become more intensive, leading to a further increase in antimicrobials used in these production systems (Van Boeckel *et al*., 2015). Surveillance and monitoring are widely acknowledged as critical components of the response to antimicrobial resistance (AMR), with the measurement of AMU in human health and animal health and production settings as a central goal of the Global Action Plan on Antimicrobial Resistance (WHO Global Action Plan on Antimicrobial Resistance, 2015) and complementary plans and strategies developed by the Food and Agriculture Organization of the United Nations (FAO) and World Organization for Animal Health (WOAH) (FAO Action Plan on Antimicrobial Resistance 2016-2020; OIE Strategy on Antimicrobial Resistance and the Prudent Use of Antimicrobials, 2016).

Antimicrobials used in animal and human medicine are very similar (FAO, 2007) and therefore resistance against antimicrobials in human medicine is of utmost concern (Critically Important Antimicrobials for Human Medicine, 2011). Antimicrobial use (AMU) data refer to estimates derived from patient-level data. This data may allow disaggregation based on patient characteristics or indications for which the medicine is being used. On the other hand, antimicrobial consumption (AMC) data refers to estimates derived from aggregated data sources such as import or wholesaler data or aggregated health insurance data where there is no available information on the patients receiving the medicines or why the antimicrobials are being used. These data sources provide a proxy estimate of the use of antimicrobials (WHO, 2018). Surveillance is the ongoing and systematic collection, analysis, and interpretation of health-related data essential to the planning, implementation, and evaluation of service delivery and public health (WHO, 2005).

Despite the growing recognition of the problem of AMR and the urgent need for setting up surveillance systems for both AMR and AMU, this is not yet systematised in the animal sector in Zimbabwe. There is also a need to learn how this surveillance is being implemented in other countries to incorporate some of the aspects learned into Zimbabwe's surveillance systems.

1.1 Objectives of the report

The objectives of this report include the following:

1. To review the current state of Zimbabwe's antimicrobial resistance (AMR) and antimicrobial use/consumption (AMU/AMC) surveillance systems in the animal health sector, identifying strengths and weaknesses.
2. To explore how AMU or consumption (AMC) is monitored and reported in different countries worldwide in food-producing animals with the view of informing the relevant authorities in Zimbabwe on strategies to adopt or refine the implementation of AMU/AMC surveillance in the animal sector.
3. To explore various options for implementing AMU surveillance in the animal production sector of Zimbabwe and to determine how feasible these options are within the country's available resources.

2 Methodology

This review was carried out between June and September 2021, addressing the three objectives of this report. To address objective 1, the following documents were used: Situation Analysis of Antimicrobial Use and Resistance in Humans and Animals in Zimbabwe 2017 and the Zimbabwe One Health Antimicrobial Resistance National Action Plan 2017-2021. Three key informants were also interviewed, one from the Medicines Control Authority of Zimbabwe (MCAZ) and two from the Department of Veterinary Services (DVS).

For objective 2, the PubMed and PLOS databases were searched for information on AMU/AMC surveillance globally. The following terms were used to search publications titles using the following keywords; "AMU surveillance in food-producing animals" and "methods of AMU surveillance in food-producing animals". Only English-written full-length research articles and review papers were considered. In addition, publications from the World Health Organisation (WHO), The World Organization for Animal health (WOAH, ex-Office International des Epizooties - OIE) and the Food and Agriculture Organisation of the United Nations (FAO) websites were also searched and reviewed, together with those of the European Surveillance for Veterinary Antimicrobial Consumption (ESVAC) and the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS). A total of 26 articles and 5 websites were scrutinised to extract information on AMR, AMU/AMC and their surveillance systems.

To address objective 3, the Situation Analysis of Antimicrobial Use and Resistance in Humans and Animals in Zimbabwe 2017 and the Zimbabwe One Health Antimicrobial Resistance National Action Plan 2017-2021 documents were scrutinised to obtain information on existing systems and capacities for AMU/C surveillance. The online database search (PubMed and PLOS) used for objective 2 also yielded research publications and review articles, which, together with websites of ESVAC and CIPARS, were scrutinised for information to address objective 3. Three key informants were also interviewed, one from MCAZ and two from DVS, to obtain information for addressing this objective.

3 Results

The results are in three sections. First, an introduction to the context of Zimbabwe's animal production and veterinary medicine sector. Second, a review of antimicrobial consumption and use surveillance approaches. Third, a consideration of options for surveillance of antimicrobial consumption and use in Zimbabwe's animal sector moving forward.

3.1 Situation analysis: Zimbabwe context and current AMU/C in animals

3.1.1 Geographic and Demographic context of Zimbabwe

Zimbabwe is a landlocked country in southern Africa, lying wholly in the tropics. The 2012 national census of Zimbabwe reported the country's population to be about 13 million (Zimbabwe Population Census National Report 2012). The 2019 United Nations World Population Prospects estimated Zimbabwe's population at 14 438 802 in 2018 (United Nations website). The next national census is due in 2022. The 2012 national census indicated that the country's population was relatively young, with 41% of the population being below the age of 15 years and about 4% being age 65 years and above. The majority of the country's population (67%) lived in rural areas.

3.1.2 Economic context

Zimbabwe has faced serious economic challenges over the years. It experienced hyperinflation and economic contraction from 2000 to 2008, leading to adopting a multicurrency regime (dollarisation) in 2009. This ushered in a brief period of macroeconomic stability and positive economic growth. The country again returned to hyperinflation in 2018, which it is still experiencing, with a year-on-year inflation rate of 99.3% as at April 2021 (International Monetary Fund website). However, in the year 2021, there has been a slight upturn in the economy, with the country's Gross Domestic Product (GDP) projected to reach 3.9% after a two-year recession (World Bank Zimbabwe Economic Update., 2021).

3.1.3 Overview of the animal production sector in Zimbabwe

The agriculture sector is one of the most important pillars of Zimbabwe's economy. 70% of Zimbabwe's population lives in rural areas, and the majority depend directly or indirectly on agriculture. The sector contributes about 15% to the country's Gross Domestic Product (GDP). The livestock industry specifically contributes to 20% of the agricultural GDP or 4% of the country's GDP. Animal agriculture involves commercial beef and dairy production, sheep and goats, free range, commercial meat and egg poultry, and fish and honey bee products. Zimbabwe's current livestock population is estimated to include about 5.5 million cattle, 4.3 million goats, 500 000 sheep and 200 000 pigs (Zimbabwe Second Round Crop and Livestock Assessment Report 2019/2020). Broiler production largely dominates the poultry production sector, with the country producing an annual average of 72 million day-old chicks since 2020. Antimicrobials are used in Zimbabwe's animal sector to either treat sick animals or for prophylaxis, predominantly in poultry and pig production (Situational analysis of Antimicrobial Use and Resistance in Humans and Animals in Zimbabwe, 2017). The amounts and types of antibiotics used in different animal production sectors, and the rationales for these uses, are not well documented.

3.1.4 General organisation of the Veterinary Services in Zimbabwe

The current organisation of the Department of Veterinary Services (DVS) is depicted in Figure 1 below.

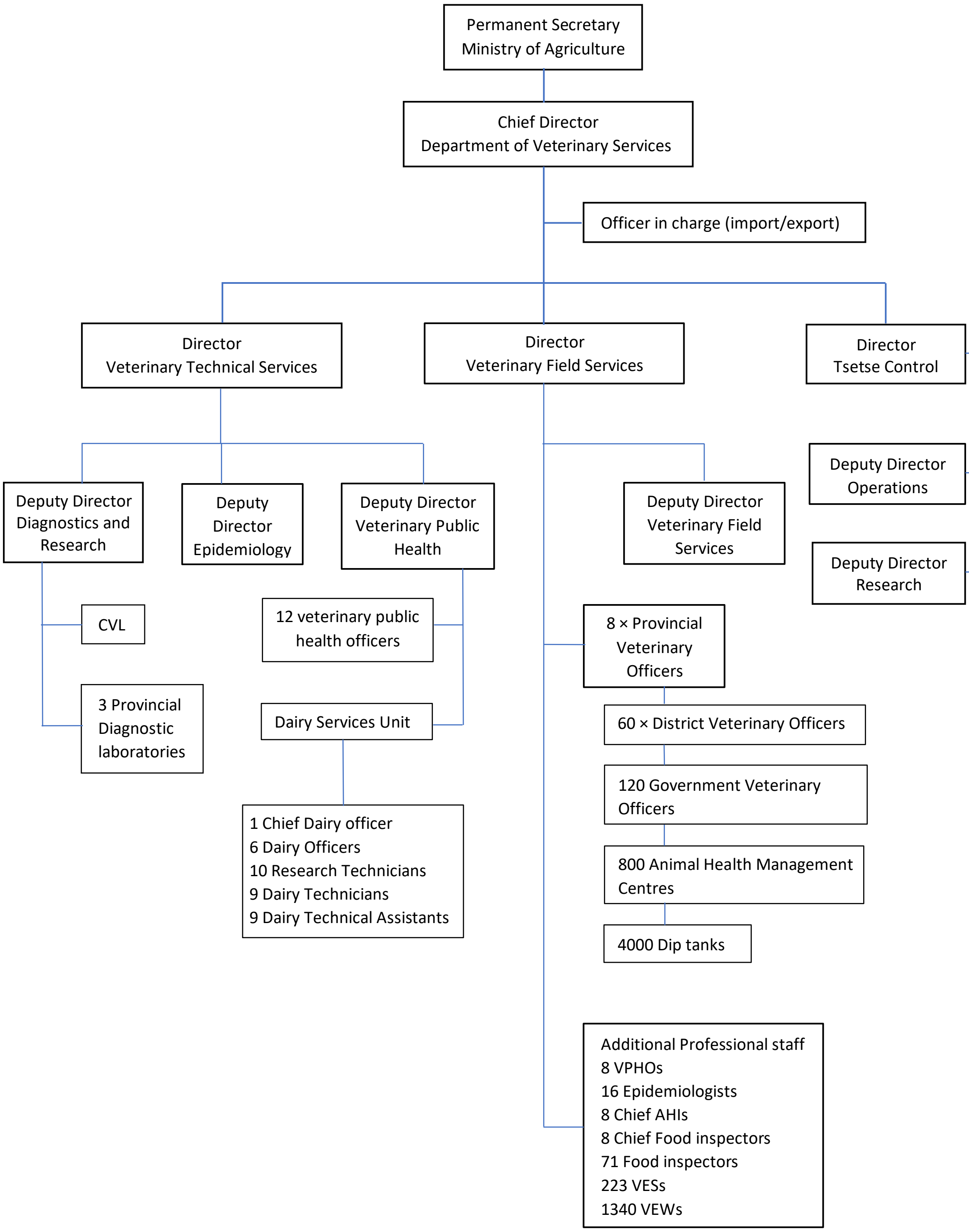

***Figure 1:** Organisation of the Zimbabwe Department of Veterinary Services*

The Department of Veterinary Services (DVS) is divided into three divisions, namely the Division of Veterinary Field Services (DVFS), the Division of Veterinary Technical Services (DVTS), and the Division of Tsetse Control. The overall mandate of DVS is to prevent the entry, establishment, spread and resurgence of animal diseases and pests of major economic and public health importance while mainstreaming animal welfare standards. The main two divisions in DVS relevant to antimicrobial use (AMU) are DVFS, which is the largest division by staff composition, and DVTS. DVFS is mainly responsible for animal disease surveillance and coordination of vaccination programs for specified animal diseases and cattle dipping for tick-borne disease control. DVTS mainly focuses on technical veterinary aspects, such as laboratory diagnosis and research, epidemiology and informatics and veterinary public health.

Within DVS, there is a vertical organisation which provides a simple direct line of control, delegation and reporting- the "chain of command", which is effective and managed. For example, in DVFS, information is reported from the lowest field office level (Animal Health Management Centre- AHMC) to a District Veterinary Officer (DVO) and thence to a Provincial Veterinary Officer (PVO), who, in turn, reports to the Director of Veterinary Field Services. There are 60 district veterinary offices, and below the district level, there are local AHMCs, a total of 800 nationally. Within the jurisdiction of each AHMC area, there are a number of dip tanks (usually 3 to 8/AHMC), which total about 4,000 across the country. AHMCs are field veterinary centres from which animal health and extension services are delivered, and the dip tanks are managed under the supervision of Veterinary Extension Workers (VEWs), who monitor and report the numbers of animals dipped, collect dip-tank fees and report any suspected notifiable disease occurrences. The DVS has one Central Ventral Veterinary Laboratory (CVL) and three provincial veterinary laboratories. DVS also has access to specialist testing by private laboratories within Zimbabwe and abroad as necessary. There are at least seven reported and accredited private veterinary laboratories which can perform certain tests on behalf of the DVS.

In Zimbabwe, the food safety of animal products is regulated through the Public Health Act [Chapter 15:17], which is implemented by the Ministry of Health and Child Care (MoHCC) with some delegated authority to local authorities and DVS. The Veterinary Public Health (VPH) branch in DVTS is responsible for this role. The Diagnostics and Research branch of the Division of Veterinary Technical Services (DVTS) captures and stores data through an information management system called SILAB, with subsequent data analysis being done using Microsoft Excel. Data collection in the Veterinary Public Health (VPH) branch of DVTS is paper-based, with the data then entered into Microsoft Word documents. The VPH branch is planning to develop an Excel database where all data generated in the future will be stored. Primary data collection in the Division of Veterinary Field Services (DVFS) is paper-based but then entered into an Excel database by provincial veterinary epidemiologists, who then finally transmit the data to a central Excel database in the Epidemiology Unit of DVFS.

3.1.4.1 DVS operational funding

The main activities of the DVS at central headquarters are funded through an allocation provided by the Ministry of Finance based on proposed activities. These funds are utilised for operational costs of all activities based at the DVS headquarters, including those of the Disease Prevention and Control Section (mainly vaccine procurement and distribution), the CVL (reagents), the Epidemiology Unit and the VPH branch. Some of the central DVS funding is utilised for field operations; however, most field activities are funded through the Provincial Veterinary Office, which is financed through the retention of a (variable) percentage of the fees collected by the DVS Agricultural Revolving Fund (ARF) in the course of providing services, including mainly dip-tank fees, movement permit fees, meat inspection fees, among other licencing fees. As seen in Figure 2 below, there is still a serious shortage of funds being made available to DVS to perform anything more than the most essential core activities related largely to licensing and inspection/approval of various premises or establishments.

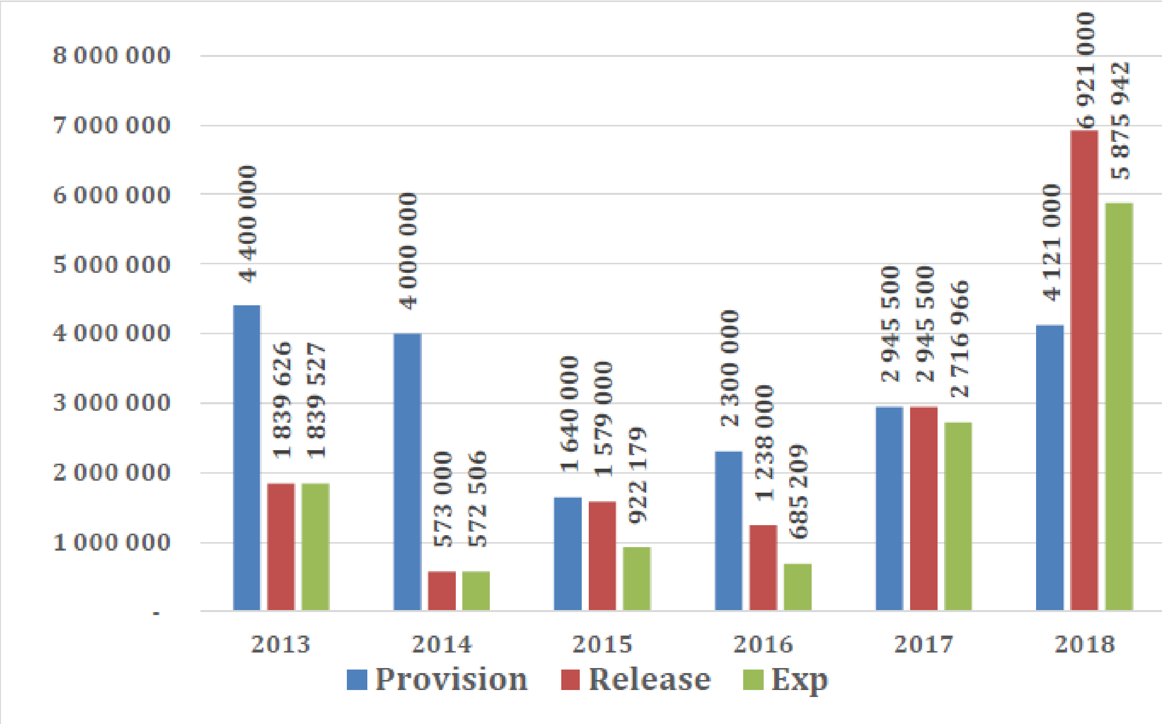

Figure 2: Funds released to DVS from the National Treasury for the 2013 to 2018 period (in United States Dollars)

3.1.4.2 Performance of the Zimbabwe Veterinary Services

Zimbabwe is a member of the World Organization for Animal Health (WOAH). In order to assess the status of implementation of veterinary services in its member states, the WOAH conducts periodic Performance of Veterinary Services (PVS) Pathway missions. Since 2009, Zimbabwe has undergone four PVS missions, namely the PVS Evaluation (initial) in 2009, PVS Evaluation (follow-up) in 2018, PVS (Gap-Analysis) in 2014 and PVS (Legislation) in 2015. Key strengths and weaknesses of DVS found in the most recent PVS Evaluation mission of 2018 are indicated in Table 1 below.

Table 1: Strengths and weaknesses of DVS, according to the 2018 PVS Evaluation mission

	Strengths		**Weaknesses**
1	High number of qualified and experienced staff, both veterinarians and veterinary paraprofessionals	1	Low levels of motivation for most veterinary personnel, due to poor salaries and loss of other benefits
2	The Ministry Permanent Secretary is respectful of the technical decisions being made by senior decision makers in DVS as members of a Livestock policy hub and stand by their decisions	2	There is variable level of veterinary supervision of veterinary paraprofessionals
3	The DVS uses a performance assessment framework to monitor progress against defined strategic objectives and activities.	3	Lack of mobility, equipment, veterinary medicines and other supplies for veterinarians and paraprofessionals to perform their functions effectively
4	A strong and direct chain of command between central headquarters to AHMCs via provincial and district veterinary offices	4	There is no formal training plan in use by DVS and no regular continuous education courses are available
5	Good Standard operations procedures have been prepared for guidance of field operators.	5	There is currently insufficient use of animal health and production data being collected via field reporting, for the purpose of planning risk-based animal health and production programmes
6	Excellent collaboration with MoHCC with regards to the regulation of distribution, sale and use of veterinary medicines.	6	Split in chain of command of VPH department officers working at provincial level
7	Good levels of collaboration with most other external institutions with common interest of the DVS	7	Insufficient use being made of an agreement between MoHCC and DVS authorising veterinary inspectors to inspect veterinary drug retail outlets on their behalf.
8	Emergency funds for sanitary emergencies can be accessed from central government through a relatively straight forward process	8	Insufficient funds from central government for the DVS to carry out many of its core functions
		9	Over-reliance on external funding for capital investments, maintenance and repair of infrastructures and equipment
		10	There is no specific fund set aside for coping with sanitary emergencies or compensation

3.1.5 AMR Action in Zimbabwe's animal sector

3.1.5.1 AMR Policy and legislative context

In 2017, Zimbabwe launched a One Health Antimicrobial Resistance National Action Plan (2017- 2021), which set the tone for the country's response to AMR. This National Action Plan (NAP) was drafted to address challenges identified in the 'Situational Analysis on Antimicrobial Use and Resistance in Humans and Animals in Zimbabwe' (CDDEP) report, also produced earlier in 2017. The strategic objectives of the NAP are in line with those of the WHO GAP for AMR, with the second one being to "*improve understanding of the AMR burden and antimicrobial use patterns through surveillance*". This was to be achieved through strengthening diagnostic laboratory capacity for AMR, developing a "One-

Health" integrated surveillance system, establishing an AMU monitoring system for antimicrobials for human and animal use, and strengthening capacities for generating and analysing AMR/AMU data.

The major pieces of legislation governing the animal health sector in Zimbabwe in the context of AMR and AMU include:

1. Animal Health Act [Chapter 19:01] (1970): This provides for the prevention of the entry, establishment and spread of animal diseases and pests of major economic and zoonotic importance through the implementation of various animal health sanitary measures, among them surveillance, quarantine, test and slaughter of reactors, public education, inspection, certification and movement control.
2. Public Health Act [Chapter 15:17] (2002): This creates a legal framework for the protection of public health in Zimbabwe and, for this purpose, provides for powers of the administration (Ministry of Health and Child Care) to regulate and control the slaughter of animals, food production and handling, food and water supply, animal diseases etc.
3. Veterinary surgeons Act [Chapter 27:15]: provides for the regulation of the practice of veterinary surgery and medicine in Zimbabwe and all matters related to the practice.
4. Medicines and Allied Substances Control Act [Chapter 15:03]: This provides for the establishment of the Medicines Control Authority of Zimbabwe, which regulates the registration of medicines, together with instituting controls and restrictions to medicines and other substances.
5. Dangerous Drugs Act [Chapter 15:02]: This provides for the control of the importation, exportation, production, possession, sale, distribution and use of dangerous drugs
6. Fertilizers, Farm Feeds and Remedies Act [Chapter 18:12]: this provides for the registration of fertilizers, farm feeds, sterilizing plants and certain remedies (including antimicrobials in feed) and to regulate and restrict the importation and sale of fertilizers, farm feeds and certain remedies.

3.1.5.2 Antimicrobial Resistance Surveillance in Zimbabwe's animal health sector

In the animal health sector, antimicrobial susceptibility testing (AST) is conducted in public and private veterinary laboratories. In the public sector, the Central Veterinary Laboratory (CVL) is the country's reference centre for veterinary diagnostic laboratory testing. It is complemented by three provincial veterinary diagnostic laboratories in Mutare, Bulawayo and Masvingo. There is also the University of Zimbabwe Veterinary Science Faculty Bacteriology laboratory and two private veterinary laboratories conducting bacterial identification and AST testing. However, the collaboration between public and private veterinary laboratories, particularly in the sharing of isolates and AST results from private laboratories, remains limited.

Structured AMR surveillance in the public sector is mainly done during projects funded by development partners, such as the AGISAR and ESBL Tricycle projects, both 'One-health' in nature and funded by the WHO. In 2019 AMR surveillance was done for *Escherichia coli* and *Salmonella* under the AGISAR project. The CVL is currently involved in the ESBL Tricycle project, involving collection of poultry ceca samples, bacterial culturing for *Escherichia coli* and then conducting ASTs on isolates. The project aims to run the process on a total of 240 samples.

During laboratory testing at the CVL, ASTs are routinely done on milk samples, as the Mastitis Control Scheme requires. For other sample types, ASTs are only done at the customer's request. AST results have been traditionally entered into a computer at the CVL, albeit in an unstructured way. The CVL now uses a laboratory information management system (SILAB), which stores data for routine laboratory testing and its developers are currently developing a module to capture AMR data. It is also planned to decentralise SILAB to the provincial veterinary diagnostic laboratories.

Currently, CVL staff have no formal training on the Global Antimicrobial Resistance and Use Surveillance (GLASS) program, nor have they been formally incorporated in it by their human health counterparts, despite conducting ASTs on GLASS priority pathogens such as *Escherichia coli, Staphylococcus aureus, Salmonella* and *Klebsiella*.

3.1.5.3 Antimicrobial Use/Consumption Surveillance in Zimbabwe's animal health sector

The Medicines and Allied Substances Control Act [Chapter 15:03] identifies the Medicines Control Authority of Zimbabwe (MCAZ) as the competent authority in regulating the importation, manufacture, distribution, sale, and use of both human and veterinary medicines, blood and blood components, medical devices, in-vitro diagnostics and certain biological reagents (OIE Veterinary Legislation Identification Mission Report, 2015). The authority does not receive government funding but charges statutory fees to applicants for various services it offers, including registration of medicines and licensing of persons and premises. The MCAZ falls under the Ministry of Health and Child Care (MoHCC).

3.1.5.4 AMC reports to the WOAH

To date, Zimbabwe has reported AMC data to the WOAH for the years 2015, 2017 and 2018. A closer look at these years reveals that Zimbabwe did not report data for 2016, 2019 and 2020. Table 2 below shows the reporting options, and antimicrobial quantities reported to the WOAH for Zimbabwe.

Table 2: Antimicrobial quantities reported to the WOAH by Zimbabwe

Reporting year	WOAH Reporting option	Antimicrobial class	Quantity consumed (kg)
2015	1	Penicillins	430
		Sulfonamides	2810
		Tetracyclines	1781
		Aggregate (enrofloxacin, colistin, neomycin)	2501
2017	2	Cephalosporins	5
		Macrolides	207
		Quinolones	123
		Penicillins	1060
		Sulfonamides	753
		Tetracyclines	3509
2018	2	Aminoglycosides	221
		Flouroquinolones	1441
		Glycopeptides	1000
		Macrolides	407
		Polypeptides	184
		Sulfonamides	1192
		Tetracyclines	2337

In all the reporting years, the AMC data is purely for veterinary medical use, with none for non-therapeutic (growth promotion) reported. The AMC data reported was also not differentiated by route of administration. All AMC data reported for Zimbabwe so far was based on the MCAZ import data. It was also intimated in all reports that Zimbabwe does not have legislation on the use of antimicrobial agents as growth promoters in animals. Furthermore, Zimbabwe does not yet publish online national reports of antimicrobial use or sales data in animals. The estimated coverage of accessible AMC data of Zimbabwe reported to the WOAH, out of the total amount, was estimated at an average of 90%, with the residual 10% covering illegal antimicrobial imports and counterfeits. It is also important to note that Zimbabwe's AMC data reported to the WOAH consists of numerator data, i.e. antimicrobial quantities consumed in kilograms per antimicrobial class, with no denominator (animal biomass) data; hence, Zimbabwe's AMC data is not adjusted by biomass. This means that Zimbabwe's AMC data in animals currently cannot be compared with other countries, within Africa and other WOAH regions.

From the data submitted so far to the WOAH, tetracyclines are the most imported antimicrobials, followed by sulfonamides (including trimethoprim), fluoroquinolones and penicillins, in decreasing order, and this trend is similar to that of other African countries (Zuhura *et al*., 2020). To date, there has never been any farm-level AMU surveillance across all animal species in Zimbabwe.

3.2 Review of standards and methods for AMU/C in animals

3.2.1 WOAH standards for AMC Data collection

Towards the standardization of surveillance and monitoring of AMU worldwide, the WOAH developed standards on "Monitoring of the quantities and usage patterns of antimicrobial agents in food-producing animals"[Terrestrial Animal Health Code Chapter 6.9] and "Monitoring of the quantities and usage patterns of antimicrobial agents used in aquatic animals”[Aquatic Animal Health Code Chapter 6.3].

In the Global Action Plan on AMR framework, the WOAH has built a global database of antimicrobial agents intended for animal use, supported by the Tripartite (WHO, FAO and WOAH) collaboration. The WOAH launched its first annual data collection in 2015 and published the report in 2016. The second report, published in 2017, introduced a new methodology to report quantitative data in the context of relevant animal populations and included, for the first time, an annual analysis of antimicrobial quantities adjusted for animal biomass on a global and regional level (Gochez *et al*., 2019).

The WOAH ad hoc Group on Antimicrobial Resistance developed a template for harmonized AMU data collection and guidance for its completion that are available in three official WOAH languages (i.e. English, French and Spanish). Annually, the WOAH sends the AMU reporting template to all its 182 member countries and 11 non-WOAH Member countries, with the deadline for data submission being December of that year. The template, to be completed by respondents, is provided in the form of an Excel file that includes four worksheets labelled “Baseline Information”, “Reporting Option 1”, “Reporting Option 2,” and “Reporting Option 3”. The “Baseline Information” sheet can be answered by any country and collects general information on topics including the use of antimicrobials as growth promoters and any barriers to reporting quantitative data on antimicrobial agents used in animals. The Baseline Information sheet also has questions relevant to data collection for countries able to provide quantitative data.

On completion of the Baseline Information, respondents can either submit the questionnaire if no quantitative data are available, or they can complete one of the three “Reporting Options” if quantitative data are available. The three reporting options represent increasing levels of detail of quantitative data of antimicrobial classes used in animals, with the possibility of separating amounts reported by type of use (veterinary medical versus non-veterinary medical), animal groups (terrestrial food-producing, aquatic food-producing, or companion) and routes of administration (Gochez, 2017).

In order to ensure harmonization of submitted data, the WOAH established the List of antimicrobial classes to be reported by participant countries, with data reported being either of antimicrobials sold, imported, prescribed or used in the country. All pharmaceutical forms are included, and the quantities for each antimicrobial class can be reported either for veterinary medical use or growth promotion purposes.

3.2.1.1 Analysis of Global AMU/AMC data by the WOAH

In order to ensure comparability of the quantity of antimicrobials used in animals between regions and over time, this data is evaluated in the context of the relevant animal populations, which can vary in size and composition. The WOAH uses the following calculation for analysing quantitative data:

$$\frac{\text{Antimicrobial agents reported (mg)}}{\text{Animal biomass (kg)}}$$

Animal biomass is calculated as the total weight of the live domestic animals in a given population present during a year in a specific area, used as a proxy to represent those likely exposed to the quantities of antimicrobial agents reported. Several methodologies have been used by other surveillance groups (e.g. ESVAC, CIPARS) to calculate animal biomass, but none could be directly used by the WOAH global database as the data used in the calculation of biomass eg animal live-weights by production class & total animal populations by production class, vary between different regions of the world and cannot be generalised (Gochez *et al*., 2019).

The WOAH's calculation of animal biomass is based on using globally available datasets - the World Animal Health Information System (WAHIS) and the United Nations Food and Agriculture Organization Statistics (FAOSTAT). The formulas for calculating biomass by species were developed using these two datasets and were compared to references from countries where detailed animal population data by production class are available. The formulas chosen for the calculation of the WOAH denominator reflect the best-fit estimations using the more general global animal population data (WAHIS, FAOSTAT) when compared to available reference figures. The derived formulas were then applied to all countries providing quantitative data for the target year. All weights and biomass figures are measured in kilograms (kg). Data collected by these global animal surveillance databases, WAHIS and FAOSTAT, are point-in-time species-level census data with little to no detail on the production class (Gochez *et al*., 2019).

Countries submit AMU data to the WOAH during its data call rounds, after which an Annual Report on antimicrobials intended for use in animals is drafted and published. To date (September 2021), the WOAH has conducted six (6) rounds of data calls and published five (5) reports.

3.2.2 AMU/AMC surveillance in food-producing animals in Low-and-Middle income countries (LMICs)

3.2.2.1 Consumption data reported to WOAH

Since the WOAH's first call for AMU data in 2015, LMIC countries responding to the data calls have gradually increased in number, such that in the fourth round of the data call in 2019, 44 out of 54 and 25 out of 32 countries, from Africa and Asia respectively, responded to the call (OIE, 2020). In this fourth round of data calls, 27 Africa WOAH-member countries out of 54 (61%) provided quantitative data on antimicrobial use, while the remaining African countries (39%) provided qualitative data only. The majority of African countries (46%) use import data to generate AMU data, with the rest being derived from sales data (40%), purchase data (7%) and prescription data (7%). Most of the quantitative data from African countries cannot be differentiated by animal group, and this corresponds with the African region's predominant use of "Reporting option 1" of the WOAH template. The major impediment facing African countries in reporting antimicrobial quantities is the lack of a regulatory framework, with a lack of resources also compounding the problem.

Regarding the Asia, Far East and Oceania regions, 23 WOAH members out of 25 provided quantitative data, with two countries providing qualitative data only. The main barrier to reporting quantitative data in the region was agricultural suppliers not reporting sales data to the veterinary authority and not keeping records of veterinary products dispensed. The major sources of quantitative data in the region were sales data (56%) and import data (33%), with use only contributing 6% to the total. 63% of quantitative data from the region was differentiated by animal group, with 37% undifferentiated. These findings in the WOAH reports are consistent with Moulin *et al.* (2015)'s assertion that the majority of LMICs currently lack structures capable of quantifying consumption at a sufficient resolution to provide usage data by antimicrobial class, animal species, production context, purpose of usage, and route of administration, which are necessary to facilitate effective interventions to optimize use.

3.2.2.2 Consumption data in national systems

Within the context of LMICs, it is important to mention Thailand's application of a phased approach to antimicrobial consumption monitoring. In 2015, Thailand's International Health Policy Program and One Health partners established a human and animal national surveillance for antimicrobial consumption (Thai SAC) system (Schar *et al*., 2018). Thailand's 1967 Drug Act mandates pharmaceutical importers and producers to submit an annual report on the total volume of importation and manufacture of all medicines, including antimicrobials, to the Thai Food and Drug Administration. This total national antimicrobial sales data forms the foundation of Thai SAC, although the current reporting format does not require disaggregation by animal species.

3.2.2.3 Antibiotic use surveys

Besides the collection of AMC data for reporting to the WOAH in LMICs, there has also been some research on AMU, particularly in Asia, with most of the publications obtained from *ad hoc* farm surveys (Barroga *et al*., 2020; Mouiche *et al*., 2020; Tuat *et al*., 2021; Umair *et al*., 2021). Surveys based on single farm visits may incur recall biases as most farmers in LMICs, especially smallholder ones, do not keep records (Beegle *et al*., 2012). Even though they are costly, longitudinal study designs where farmers are requested to keep records and /or antimicrobial product containers can potentially yield more accurate data than unannounced 'one-off' visits. However, there is a risk that farmers may change their behaviour or provide inaccurate data, with the latter being possible if farm visits are conducted by veterinary authorities that are perceived to negatively judge farmers' AMU practices. Longitudinal study designs may also allow insights into the seasonality of diseases (Van Rennings *et al*., 2015) and repeated behaviour of consumption over time (especially when consecutive cycles of production are investigated) (Kuipers *et al*., 2016). They may, however be affected by a low response rate since they are time-consuming and require considerable farmer commitment.

3.2.3 AMU/AMC Surveillance in animals in High-income countries (HICs)

3.2.3.1 Europe

The European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) project was established in 2009 by the European Medicines Agency (EMA). The aim of the project was to develop a harmonised approach for the collection and reporting of data on the use of antimicrobial agents in animals from the European Union (EU) and European Economic Area (EEA) member states (EMA, 2014). It reports antimicrobial consumption in animals by collecting sales data of veterinary antimicrobials in 31 countries, which covers 95% of total food-producing animal populations. The data sources come from wholesalers (17 countries), marketing authorization holders (4 countries), and both wholesalers and marketing authorization holders (2 countries). Some countries provide feed mill data.

In all countries, it is mandatory by law for pharmaceutical operators to report their sales data to the national authority, except in France, Hungary, Netherlands, and Spain. ESVAC has an interactive database that allows users to access a summary of the specific ESVAC data they are interested in, including data for a specific country or sales of a particular antimicrobial class. ESVAC also publishes an annual report presenting sales data on veterinary antibiotics collected from the 31 countries of the ESVAC network. It also highlights key changes and trends over time. Scientists, veterinarians and other animal healthcare professionals, risk assessors and policymakers in member states use the annual report results as a reference for antimicrobial policies and for guidance on the responsible use of antimicrobials. ESVAC also produces country-specific reports, which report sales changes by antimicrobial class, along with a brief summary and discussion of the data.

In July 2018, EMA launched a project stratifying sales data of veterinary antimicrobials by animal species, to enable an approximate estimation of consumption by different species, by allocating a proportion of the total sales of a veterinary antimicrobial to each species it is used in (EMA website). To enable the collection of standardized data, the EMA developed a data reporting protocol and a data collection form for participating countries to provide their sales data of veterinary antimicrobials and animal population data.

3.2.3.2 Canada

The Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) monitors trends in AMU and AMR in selected bacterial organisms from human, animal and food sources across Canada. The program is based on several representatives and methodologically unified surveillance components which can be linked to examine the relationship between antimicrobials used in food animals and humans and the associated health impacts. This information supports: (i) the creation of evidence-based policies to control antimicrobial use in hospital, community and agricultural settings and thus prolong the effectiveness of these drugs and (ii) the identification of appropriate measures to contain the emergence and spread of resistant bacteria between animals, food and people in Canada (CIPARS website).

In 2017, regulatory changes were made to the Food and Drug Regulations for annual sales reporting to increase oversight of antimicrobials available for use in animals to support antimicrobial resistance (AMR) surveillance and antimicrobial stewardship. These changes require manufacturers, importers and compounders to report annual sales of medically important antimicrobials intended for use in animals. To implement the regulatory reporting requirements, Health Canada and the Public Health Agency of Canada developed the Veterinary Antimicrobial Sales Reporting (VASR) system. The VASR system collects data on volumes of antimicrobials and total quantity sold or compounded by animal species and province/territory. The reporting year reflects data collected for the period of January 1 to December 31. All data collected by the VASR system feeds into CIPARS, which analyses it and communicates findings through an annual report and surveillance bulletins for AMU and AMR. CIPARS also collects AMU data from sentinel broiler chicken, pig, and turkey farms and has recently launched two sentinel farm surveillance projects in feedlot and dairy cattle.

3.2.3.3 United States of America

In the United States of America (USA), the US Food and Drug Administration (FDA) Center for Veterinary Medicine (CVM) is responsible for ensuring the safety and effectiveness of animal drugs, including antimicrobials, and has taken important steps to address potential antimicrobial resistance concerns surrounding the use of these drugs in food-producing animals, including changes to the approved use conditions of medically important antimicrobials to support their judicious use in food-producing animals (Bright-Ponte., 2020).

In the US government’s National Action Plan for combating Antimicrobial Resistance, 2020 to 2025, one of the objectives is to enhance the monitoring of antimicrobial resistance patterns, as well as antimicrobial sales, usage and management practices, at multiple points in the production chain for food animals. As one component of surveillance, CVM collects data from drug sponsors (manufacturers and wholesalers) on the amount of antimicrobials sold for use in food-producing animals annually and publishes a summary of these data. Drug sponsors submit estimates of species-specific sales for the four major food-producing species in the US (cattle, swine, turkeys and chickens). In 2017, the CVM introduced a method to adjust annual sales data based on the estimated animal biomass by food-producing species that may be exposed to the drug (Bright-Ponte., 2020). The method utilizes annually reported animal populations and weights.

The FDA, other government agencies, academic institutions, and industry partners collaborate to enhance the collection of antimicrobial use data in veterinary settings. The CVM works closely with the US Department of Agriculture (USDA) in support of data collection efforts to gather information on antimicrobial use and stewardship practices on farms through programmes such as the USDA

Animal and Plant Health Inspection (APHIS) National Animal Health Monitoring System (NAHMS). The USDA NAHMS programme has collected antimicrobial use and selected bacterial antimicrobial resistance data within national studies conducted periodically for over 25 years. The NAHMS program conducts national surveys of various livestock commodity groups every 5 to 10 years, and these data have been used to assess antimicrobial use and resistance trends.

In 2016, the FDA availed funds to support data collection on antimicrobial use in animal agriculture. The funded data collection efforts were intended to provide information on antimicrobial use practices in various animal production settings (i.e. cattle, swine and poultry) and assess potential data collection methodologies to help optimize long-term strategies for collecting and sustainably reporting such data. The funding, in the form of cooperative agreements, was awarded to two grants. The two projects awarded were for the characterization of AMU in US beef feedlots and dairies; and AMU data collection in US poultry and swine production (Bright-Ponte., 2020).

3.2.4 Antimicrobial use metrics and indicators

There are many approaches to metrics for quantification and reporting of antimicrobial use, each with its advantages and disadvantages and no single method is considered to be ideal in all circumstances (see Table 2 below). Measurements of antimicrobial use in animal production may address different objectives, such as monitoring use over time, setting benchmarks to promote antimicrobial stewardship and investigating associations between use and resistance. Different metrics are likely to be more or less appropriate depending on the objective of the monitoring programme (Bright-Ponte., 2020).

For AMU surveillance, metrics (the technical units of measurement, such as frequency of use) and indicators (an AMU metric in relation to a denominator, such as animal biomass or animal-time unit have been developed. Milligrams weighted by population and weight (mg/PCU) are used for reporting national sales and distribution data across countries in the European Union (EMA, 2017). Another AMU indicator is treatment incidence (TI), which pertains to the total number of defined daily doses in animals adjusted for animal-time units (Timmerman *et al*., 2006; Persoons *et al*., 2012; Callens *et al*., 2012). The number of defined daily doses in animals per Population Correction Unit (PCU) is an AMU measurement to monitor AMU sales data in animals (*ECDC/EFSA/EMA Report 2017*). The defined daily dose for animals (DDDvet, ADDD or DDDA) is the assumed average daily dose per kg animal per species per day. Another closely related metric is the defined course dose (DCDvet or ADCD), which is the assumed average dose per kg animal per species per treatment course.

International comparisons of animal antimicrobial use (AMU) have typically been based on total national estimates of antimicrobials sales standardized by the national animal biomass calculated as the population correction unit (PCU) (Radke., 2017). This approach has been criticized in favour of daily defined dose animal metrics (DDDA), which account for drug potency and usage at species level, if not by animal age or weight (Bondt *et al*., 2013). However, current and future implementation of DDDA is hampered by its high resource demands (EMA, 2013), including antimicrobial use by species, if not by animal age or weight, and the lack of a global DDDA standard. In contrast, national estimates of antimicrobial usage standardized using PCU are available for over 25 countries and encompass use in all food-producing species (CIPARS Report 2014). PCU will, therefore, for the foreseeable future, likely be continued to be used in international comparisons of animal AMU, as well as comparison of usage between species (UK VARSS Report 2013).

PCU serves the purpose of controlling for animal demographics, which can vary over time within a country and between countries. The PCU is calculated by totalling the number of livestock or poultry in an animal category multiplied by a standardized theoretical weight of an animal in that category at the age it would most likely be treated with antimicrobials, which is called the average weights at treatment (AWT).

Table 3: AMU metric types used for food-producing animals

	Type of metric	Advantage	Disadvantage
1	Count-based	Simple to calculate and understand	Not comparable between times and regions
2	Mass-based (mg)	Easy to understand	It can be misleading as it does not account for variations in the mg/kg dosage of antimicrobials.
3	Daily dose-based (DDDvet, ADDD)	Account for differences among drugs in concentration and duration of effect.	Are affected significantly by the standard animal weights selected for calculation
4	Course-based (DCDvet)	Incorporates the length of course of treatment	Also affected by standard animal weights chosen for calculation.

3.3 Options for AMU/C surveillance in Zimbabwe's animal sector

Based on the information gathered and compiled in this report, three proposed strategies for AMC/U surveillance in Zimbabwe (named Options 1, 2 and 3) are outlined below:

Option 1: antimicrobial consumption data

The mandatory submission of antimicrobial sales data by drug wholesalers and retailers to the Medicines Control Authority of Zimbabwe and in turn, the Department of Veterinary Services (DVS). Submission of AMC data to the MCAZ would be on an annual basis. Both the MCAZ and DVS would be responsible for developing the tools for data collection, with DVS then playing an integral role in managing the data, analyzing and interpreting it and finally reporting it to relevant stakeholders such as farm industries and veterinarians, and the nation at large through suitable platforms such as online reports or stakeholder meetings. This system of AMU/AMC surveillance follows the one used in other countries like Thailand and Canada.

Option 2: sentinel antimicrobial use data

DVS would establish an active farm-level AMU surveillance system in selected food-producing animals, similar to the CIPARS program in Canada. This program involves AMU surveillance on volunteer sentinel farms. In Zimbabwe, the program could start off in the poultry production sector, and later be expanded to other food-producing animals such as pigs and dairy cattle. AMU data derived from Option 2 will complement that derived from Option 1.

Option 3: representative antimicrobial use data

In addition to Options 1 and 2, Zimbabwe could also consider conducting a national AMU assessment of farming households through incorporation of AMU-related questions in the questionnaire used in the annual Crop and Livestock Assessments conducted by the Ministry of Lands, Agriculture, Water, Fisheries and Rural Resettlement. This approach follows that done in Uganda in 2018 in which the Uganda Bureau of Statistics (UBOS) collaborated with Food and Agriculture Organization of the United Nations (FAO) in introducing key AMU questions in the Annual Agricultural Survey (AAS), gathering data from agricultural households nationwide (Mikecz *et al*., 2020). The results from this survey may allow users to explore linkages between antibiotic use and livestock production practices, thereby informing policy decisions. Results from this survey may also inform DVS on areas where to focus future sentinel AMU surveillance in the country

3.3.1 Feasibility assessment of the proposed AMU/C surveillance options

The three proposed options for AMU/C surveillance can be assessed in terms of their technical, legal, time, operational and financial feasibilities. This is outlined below.

3.3.1.1 Option 1: Antimicrobial Consumption. Mandatory reporting of antimicrobial sales data to DVS

a. Technical feasibility

There are data management requirements which need to be taken into account when setting up an AMU/ AMC surveillance system. Digital data collection, which is the most appropriate in this case, requires tablets with data collection software (eg ODK) installed. The AMC data collected would then be uploaded into a server, which should have ample space as required by the AMC database. Subsequent analysis of the data will be done using either Microsoft Excel or R, as these are free software, requiring no subscriptions.

Currently, DVS has no tablets to collect AMC data and hence need to be procured. DVS staff would need training on how to collect AMC data using the ODK or other software, and also on how to analyse AMC data using data analysis software (Excel or R), together with interpretation and reporting. Personnel to be trained on data analysis and interpretation will be those working in the DVS Epidemiology Unit. DVS also needs to procure a new server, specifically dedicated to store the AMC data. In addition, the internet bandwidth of DVS needs to be increased to facilitate uninterrupted internet connectivity.

b. Legal feasibility

The current competent authority with regards to regulating the use of veterinary antimicrobials is the MCAZ, as stipulated in the Medicines and Allied Substances Control Act [Chapter 15:03]. Unfortunately, the MCAZ is severely understaffed to efficiently monitor and manage AMU/AMC data. Hence the MCAZ should collaborate with DVS in the area of AMU/AMC surveillance, and ideally a Memorandum of Understanding should be signed between both parties, stating the specific role each organization will perform in this collaboration.

Currently, there is no legal framework compelling veterinary drug wholesalers and retailers to submit AMU data to the competent authority (MCAZ), and it is imperative that such a regulatory framework be created to enable submission of antimicrobial sales data by drug sellers.

c. Time feasibility

There are no stringent time constraints governing the establishment of such an AMU surveillance system in Zimbabwe. From the European Surveillance for Veterinary Antimicrobial Consumption (ESVAC) experience, it was realised that it usually takes at least three to four years to establish a valid baseline for the data on sales of veterinary antimicrobials.

d. Operational feasibility

Due to the excellent working relationship between the MCAZ and DVS, the two organizations should work hand in hand in implementing AMU/C surveillance in the animal sector of the country, with MCAZ having the mandate, and DVS possessing a large assortment of skilled manpower.

e. Financial feasibility

The initial costs of setting up the AMU/C surveillance system will probably be high and will cover activities ranging from stakeholder meetings, development of data collection tools, training of personnel and procurement of IT equipment such as servers and hand-held data collection devices such as tablets. Funding of activities from government will probably be limited due to resource constraints and it is anticipated that development partner organizations may be able to fill the financial gap. DVS and MCAZ may also consider mobilizing funding from the private sector through public-private partnerships.

3.3.1.2 Option 2: Sentinel AMU surveillance. Establishing an active farm-level AMU surveillance

a. Technical feasibility

DVS has highly experienced, trained staff within its structures, which extend throughout the country, even in the most remote areas. There is a perception that antimicrobials are mostly used in the poultry production sector; hence the program can initially target broiler farms. Similarly, with Option 1, data management requirements must be considered when establishing farm-level AMU surveillance. Tablets with data collection software would be needed to facilitate data collection, together with training of data collectors. Collected AMU data would be transmitted to the DVS Epidemiology Unit in Harare, where it is stored in a server, analysed and interpreted.

b. Legal feasibility

There are no legal constraints impeding the setting up of active farm-level surveillance. Furthermore, sentinel farms participating in the program join on a voluntary basis.

c. Time feasibility

AMU data is collected every year from the sentinel surveillance farms, just as is done in the Canada Integrated Program for Antimicrobial Resistance Surveillance (CIPARS).

d. Operational feasibility

Veterinary extension personnel in regions where sentinel farms are located will be responsible for collecting the AMU data. This is after they would have received training on the data collection techniques. All collected data is transmitted to the central EPI Unit, where it is analysed and interpreted.

e. Financial feasibility

Similar to Option 1, resources to set up the active farm-level AMU surveillance may be limited on the part of DVS, with development partners expected to play a significant role in initially funding the program, then DVS sets up structures to make the program sustainable in the long term.

3.3.1.3 Option 3: Representative antimicrobial use data. Conducting a national survey

a. Technical feasibility

Crop and Livestock Assessments are conducted by the Department of Agricultural Extension (AGRITEX) in the Ministry of Agriculture through Agricultural Extension Officers. Currently, AGRITEX officers have limited to no knowledge of AMR and so may need some awareness training on the subject to make them understand why AMU-related questions are included in the questionnaire. Obtaining approval for AMU-related questions to be included in the Crop and Livestock Assessment questionnaire may be quite challenging. It may need high-level stakeholder engagement with Ministry officials to convince them why this is necessary.

The current tool used to collect data in these assessments is paper-based but would need to be digitized for AMU data collection and for that purpose, tablets would need to be procured to facilitate that process, together with enumerator training on the data collection process. Collected data would be transmitted to servers in the DVS Epidemiology Unit, where it would be subsequently managed, analysed and interpreted.

b. Legal feasibility

Legal hurdles, if any, to including AMU-related questions in the assessment questionnaire can potentially be overcome through high-level stakeholder engagement.

c. Time feasibility

The quantitative AMU data collection process will follow the time confines of the Crop and Livestock Assessment program.

d. Operational feasibility

The data collection process would proceed smoothly provided that the AGRITEX enumerators would have received training on the administration of the AMU-related questions.

e. Financial feasibility

Option 3 is feasible, provided that both government and development partner organizations make significant financial contributions to the process.

4 Conclusions and Recommendation

The need to establish AMU /AMC monitoring systems in animal production systems globally cannot be overemphasized, given the urgent need to address AMR. It is encouraging that some country and regional AMU surveillance systems, exemplified by CIPARS and ESVAC, respectively, are already in place, and countries in other parts of the world, which are still establishing their AMU/C monitoring systems, can borrow some aspects from these more established systems and incorporate into theirs. More importantly, the establishment of the WOAH monitoring system for antimicrobials intended for use in animals will go a long way in assisting member countries in establishing and strengthening their AMU/C monitoring systems. It is essential that countries set up these AMU/C monitoring systems early in order to give enough time to establish a valid data baseline. A European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) report mentioned that 3 to 4 years are needed to establish a valid baseline for sales data of veterinary antimicrobial agents.

Countries also need to diversify their sources of AMU/AMC data and, ideally, increase data collection at the farm level in order to capture actual levels of antibiotic use at the farm. This will be important for informing stewardship efforts and developing policies to curb AMR development.

This report proposes three options for implementing AMU/C surveillance in the animal sector in Zimbabwe, with the two most important ones, Options 1 and 2, potentially producing actual quantities of antimicrobials used. Option 3 complements options 1 and 2 in that inferences can be made into the drivers behind AMU/inappropriate AMU. Option 1 is the most important and practical means of AMC surveillance in the animal sector of Zimbabwe. However, a legislative review is imperative to compel veterinary drug wholesalers and retailers to submit sales data for veterinary antimicrobials to the competent authority. Option 2, which collects data at the farm level, sheds more light on the actual antimicrobial quantities used by animals and the context, enabling appropriate antimicrobial stewardship programs to be implemented.

In summary, all three options for implementing AMU/C surveillance are feasible, but all require substantial funding, be it from the government, development partners, or the private sector, to operationalise them. The possible sources of funding for some of these activities in Zimbabwe include the Fleming Fund Country Grant and the Multi-Partner Trust Fund (MPTF), all administered by FAO Zimbabwe. The Fleming Fund Country Grant recently funded the development of a One-Health strategy for antimicrobial use/consumption surveillance, which awaits finalization.

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