Final Report

Antimicrobial Resistance and Usage data and reporting: The market is driving reporting of AMR and AMU

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Abstract

Antimicrobial resistance (AMR) is a One Health global issue. There are increasing pressures internationally and nationally for animal industries to monitor and publish levels of AMR and antimicrobial use (AMU). This project was undertaken to identify the key drivers of AMR and AMU monitoring by the Australian red meat industry. It interrogated international and national strategies for AMR and AMU surveillance and reporting and questioned how close we (and our trade partners) are to meeting emerging market expectations.

The study went beyond the higher strategy level and investigated the policies on AMR and AMU of some of the key companies we trade with, plus expectations of key lobby groups.
While the Australian red meat industry has an excellent track record with respect to levels of AMU and AMR (compared to many of our trade partners), our AMU data is extremely out of date, and the nature of that data (aggregated veterinary sales) makes its relevance to antimicrobial stewardship poor. AMR surveillance has been completed four times but may need to be more systematic.
We have a chance to act now, to establish an AMU and AMR monitoring and reporting system that is relevant to our country and industry's needs and meets market expectations.

Executive summary

Background

Antimicrobial resistance (AMR) is a One Health global issue. There are increasing pressures globally and domestically for Australian animal industries to collect and report data on AMR and antimicrobial usage (AMU).

Objectives

The main aims of this project were to establish the key drivers of the collection of data on and reporting of AMR and AMU by the Australian red meat industry and to identify gaps and opportunities for the red meat industry to meet these expectations.

Methodology

The expectations or current practices of reporting of AMR and AMU by key stakeholders were interrogated. Stakeholders were grouped into:

- Countries (and coalitions of countries)
- Companies (and their representatives)
- Consumers (and their representatives)

Results/key findings

The World Health Organisation (WHO) global strategy on AMR specifically points to member countries having AMR surveillance and AMU monitoring systems. The Tripartite of the WHO, the Food and Agriculture Organization (FAO), the World Organization for Animal Health (OIE) have a memorandum of understand on One Health and AMR and those organisations are tasked with the implementation of that global strategy.

From the animal industries' perspective, there are specific sections of the OIE Terrestrial Animal Health code (2021) which describe how AMR surveillance should be conducted and how AMU data collected and reported. The Australian Government AMR Strategy – 2020 and beyond closely follows the global strategy and the Australian Animal Sector National AMR Plan (2018) also aligns. The National Strategy has, as one of its objectives: "Create a sustainably funded national One Health surveillance system that integrates human, animal, food and environmental usage and resistance data". Similarly, the Animal Sector plan has, as objective 3; "Develop nationally coordinated One Health surveillance of antimicrobial resistance and antimicrobial usage". The Australian Government is looking to establish a "One Health" surveillance system and they also intend to repeat the 2014 APVMA report of AMU in the Australian livestock industries (based on aggregate veterinary sales data from 2005-2010). However, the process is likely to be so slow that the other market drivers of AMR and AMU reporting in the animal sectors may need to be met in advance of any nationally coordinated system.

The other market drivers of AMR (and especially AMU) reporting include the countries to which we export our animal products, companies buying those products and the end consumers. The 2014 APVMA report showed low usage in livestock (and extremely low usage comparatively in cattle). Data on usage in this report illustrate that compared to most countries, our AMU is low, but our published data is many years behind theirs. Lobbying organisations are increasingly calling for Australia to "prove it" when we say that our usage in livestock is low. For example, a recent paper

submitted to the UK government about the FTA with Australia and the US criticised Australia for our lack of regular reporting on AMU.
Surveys of AMR done in red meat have found very low levels of AMR, especially to antimicrobials that are considered highly important for human health. To date there have been four of these surveys, but trade partners and Government are likely to be looking for a more organised, frequent AMR surveillance system than we currently have.

Benefits to industry

This report provides a reference document on the key expectations from the top (Tripartite) down for measurement and reporting of AMR and AMU by Australian livestock (and specifically red meat) industries. It identifies gaps in our current reporting capabilities, along with key areas where, were we to improve our capacity we would be in a stronger position with respect to trade than we currently are.

Future research and recommendations

If the animal (and specifically red meat) sectors wish to produce regular, relevant data on usage and resistance, (for example to address market demands) it is likely they will need to develop the capacity to do this themselves. It may be in the best interests of the red meat sector to develop their own usage and resistance monitoring system, and to report those data in a more meaningful, timely and appropriate manner than is currently done.

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1. Why would we want to report our AMR and AMU?

1.1 AMR is a "One Health" international issue

The World Health Organisation (WHO) has declared that AMR is one of the top 10 global public health threats facing humanity. From the oft-cited O'Neill review (commissioned by the UK Government and summarised in a 2016 report) it was estimated that by 2050, unless action is taken, 10 million deaths per year will be attributable to AMR. Additionally, there will be 1.2 trillion USD additional expenditure on healthcare by 2050[1]. As a result, 113 Member States (including Australia) have signed the 2021 WHO call to action on AMR. All strategies that have been or are being put into place to combat AMR globally include recording and reporting of AMR and AMU.

1.2 AMU drives AMR

Antimicrobial resistance is a natural process. Bacteria become resistant to antimicrobials via various mechanisms, but AMU selects for the resistant bacteria when susceptible bacteria are killed, while those that are resistant survive and multiply. AMU has long been associated with increased risk of the development of AMR and in production animals this association is well described in the 2012 review paper by Landers et al. [2]

1.3 The Australian Red meat sector has a good record with AMR and AMU

1.3.1 AMR

MLA has funded several surveillance projects in the Australian red-meat industry.[3,4,5,6] The results of recent surveys demonstrate very low levels of AMR in bacteria from cattle and sheep in Australia, especially in antimicrobials considered to be critically important to human health (CIAs)[5,6]. Additionally, there was not found to be any increase in AMR in more intensive situations (such as feedlots).

1.3.2 AMU

The 2014 Australian Pesticides and Veterinary Medicines Authority (APVMA) report *Quantity of Antimicrobial Products sold for Veterinary Use in Australia* was the most recent publication on AMU in the animal sector in the country[7]. This report had noted limitations. It reported aggregate sales data in tonnes of active constituent, and it combined all cattle (beef, extensive and intensive and dairy) together with sheep in the report. This is primarily because many of the antimicrobials are labelled for use in cattle and sheep, so from aggregate sales data, it would be impossible to differentiate the different species and classes of stock.

A 2013 report, funded by MLA titled *A survey of antibacterial product use in the Australian cattle industry*[8] reported approximate numbers of cattle treated with different classes of antimicrobials in 2012, and importantly at that time, only 1% of feedlot cattle were estimated to have been treated with ceftiofur (a critically important antimicrobial (CIA) for human health). Another CIA, virginiamycin was estimated to have been given to 6.6% of grain fed cattle and the authors of the study suggested the continued monitoring of usage of both CIAs, with clear evidence of judicious use. The authors also suggested:

MLA and ALFA should approach the four or five most influential feedlot veterinarians to canvass options for the collection of data on antimicrobial usage and indications in feedlots, also for input to (a suggested 3-yearly repetition of the 2011/12 study). MLA and ALFA will need to consider incentives, including recompensing the veterinarians for this service and, above all, propose ways to protect the confidentiality of information provided.

From an international perspective, the data we do have indicates that we rank extremely low in antimicrobial usage in livestock (Figure 1) and especially in cattle (Figure 2)[9]. However, our data is very old compared to most other countries represented in the graphs.

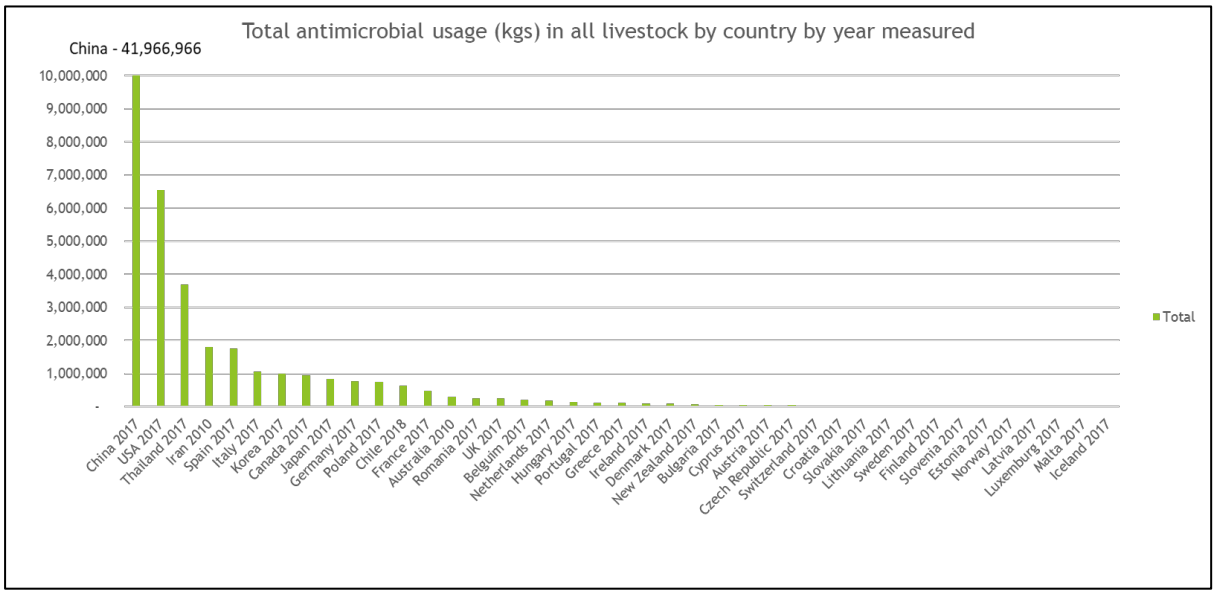


Figure 1 Total antimicrobial usage in livestock with year reported

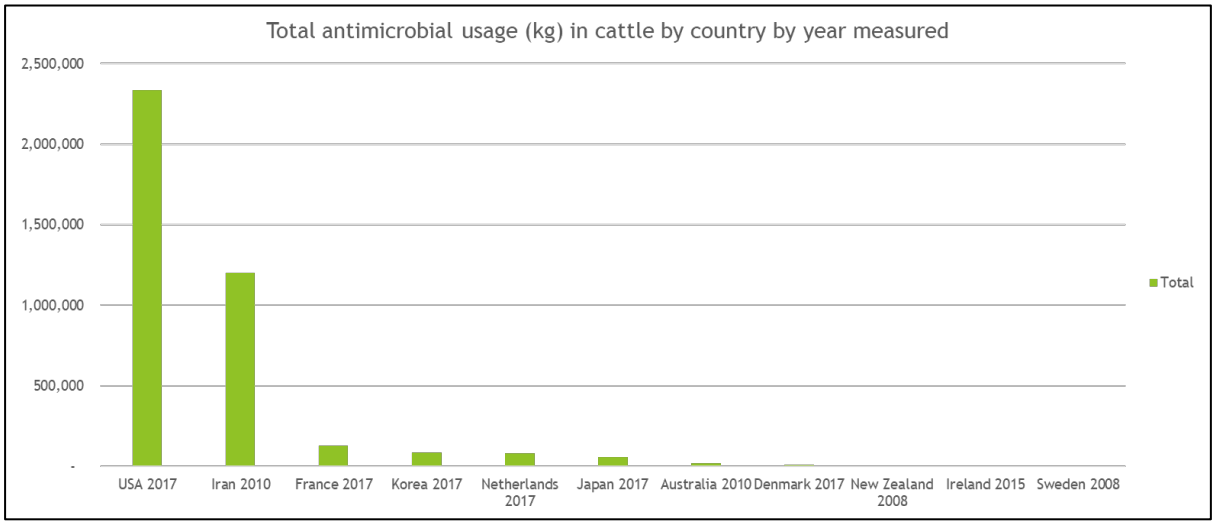


Figure 2 Antimicrobial usage in cattle with year reported

2. What are the key drivers for us to report our AMR and AMU?

2.1 Countries and coalitions of countries

2.1.1 The Tripartite plus – WHO, OIE, FAO and UNEP

The World Health Organization (WHO), World Organization for Animal Health (OIE) and Food and Agriculture Organization (FAO), joint efforts are a coordinated One Health approach and constitute the Tripartite Collaboration on AMR. The Tripartite signed a Memorandum of Understanding on One Health and AMR in 2018. Recently UNEP joined the Tripartite and it has become known as the Tripartite plus.

The tripartite AMR country self-assessment survey (TrACSS) 2019–2020 asked questions aligned to the Global Action Plan. The global analysis report and online tool indicate that Australia is not performing highly with respect to AMR and AMU surveillance and reporting, compared to other high-income countries (Figure 3)[10]. Countries assess their progress towards a specific question by ranking themselves A to E, where A is the least progressed and E is the most.

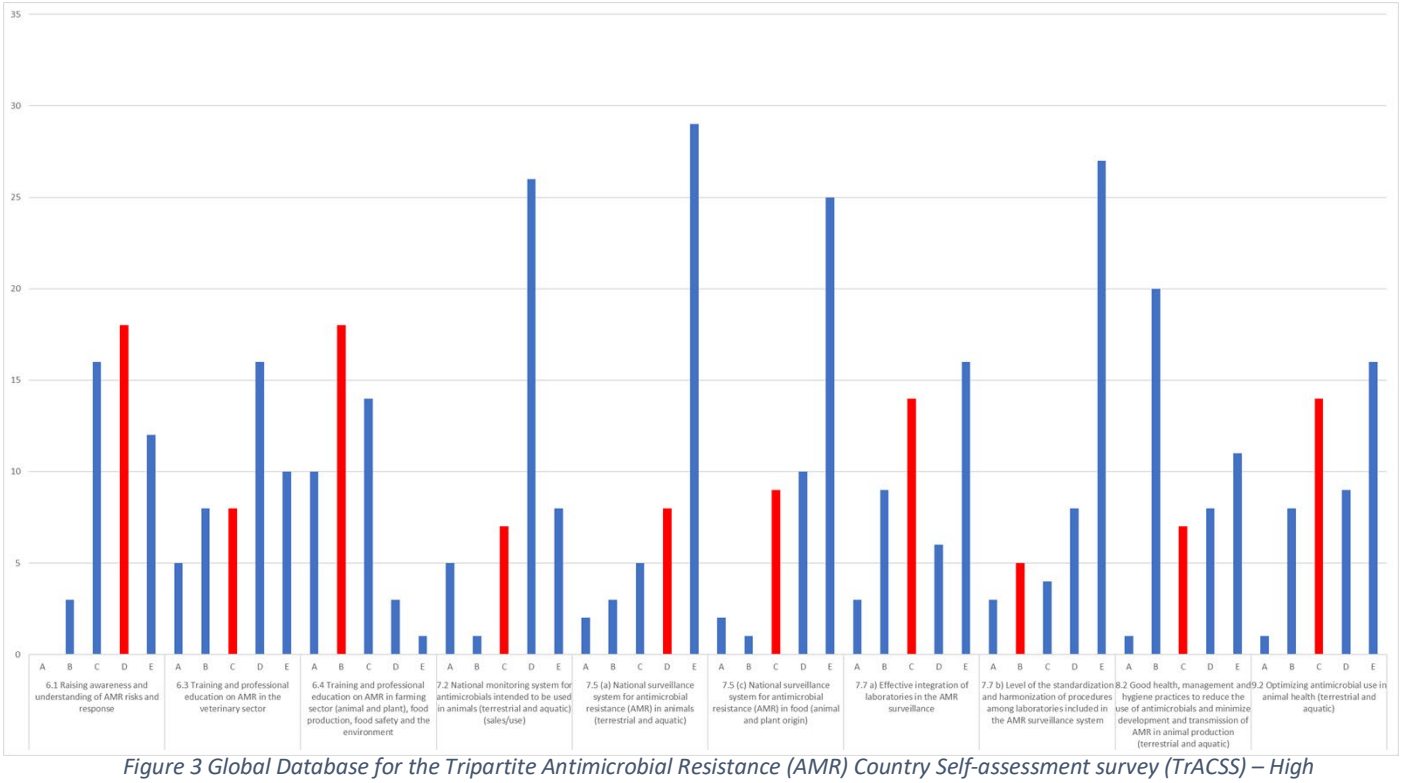


Figure 3 Global Database for the Tripartite Antimicrobial Resistance (AMR) Country Self-assessment survey (TrACSS) – High income countries (Australian response in red band)

Specific questions on AMS, or AMR/AMU surveillance and monitoring which are relevant to the Australian red meat sector include *6.3 Training and professional education on AMR in the veterinary sector,* where Australia ranked itself as a C, *6.4 Training and professional education on AMR in farming sector (animal and plant), food production, food safety and the environment*, where Australia ranked itself as a B, *7.2 National monitoring system for antimicrobials intended to be used in animals (terrestrial and aquatic) (sales/use)*, where Australia ranked itself as a C and *National surveillance system for antimicrobial resistance (AMR) in animals (terrestrial and aquatic),* where Australia ranked itself as a D.

The report summarised the findings, and some of the key conclusions are below:

In the OIE template, countries were asked if a national report on the antimicrobial agents used in animals was available online. In the fifth round of data collection, 95 countries (n = 133; 71%) did not publish online national reports, Europe is the only region where more than 50% of countries' national reports are available online. The OIE encourages all Members to publish their own national reports on the sales or use of antimicrobial agents in animals, to ensure transparency and to assess trends.
Strengthening data collection for AMR surveillance and antimicrobial consumption/ use and ensuring better data reporting and sharing across sectors are needed to secure a detailed picture of AMR and antimicrobial consumption/use in countries, based on the One Health approach. Additionally, better data need to be collected and shared with the multisectoral group working on AMR national action plan implementation so national policies and strategies can be revised and aligned with the country situation in a more effective way.

Further details on the criteria for this assessment, and how close the red meat sector is to achieving them will be discussed in the sections on the WHO and OIE.

WHO

The World Health Organisation, along with the other members of the Tripartite lead the global response to AMR through the Global Action Plan on Antimicrobial Resistance (2015)[11]. Additionally, in 2021, Australia along with 112 other member states signed The Call to Action on Antimicrobial Resistance (AMR) – 2021[12] Some of the key objectives from the Global Action Plan that are relevant for the Australian Livestock sector include:

Objective 1: Improve awareness and understanding of antimicrobial resistance through effective communication, education and training
Potential measures of effectiveness: extent of reduction in global human consumption of antibiotics (with allowance for the need for improved access in some settings), and reduction in the volume of antibiotic use in food production.
Member State action:
Establish antimicrobial resistance as a core component of professional education, training, certification and development for the health and veterinary sectors and agricultural practice.

Progress towards achieving the objective in the red meat sector in Australia: All Australian veterinary schools have components of the curriculum relating to AMR and AMS. Through the AMR Vet Collective (AMRVC), there is now a Continuing Professional Development (CPD)program in AMS for veterinarians, which provides them with CPD points and a certificate, however this program is focused more on companion animal vets. There is the opportunity for a cattle-specific module to be developed through the AMRVC. While all the livestock industries have information on AMS and in some cases a requirement for an AMS plan to be implemented (for example, the new requirement for Lot Feeders through NFAS), there is no formal training or certification in AMS for red meat workers.

Opportunity: Development of cattle-vet specific AMR CPD training. Implementation of AMS training and certification for red meat workers.

Objective 2: Strengthen the knowledge and evidence base through surveillance and research
Potential measure of effectiveness: extent of reduction in the prevalence of antimicrobial resistance, based on data collected through integrated programmes for surveillance of antimicrobial resistance in all countries
Member State action:
Develop a national surveillance system for antimicrobial resistance that:

- *strengthens surveillance in animal health and agriculture sectors by implementation of the recommendations of the WHO Advisory Group on Integrated Surveillance of Antimicrobial Resistance for antimicrobial susceptibility testing of foodborne pathogens, the standards published in the OIE terrestrial and aquatic animal codes including the monitoring of resistance and antimicrobial use; the FAO/ WHO Codex Alimentarius Code of Practice to Minimize and Contain Antimicrobial Resistance and the Codex Alimentarius Guidelines for Risk Analysis of Foodborne Antimicrobial Resistance;*
- *Collect and report data on use of antimicrobial agents in human and animal health and agriculture so that trends can be monitored and the impact of action plans assessed.*
- *The international research community and FAO should support studies to improve understanding of the impact of antimicrobial resistance on agriculture, animal production and food security, as well as the impacts of agricultural practices on development and spread of antimicrobial resistance, and to reduce non-therapeutic use of antimicrobial agents in agriculture through the development of sustainable husbandry practices.*

Progress towards achieving the objective in the red meat sector in Australia: Although the integration of surveillance for AMR cross-sectorally is not well developed, MLA has funded several surveillance projects in the Australian red-meat industry[3,4,5,6]. The results of recent surveys[5,6] demonstrate very low levels of AMR in bacteria from cattle and sheep in Australia. Recently published data on AMU in the red meat sector is not available. The 2014 APVMA report was the most recent publication on AMU[7].

Opportunity: Provision for ongoing surveillance of AMR in the red meat sector.
Development of an appropriate, sustainable and ongoing AMU surveillance system in the red meat sector.

Objective 4: Optimize the use of antimicrobial medicines in human and animal health
Potential measure of effectiveness: extent of reduction in global human consumption of antibiotics (with allowance for the need for improved access in some settings), the consumption of antibiotics used in food production (terrestrial and aquatic livestock, and other agricultural practices), and the use of medical and veterinary antimicrobial agents for applications other than human and animal health.
Member State action:
- policies on use of antimicrobial agents in terrestrial and aquatic animals and agriculture, including: implementation of Codex Alimentarius and OIE international standards and guidelines as well as WHO/OIE guidance on the use of critically important antibiotics; phasing out of use of antibiotics for animal growth promotion and crop protection in the absence of risk analysis; and reduction in nontherapeutic use of antimicrobial medicines in animal health.
OIE, supported by FAO and WHO within the tripartite collaboration, should build and maintain a global database on the use of antimicrobial medicines in animals p17

Progress towards achieving the objective in the red meat sector in Australia: Antibiotics for use in red meat animals are approved by the Australian Pesticides and Veterinary Medicines Authority (APVMA). All antibiotics undergo a rigorous pre-approval process where the safety to animals, humans and the environment is assessed, and residues in animal products are monitored. Through the implementation of AMS plans, and the use of prescribing guidelines by

veterinarians, guidance on the prudent use of CIAs and prophylaxis is well established. However, the efficacy and of these measures has not been assessed.

Note: If the OIE is looking to develop a database of AMU in animals, this is likely to come from aggregate data (for example from the APVMA sales data), which has limitations.

Opportunity: Establish a method of assessing prudent use of antimicrobials, and the effect of implementation of AMS plans, through continued monitoring of AMU (especially in CIAs).

Objective 5: Develop the economic case for sustainable investment that takes account of the needs of all countries, and increase investment in new medicines, diagnostic tools, vaccines and other interventions
Potential measures of effectiveness: extent of increase in sustainable investment in capacity to counter antimicrobial resistance for all countries, including investment in development of new medicines, diagnostics and other interventions. FAO, OIE and other partners should support appropriate analyses to establish the case for investment and to inform the selection of interventions to improve animal husbandry, management, health, hygiene and biosecurity practices aimed at reducing antimicrobial use (and antimicrobial resistance) in different production settings.

Progress towards achieving the objective in the red meat sector in Australia: The development of AMS plans incorporates most of the measures mentioned, namely "*animal husbandry, management, health, hygiene and biosecurity practices aimed at reducing antimicrobial use (and antimicrobial resistance)".*
Opportunity: Continued refinement of AMU through improvements in AMS. This should include opportunities for the development of improved diagnostics and new vaccines.

OIE

The OIE Terrestrial Animal Health code (2021)[13] has very specific recommendations for the implementation of some of the objectives in the global action plan, especially regarding the animal sector: 6.7 Introduction to the recommendations for controlling antimicrobial resistance, 6.8 Harmonisation of national antimicrobial resistance surveillance and monitoring programmes, 6.9 Monitoring of the quantities and usage patterns of antimicrobial agents used in food-producing animals.

From section 6.8:
General aspects of antimicrobial resistance surveillance and monitoring programmes
Surveillance of antimicrobial resistance and monitoring of the prevalence of, and trends in, resistance in bacteria from animals, food, environment and humans, constitutes a critical part of animal health and food safety strategies aimed at limiting the spread of antimicrobial resistance and optimising the choice of antimicrobial agents used in therapy. Feed should also be considered according to national priorities.
Surveillance or monitoring of bacteria from products of animal origin intended for human consumption collected at different steps of the food chain, including processing, packing and retailing, should also be considered.

This section contains a table giving recommended sampling sources, sample types and output (see table in appendix). The red meat sector has conducted surveys on AMR that conform to these recommendations.

From section 6.9:
a) Type of antimicrobial use data
The data collected at minimum should be the weight in kilograms of the active ingredient of the antimicrobial(s) used in food-producing animals per year. It is possible to estimate total usage by collecting sales data, prescribing data, manufacturing data, import and export data or any combination of these.
The total number of food-producing animals by species, type of production and their weight in kilograms for food production per year (as relevant to the country of production) is essential basic information.
Information on dosage regimens (dose, dosing interval and duration of the treatment) and route of administration are elements to include when estimating antimicrobial usage in food-producing animals.

The aggregate data collection described in the first paragraph is the method employed in the APVMA report (2014)[7]. This has significant limitations, as much of the data covers all cattle (beef and dairy) and sheep. The paragraphs describing the data on numbers of animals, weights and dosage regimes allow a more accurate estimate of use (in mg/kg). However, it would still be difficult to differentiate types of cattle, sheep (age, gender etc) and would give no indication of appropriateness of use. This elaboration of data collection refers to the end user, and recommends more detailed analysis of usage, which would lend itself more to an assessment of appropriate use, compared to the aggregate analysis methods described earlier.
Opportunity: to use these guidelines in the development of AMU surveillance, to be able to ascertain appropriate use.

Reporting formats of antimicrobial use data
The antimicrobial agents, classes or sub-classes to be included in data reporting should be based on current known mechanisms of antimicrobial activity and antimicrobial resistance data.
Nomenclature of antimicrobial agents should comply with international standards where available.
For active ingredients present in the form of compounds or derivatives, the mass of active entity of the molecule should be recorded. For antimicrobial agents expressed in International Units, the factor used to convert these units to mass of active entity should be stated.
The reporting of antimicrobial use data may be further organised by species, by route of administration (specifically in-feed, in-water, injectable, oral, intramammary, intra-uterine and topical) and by type of use (veterinary medical or non-veterinary medical).
Regarding data coming from end-use sources, further breakdown of data for analysis of antimicrobial use at the regional, local, herd and individual veterinarian or veterinary practice levels may be possible.
According to the OIE risk assessment guidelines (refer to Chapter 6.11.), factors such as the number or percentage of animals treated, treatment regimes, type of use and route of administration are key elements to consider.
When comparing antimicrobial use data over time, changes in the size and composition of animal populations should also be taken into account. The interpretation and communication of results should take into account factors such as seasonality and disease conditions, animal species and age affected, agricultural systems (e.g. extensive range conditions and feedlots), animal movements, and dosage regimens with antimicrobial agents.

FAO

As the third member of the Tripartite, the communications from the FAO on AMR closely align with the Global Action Plan. The FAO is the host of the CODEX secretariat, so the codes and standards on AMR come from that organisation. These include the Guidelines for Risk Analysis of Foodborne Antimicrobial Resistance (CAC/GL 77-2011) and Code of Practice to Minimize and Contain Antimicrobial Resistance (CAC/RCP 61-2005)[14]. The FAO also develops guidelines for different production systems, and this organisation seems to have taken the lead on the environmental aspects of the AMR, with UNEP working with them. For example, the FAO developed the Technical brief on water, sanitation, hygiene and wastewater management to prevent infections and reduce the spread of antimicrobial resistance (2020)[15].

FAO Action Plan on AMR addresses four major Focus Areas:

- *improve awareness on AMR and related threats;*
- *develop capacity for surveillance and monitoring of AMR and AMU (antimicrobial use) in food and agriculture;*
- *strengthen governance related to AMU and AMR in food and agriculture;*
- *promote good practices in food and agricultural systems and the prudent use of antimicrobials.*

UNEP/OECD

In all its AMR-related communication, OECD refers to the Tripartite. Much of its communication is also very high level. While promoting a One-Health approach to AMR, there is a bias towards public health in several of the infographics (see Figure 4 from UNEP). The text below is from "Stemming the Superbug Tide – just a few dollars more" (2018). [16]

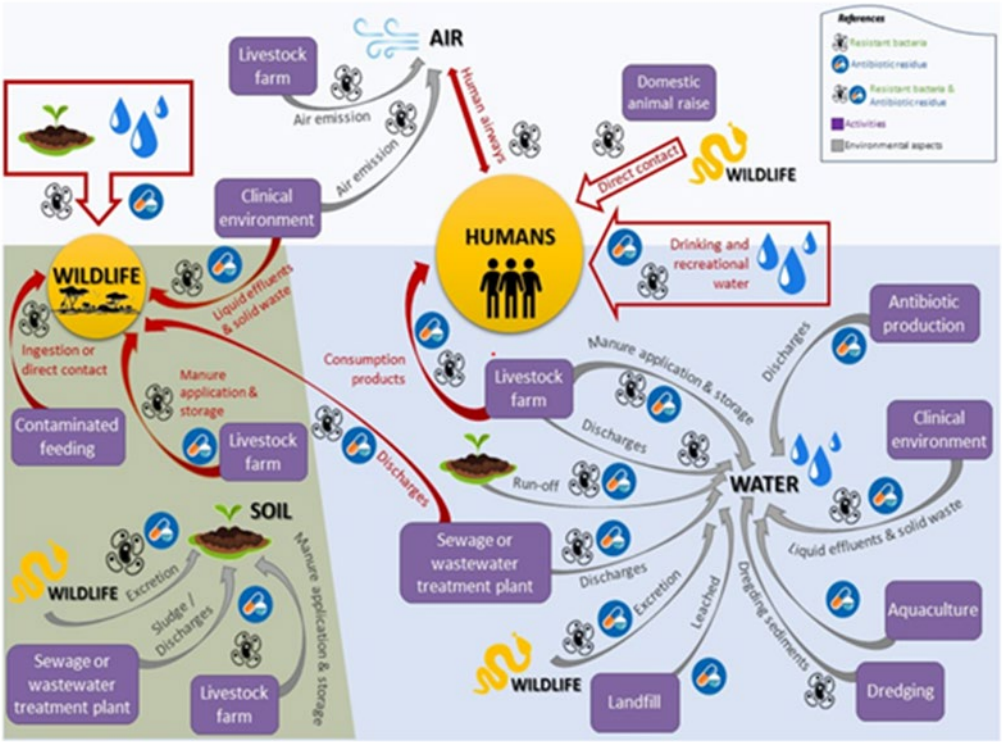


Figure 4 Infographic on AMR and the environment from UNEP. https://www.unep.org/explore-topics/chemicals-waste/what-we-do/emerging-issues/antimicrobial-resistance-global-threat

One Health approach and agricultural policies

The magnitude of antimicrobials in livestock production underscores the critical role of the agricultural sector in combatting AMR. In the United States, antimicrobial use in food animals has been estimated to account for approximately 80% of antimicrobial consumption in the country and is expected to increase by two-thirds by 2030 (Van Boeckel et al., 2015). This widespread use of antimicrobials in agriculture is a major driver of the emergence and spread of antimicrobial resistant microbes in humans and the environment, and interventions reducing antimicrobial use in animals have been shown to affect resistance development in humans. A meta-analysis of nearly 200 studies evaluating the impact of interventions to reduce antimicrobial use in food-producing animals found not only a difference in resistance among animals but also a 24% lower incidence of resistance in human populations, particularly those with direct animal contact (Tang et al., 2017).

Through the multisectoral One Health approach, WHO, the World Organisation for Animal Health (OIE), and the Food and Agriculture Organization of the United Nations (FAO) are tackling all causes of antimicrobial resistance and addressing its public health implications. Such a holistic view of resistance is critical given that resistant bacteria spread between humans, animals, and the environment, meaning that success in one sector requires success in others. The broad aims of the One Health approach are to (WHO, 2017):

- *ensure that antimicrobial agents continue to be effective and useful for curing diseases in humans and animals*
- *promote prudent and responsible use of antimicrobial agents*
- *ensure global access to medicines of good quality.*

Specific policy measures that have been implemented in the agricultural sector include regulatory measures that limit the use of over-the-counter antimicrobials, wholesale bans of specific antimicrobials and growth promoters, manufacturing requirements and quality control, and surveillance and monitoring of agricultural use (Cogliani, Goossens and Greko, 2011; Goutard, 2017). Because of the use of antimicrobials to prevent and manage disease outbreaks among livestock populations, effective antimicrobial resistance policy within the agricultural sector will also need to involve interventions that improve animal health.

2.1.2 G7

The main emphasis of the G7 response on AMR (which is high level) is support of the Tripartitie, and various references to AMR and the environment. There is no specific mention of AMU or AMR surveillance.

From 2021 Health Ministers' Communique[17], which discusses the establishment of the One Health High Level Expert Panel (OHHLEP)[18]:

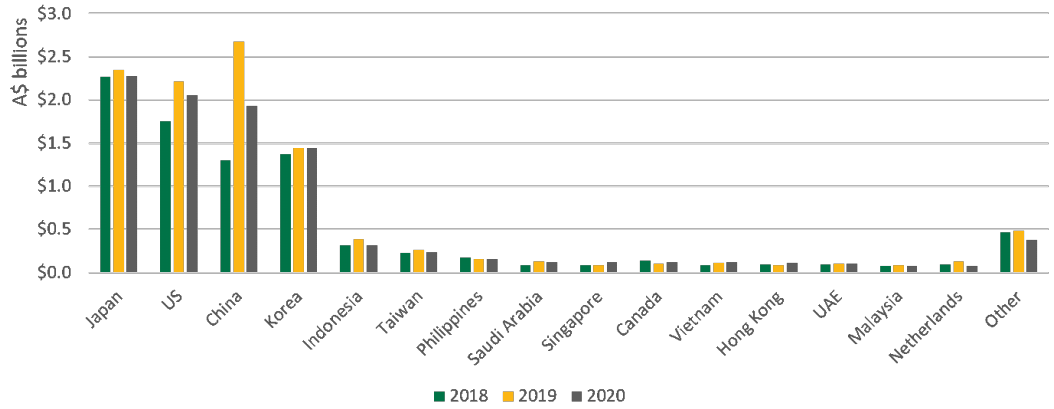
We strongly support the One Health approach, recognising that human, animal, plant and environmental health are interlinked. We welcome efforts by WHO, the Food and Agriculture Organization of the United Nations (FAO), the World Organisation for Animal Health (OIE) and the United Nations Environment Programme (UNEP) to cooperate and make the One Health approach central to their work. We welcome the establishment of the One Health High Level Expert Panel (OHHLEP) by WHO, FAO, OIE and UNEP and encourage further close coordination and collaboration including full integration of environmental and ecosystem work.

On AMR

Alongside climate and environment ministers, we recognise that the release of antimicrobials into the environment can select for antimicrobial resistance and have an impact on human, animal and environmental health. We also note that heavy metals and biocides potentially have an impact on AMR and human, animal and environmental health. We underline the importance of a One Health approach in tackling AMR and call on all governments to promptly implement measures for the sound management and reduction of inappropriate use of antimicrobials. In this context, we note the potential role that soil microorganisms may play in the fight against AMR. We call on the UNEP, in collaboration with the Tripartite organisations, to strengthen the evidence base on the contamination, mechanisms, causes and impacts of AMR emerging and spreading in the environment as mandated at the United Nations Environment Assembly. We commit to work in close collaboration with governments and relevant parties such as medicines regulators where independent of government, and agriculture, academia, industry, the Tripartite on AMR and UNEP to develop and implement long-term, sustainable solutions to this issue. We note with concern that there are currently no international standards on safe concentrations of antimicrobials released into the environment from, among other things, pharmaceutical manufacturing, healthcare facility effluent, agriculture and aquaculture. We also acknowledge the work of the AMR Industry Alliance in this regard. We commit to accumulate knowledge on antimicrobial resistance in the environment.

2.1.3 Countries

In 2020, our largest export markets for beef were Japan, the US and China (Figure 5). When we compare our AMU in cattle with some of these partners, we appear to be in a strong position in Australia (Figure 2). However, recent FTA negotiations with the UK highlighted the tenuous position we are in, given the age of our AMU data.



Source: IHS Markit

Figure 5 Australian beef exports by market https://www.mla.com.au/prices-markets/market-news/2021/value-of-australian-beef-exports-falls-in-2020/

Japan

Japan is our largest export market for beef. In 1999 they established the Japanese Veterinary Antimicrobial Resistance Monitoring System (JVARM)[19]

JVARM is said to conform to the OIE recommendations for AMR surveillance and laboratory testing, but their AMU data is similar to the APVMA data in that it is based on aggregate sales data, and some antimicrobials are registered for multiple species. Their most recent report on AMR and AMU was published in 2017.[20] The summary table on AMU in food producing species is in the Appendix.

Japan's AMR surveillance in cattle involves samples from healthy animals at abattoirs and susceptibility testing for *E. coli*, *Enterococcus*, *Campylobacter* and *Salmonella*. Additionally, they reported on resistance in diseased animals to *Salmonella*, *Staphylococcus aureus* and *E. coli*.

US

The US is our next largest export market for beef. Since 2010 the FDA have reported annually on amounts of antimicrobials sold for food producing animals[21].
The National Antimicrobial Resistance Monitoring System (NARMS) is a U. S. public health surveillance system that tracks antimicrobial susceptibility of select foodborne enteric bacteria. NARMS was established in 1996 as an interagency, collaborative partnership between U.S. Food and Drug Administration (FDA), the Centers for Disease Control and Prevention (CDC), and the U.S. Department of Agriculture (USDA). NARMS monitors AMR in food animals through the USDA Food Safety and Inspection Service (FSIS)[22]. Sampling is conducted quarterly of product and cecal for *Campylobacter*, *E. coli*, *Salmonella* and *Enterococcus*.

UK

In the animal sector, the UK produce the Veterinary Antibiotic Resistance and Sales Surveillance Report (UK-VARSS) annually and have done so since 2013[23]. This, like the APVMA report is based on aggregate sales of veterinary medicines, but as described in the excerpt from the UK action plan below, the UK government are looking at systems to evaluate AMU in individual sectors.

In the UK, we continue to develop and coordinate data collection systems to monitor antibiotic use in different animals, with systems now in place covering a high percentage of the sector for the pig, meat, poultry, laying hen, gamebird, salmon and trout industries, and in development for others (dairy, cattle and sheep). We also collect data on veterinary sales of antibiotics, which, can be used to validate antibiotic use data. These systems should allow both veterinarians and farmers to benchmark their use and review their approach to antibiotic use, such as the one set up for the pig industry. These systems may make it possible to identify risk factors for higher use and practices that contribute to lower use.

Additionally, the UK has set voluntary targets for reductions in AMU in the livestock sectors.

Most recently, the Veterinary Medicines Directorate of Defra has worked with the livestock industry and the veterinary profession to set voluntary targets for reducing antibiotic use in eight food-producing animal sectors.
Our commitment to responsible use means that we have reduced our sales of antibiotics for livestock by 40% over the past five years to 37mg/kg: we fall well below the 2016 European average of 125 mg/kg. Building on this achievement, we will reduce UK antibiotic use in food producing animals a further 25% between 2016 and 2020 through the livestock sectors implementation of actions to achieve the targets they have set; the livestock sector targets will be under continued review. To make more progress we now need to assess prescribing practices and work with industry to develop evidence-based tools that can better guide these practices (including finding quicker and more reliable diagnostics tools). We also need to explore business models that can make better use of veterinary expertise in optimising antibiotic use.

Regarding the FTA between the UK and Australia, section 1.7 of the Agreement in Principle; Animal welfare and antimicrobial resistance (AMR) says "appropriate provisions on cooperation on combatting antimicrobial resistance including bilaterally and in relevant international fora on areas of mutual interest".[24] There are no specifics mentioned with respect to AMU or AMR reporting.

EU

In 2020, the European Medicines Agency published the 10th European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) report[25]. This reported on aggregate veterinary sales from 31 European countries, similar to the APVMA data, but adjusts for population corrected unit (PCU), based on numbers of animals slaughtered. All types of cattle are grouped together, but sheep are reported separately with goats Not all European countries are publishing species-specific data regularly.

The EU also produce an annual AMR summary report "The European Union Summary Report on Antimicrobial Resistance in zoonotic and indicator bacteria from humans, animals and food". The latest version (published in 2020) was for the 2018/2019 period[26].

2.2 Companies (and their representatives)

2.2.1 McDonald's

McDonald's committed to setting targets on AMU in 2018[27]. Specifically, they proposed:

By December 2018, we will collaborate with producers in our supply chain to establish pilots in each of our top ten beef sourcing markets (Australia, New Zealand, France, Germany, Ireland, Poland, UK, Canada, USA and Brazil).
By the end of 2020, we will establish market-specific reduction targets for medically important antibiotics, based on our pilot findings.
Starting in 2022 – we will be reporting progress against antibiotic reduction targets across our top 10 beef sourcing markets.

From The Natural Resources Defense Council (NRDC) Chain Reaction VI report (discussed later), it appears that McDonald's have not yet set the targets for reduction as cited above.

2.2.2 Wholefoods Market

Wholefoods market in the US have a policy of "no antibiotics, ever". Specifically, they state "No antibiotics, ever. If an animal needs antibiotic treatment, it is separated from those bought by our Meat department". They use the "Global Animal Partnership" (not to be confused with GLOBALG.A.P, discussed later) to certify their meats. Details of their specifications are below.

Global Animal Partnership (G.A.P.)

The 2020 G.A.P. Animal Welfare Pilot Standards for Beef Cattle[28] has specific requirements on medication use (section 3.1). Section 3.1.1 (below) prohibits beef producers from using antibiotics therapeutically. This is not an optimal policy from an animal welfare perspective.

3.1.1 (All Steps) The therapeutic use of antibiotics, ionophores, or sulfa drugs is prohibited for market animals. If a market animal must be treated with prohibited medications, that animal must be identified and removed from the Global Animal Partnership 5-Step Animal Welfare program.
3.1.2 (All Steps) Sub-therapeutic (preventive) levels of antibiotics, ionophores, growth hormones, beta agonists, or sulfas are prohibited for all market and breeding animals.
3.1.3 (All Steps) Records must be kept of all treatments, whether alterative remedies or medications, and the results of treatment.
3.1.4 (All Steps) No medicines may be used in an extra-label manner unless prescribed by the farm's attending veterinarian. Any such medicine must have the prescribing veterinarian's label affixed over the manufacturer's label that outlines the prescribed method of usage, duration of administration, and withholding time.
3.1.5 (All Steps) All medications must be discarded after the expiration date.

2.2.3 Red Tractor Assurance (UK)

Red Tractor Assurance is a quality assurance program for the UK food chain. Standards apply to all agricultural sectors except fish & eggs and covers Farm, Transport, Livestock Markets, Slaughter & Processing, accounting for 75% of total UK agriculture. In an independent review of food chain QA schemes in 2019, Red Tractor rated as the top scheme in the beef sector (and close to or at the top of all sectors).
Red Tractor standards do not specify reporting of AMR or AMU, but they do have AMS requirements such as:

AH.c.1 "A written annual livestock health and performance review must be undertaken by the vet" which includes review of AMU and recommendations for reduction in AMU where appropriate (without impacting welfare negatively).
The template for this is in the appendix.
AM.a.1 "Highest Priority Critically Important Antibiotics must only be used as a last resort under veterinary direction"
AM.b.1 "It is recommended that at least one member of staff responsible for administering medicines has undertaken training in the handling and administration of medicines".

All these standards would be covered by the new NFAS standards[29].
Some of the Red Tractor templates pertaining to antimicrobial stewardship can be found in the Appendix.

2.2.4 Bord Bia (Ireland)

Bord Bia/Irish Food Board was established by an act of the Irish parliament (the Dáil) on 1 December 1994. It brought together the former CBF (Córas Beostoic agus Feola - the Irish Meat and Livestock Board) and the food promotion activities of An Bord Tráchtála/the Irish Trade Board, now part of Enterprise Ireland. They have a Producer Standard – Sustainable Beef and Lamb Assurance Scheme. In section 3.4 of this standard, Animal Remedies and Related Equipment (excerpt in the Appendix) there are QA items relating to responsible use, but there is no requirement to report on AMR or AMU.

2.2.5 GLOBALG.A.P.

The GLOBALG.A.P. Livestock program covers livestock production - cattle & sheep, dairy cows, calf & young beef, pigs, poultry and turkey[30]. It also covers additional aspects of the food production and supply chain such as Chain of Custody and Compound Feed Manufacturing. AUS-QUAL is accredited by JAS-ANZ for our GlobalG.A.P. program. At the moment the requirements for GlobalG.A.P. certification include no prophylaxis, no use of 3rd generation cephalosporins and producers require a policy for reduced use on farm. In some species (for example pigs) they are now offering add-ons such as Raised Without Antibiotics (RWA).

2.3 Consumers

2.3.1 Represented by the Australian Government (DAWE and DoH)

The Australian Government, through the Department of Health (DoH) and DAWE are working towards the execution of *Australia's National Antimicrobial Resistance Strategy 2020 & beyond* (2020)[31], and the *Australian Animal Sector National Antimicrobial Resistance Plan* (2018)[32]. The strategy and plan align with the WHO Global Action Plan and the OIE strategy. Specific to the surveillance of AMR and AMU, the National Strategy promises to:

4.3 Use data on antimicrobial usage to inform antimicrobial stewardship policy and support the development of targeted, timely and effective responses
5.1 Create a sustainably funded national One Health surveillance system that integrates human, animal, food and environmental usage and resistance data

To date, the vast majority of the funding on AMR has gone to the DoH, with very going to DAWE. There are some developments with respect to surveillance of AMR and AMU from a One Health perspective, but to date these have only been preliminary engagements with stakeholders. It is likely that as this process develops, the animal industries will be asked to provide input to any surveillance undertaken. Conversations with key personnel in DAWE indicate that (for the greater good) they would like to see transparency and cooperation with respect to AMU and AMR from the animal industries. The 2014 APVMA report[7] is also going to be repeated, but there is no indication that the issues with the aggregate data from the last report have been resolved. If the red meat sector wants to ensure that their usage data is reported in a more timely, meaningful and accurate way, they will probably need to develop the methodology to access and analyse this data themselves.

Opportunity: To design a meaningful AMR and AMU monitoring system for the red meat sector that would align with the AMR strategy but would allow the red meat sector control over the methodology and analysis.

2.3.2 Influential lobby organisations

Pew Charitable Trusts (US)

The Pew Charitable trusts is a "is a global nongovernmental organization that seeks to improve public policy, inform the public, and invigorate civic life". Antibiotic Resistance is one of their project areas.

The Pew Charitable trusts have developed a framework for AMS in food animal production. Most of the components of this framework would be met by the Australian red meat industry if they implemented AMS plans, but some of the aspects of record keeping may need to be improved, especially with respect to AMU. They recently published a paper evaluating AMS in US livestock operations, and they found evaluation to be a key area that was lacking.[33]

In May 2021 the Pew Charitable Trusts wrote to the USDA to provide comment on the following area *(ii) other essential goods and materials underlying agricultural and food product supply chains, including digital products, and infrastructure*

In their letter, they suggested that the USDA "Bolster data collection programs and provide integrated and timely reports on antibiotic use and resistance". They suggested that the current National Animal Health Monitoring System (NAHMS) provides incomplete and infrequent data on AMU and AMR.

While the Pew Charitable Trusts call themselves global, all of the work they appear to have done to date on AMR is US-based. The only topic that relates to Australia that they are involved with is land conservation. That said, if they lobby for policy change in the US, this could impact Australia indirectly or directly.

Natural Resources Defense Council (NRDC) and the Chain reaction report -US

The Natural Resources Defense Council (NRDC) is a US-based charity of more than 3 million members and lobbyists. They propose to "safeguard the earth—its people, its plants and animals, and the natural systems on which all life depends". The Chain Reaction VI report was produced by NRDC alongside the Antibiotic Resistance action Center, Center for Food Safety, Food Animal Concerns Trust, and U.S. PIRG education fund[34]. The report scorecard ranks America's top restaurant chains on their policies relating to antibiotic use in their beef supply chains. Their comments on McDonald's were scathing (below).

McDonald's and Subway have made commitments to eliminate routine use of antibiotics in their beef supplies, but neither company has reported any progress toward meeting those commitments in 2020. In December 2018, McDonald's committed to setting targets for antibiotic overuse reductions in its beef supply by the end of 2020, but now well into 2021, the company has yet to announce these targets.

Alliance to Save our Antibiotics

The Alliance to Save our antibiotics is an alliance of "health, medical, civil society and animal welfare groups campaigning to stop the overuse of antibiotics in animal farming". They wrote a letter to the UK parliament regarding the FTA with Australia and the US[35]. Although for red meat, they could not criticise Australia on levels of AMU, they were critical of how old the data was, and how approximate data on numbers of animals treated was.

UK supermarkets

A summary report in 2020 by the Alliance to Save our Antibiotics[36] found that:

The supermarkets' public policies show that six supermarkets have bans on their suppliers using antibiotics routinely for disease prevention (Co-op, Lidl, M&S, Sainsbury's, Tesco and Waitrose), one has a ban in some species (Morrisons), one recommends that routine use be avoided but has no ban (Aldi) and two as yet have no restrictions other than minimum legal restrictions (Asda and Iceland).
Six supermarkets have published some antibiotic-use data (Asda, Co-op, Lidl, M&S, Tesco and Waitrose) although only Asda, Lidl, Tesco and Waitrose have published data for 2018. A YouGov survey carried out in November 2019 for the Alliance to Save Our Antibiotics found that a large majority of the general public thinks that supermarkets should publish antibiotic-use data they possess: 96% of 1,897 people who expressed an opinion thought that supermarkets should publish their data.

3. Why do we need to control the process?

3.1 The data is complex

3.1.1 Sources of data

Although the data on AMU and AMR to date look good for the red meat industry, critics are quick to point out that it is out of date, aggregate data that does not even differentiate between dairy, extensive or feedlot cattle and includes sheep (due to the dual species labelling) in the analysis. Other potential sources of AMU data, which may give a more comprehensive picture of AMU are veterinary prescribing data (which could provide more specific data with respect to species and farms) or actual farm usage data (which could give a more detailed picture of usage in different classes of animals).

3.1.2 Quality of usage

While improvements could be made in the detail and of the AMU data collected, this would still not allow an evaluation of how the antimicrobials are being used. Appropriate use is. as, if not more, important than total use. For example, if appropriate diagnostics are done before antibiotics are prescribed, a narrow spectrum antibiotic can be used, reducing the risk of resistance due to broad-spectrum antibiotic use.

Veterinary prescribing guidelines have been produced for cattle vets and these lay out best practice for veterinarians prescribing antimicrobials. It would be possible, using these guidelines and other principles of appropriate use to assess the quality of usage on farms. This is already being done in human medicine in Australia through the NAPS survey[37] and the Australian chicken meat industry are now conducting an annual survey of appropriate use with their vets[38].

3.1.3 Significance of use

Not all antibiotics are equal when it comes to the risk of AMR. The WHO have classified antibiotics from 1; highest priority critically important antimicrobials for human use to 5; no human use. Due to the different state of play with respect to AMR in Australia, the Australian Government have developed the ASTAG rating system, rating antibiotics as low, medium or high importance to human medicine (or as low or no human use). Table 1 shows the antibacterial agents registered for

antibacterial use in livestock by the APVMA with ASTAG and WHO classifications. Some classes of antibiotics, such as fluoroquinolones are not even used in livestock in Australia, while they are still used elsewhere in the World.

The antimicrobials used in cattle in Australia with a high ASTAG rating are Polymyxin B (but this is only for topical/aural or ocular use), Virginiamycin and Ceftiofur. It may become increasingly important for producers to be able to demonstrate prudent and/or reducing use of Virginiamycin and Ceftiofur due to their importance for human health. We have an opportunity at this stage to collect data that is most relevant to the cattle industry and provide support to farmers who need to evaluate their usage.

Table 1 Antibacterial agents registered for antibacterial use in livestock by Australian Pesticides and Veterinary Medicine Authority (APVMA, Information accessed June 2021)

Antibacterial Agent	*Class*	*ASTAG 2018*	*WHO2018*	*Cattle*	*Sheep*	*Pig*	*Meat Chicken*	*Egg-layer hen*
Novobiocin	Aminocoumarin	low	5	X[D]				
Spectinomycin	Aminocyclitol	med	4			X	X	X[R]
Apramycin	Aminoglycoside	med	*2*	X		X	X	
Dihydrostreptomycin	Aminoglycoside	low	2	X[DG]	X[G]	X[G]		
Framycetin	Aminoglycoside	low	2	X[J]	X[J]			
Neomycin	Aminoglycoside	low	2	X	X	X	X	X[R]
Streptomycin	Aminoglycoside	low	2	X				
TrimethoprimS	Diaminopyrimidine	med	3	X	X	X	X	X[R]
Flavophospholipol	Glycophospholipid	low	5	X[K]		X[K]	X[K]	X[RK]
Lasalocid	Ionophore	low	5	X[FK]	X[K]	X[K]	X[F]	X[RF]
Maduramicin	Ionophore	low	5				X[F]	
Monensin	Ionophore	low	5	X[FK]	X[K]	X[K]	X[F]	X[RF]
Narasin	Ionophore	low	5	X[FK]	X[K]	X[K]	X[F]	
Salinomycin	Ionophore	low	5	X[FK]	X[K]	X[K]	X[F]	X[RF]
Semduramicin	Ionophore	low	5				X[F]	
Lincomycin	Lincosamide	med	3	X[D]		X	X	X[R]
Erythromycin	Macrolide	low	1	X	X	X	X	
Oleandomycin	Macrolide	low	1	X[D]				
Tilmicosin	Macrolide	low	1	X		X		
Tulathromycin	Macrolide	low	1	X		X		
Tylosin	Macrolide	low	1	X		X	X	X[R]
Avilamycin	Orthosomycin	low	5				X	
Florfenicol	Phenicol	low	3	X		X		
Tiamulin	Pleuromutilin	low	4			X	X	
Bacitracin	Polypeptide i	low	4	X[J]	X[J]		X	X[R]
Polymyxin B	Polypeptide ii	high	1	X[J]	X[J]			
Olaquindox	Quinoxaline	low	5			X		
Virginiamycin	Streptogramin	high	3	X	X		X	
SulfadiazineT+	Folate pathway inhibitor	low	3	X	X	X	X	
SulfadimidineT+/-	Folate pathway inhibitor	low	3	X	X	X	X	X[R]
SulfadoxineT+	Folate pathway inhibitor	low	3	X	X	X		
Sulfaquinoxaline	Sulfonamide	low					X	

Chlortetracycline	Tetracycline	low	3	X		X	X	X^{R}
Oxytetracycline	Tetracycline	low	3	X	X	X	X	
Cephapirin	β lactam cephalosporin	med	3	X^{H}				
Cephalonium	β lactam cephalosporin	med	3	X^{D}				
Cefuroxime	β lactam cephalosporin	med	3	X^{D}				
Ceftiofur	β lactam cephalosporin	high	1	X				
Amoxicillin	β lactam penicillin	low	2	X	X	X	X	X^{R}
Ampicillin	β lactam penicillin	low	2	X^{D}				
Cloxacillin	β lactam penicillin	med	3	X^{DJ}	X^{J}			
Penethamate	β lactam penicillin	low	2	X	X	X		
Penicillin (and salts)	β lactamase inhibitor	low	2	X	X	X		
Amoxicillin with	β lactamase inhibitor	med	2	X^{D}				

A IMPORTANCE for human medicine: ASTAG, version 1.0 2018; nhu no human use; WHO, version 6 2018; 1 HPCIA (Highest Priority Critically Important Antimicrobials for human use); 2 CIA (Critically Important Antimicrobials for human use); 3 HIA (Highly Important Antimicrobials for human use); 4 IA (Important Antimicrobials for human use); 5 nhu (No Human Use), S combination with a sulfonamide; T+/- with or without trimethoprim, D active only available in an intramammary product, R pullet laying replacement, F Label claim for coccidiosis or K growth promotion G(Dihydro)streptomycin/penicillin combination available under APVMA permits issued to

3.2 We need to control the message

It will be very important that the 'story' portrayed by the red meat industry (and all animal industries) isn't simply the headline of total usage. We need to be able to tell WHY and HOW we use antibiotics. In all situations, animal health and welfare are paramount. We are looking for LOW AMU not NO AMU. In the UK, where targets for reduced use have been set, there have been instances of negative press when usage has risen in the face of disease burden[39]. In other areas of the World, such as the US, where there is a movement for "No Antibiotics Ever" (NAE) or "Raised Without Antibiotics" (RWA), there are disturbing reports on increased morbidity and mortality in the antibiotic free environments. For example, in a US study of pigs challenged with porcine reproductive and respiratory syndrome virus (PRRSV), the percentage of mortality or removals in pigs treated with antibiotics prophylactically, judiciously or not at all were 20.94%, 24.98% or 57.98% respectively, despite all pigs being vaccinated against PRRSV[40]. In another study on broiler chickens, birds raised without antibiotics were at greater risk of eye burns, footpad lesions, and airsacculitis, key indicators of animal welfare, compared with birds raised with antibiotics[41].

From an animal welfare perspective, it would be inappropriate for the Australian Red Meat industry to endorse these systems. We should seek to promote low use, of low importance antibiotics (unless higher importance use is absolutely justified by a vet) for appropriate reasons. It will be important that we are able to justify our claims of stewardship practices, through evaluation of the implementation of stewardship on farms. Our message to stakeholders will need to be that we are responding to international and consumer concerns.

3.3 We need to be ready now

As a country, Australia are clear laggards in reporting to international bodies on AMU in livestock. This is likely to result in increased pressure on the Government (and then from the Government to industry) to produce data. With the bulk of funding for AMR historically going to human health, it is

unlikely that Government will fund the collection of meaningful AMU data, or AMR surveillance entirely (if at all).

Simultaneously, and probably before anything meaningful is done by the Government, the UK/EU FTA and its AMR provisions may create long term technical barriers to trade. In addition, domestic and overseas consumer or customer concerns about AMR and AMU mean we need to be ready with reliable data to back up any claims we may need to make about our AMU and AMS practices.

DAWE are funding a project on aggregate data, from APVMA sales and from veterinary use. Additionally, there have been initial Government consultations on a 'One Health' AMR/AMU surveillance system. However, if we wait for a government program to be established, we may be too late to tell our story, or create the most meaningful way to collect and present the data.

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5. Appendix

5.1 OIE Terrestrial Animal Health code (2021) Chapter 6.8 – sampling sources for AMR surveillance

Online access:

https://www.oie.int/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/

Chapter 6.8.- Harmonisation of national antimicrobial resistance surveillance and monitoring programmes

Table 1. Examples of sampling sources, sample types and output

Source	Type	Output	Additional information required or additional stratification
Herd or flock of origin	Faeces or bulk milk	Prevalence of resistant bacteria originating from animal populations (of different production types). Relationship between resistance and antimicrobial use	Age categories, production types, etc. Antimicrobial use over time
Slaughterhouse/Abattoir	Faeces	Prevalence of resistant bacteria originating from animals at slaughter	
	Caeca or intestines	As above	
	Carcass	Prevalence of resistant bacteria after carcass dressing, representative of the hygiene of the process and the contamination during slaughter	
Processing, packing	Food products	Prevalence of resistant bacteria after processing, representative of the hygiene of the process and the contamination during processing and handling	
Point of sale (Retail)	Food products	Prevalence of resistant bacteria originating from food, exposure data for consumers	
Various origins	Animal feed	Prevalence of resistant bacteria originating from animal feed, exposure data for animals	
Various origins	Environment	Occurrence of resistant bacteria originating from the animal-immediate or the wider environment	

5.2 Data on Japanese AMU 2016-17

https://www.maff.go.jp/nval/yakuzai/pdf/200731_JVARMReport_2016-2017.pdf

The estimated volumes of veterinary antimicrobials sold for food-producing animals (cattle, pigs, horses, chickens, and others) in terms of active ingredients are listed in Table 58. During the period 2013 to 2016, the estimated volume of sales ranged between 640.25 t and 669.68 t. The approximately 18 t increase in sales over this period was mainly accounted for by increases in penicillins (approximately 24 t), aminoglycosides (approximately 10 t), and 16-membered macrolides such as tylosin (approximately 17 t). Tetracyclines (275.83 tons to 286.74 tons) took up the largest share in the overall volume of sales of antimicrobials for food-producing animals, accounting for 41.9

to 44.0%. In contrast, the volume of sales of the third-generation cephalosporins and fluoroquinolones that are important for human health remained about 0.5 tons and 5 tons respectively, accounting for less than 1% of total volume of sales in food-producing animals (Table 65).

Table 65. The estimated volumes of sales of veterinary antimicrobials used for food-producing animals (cattle, pigs, horses, chickens, and others) in terms of active ingredients (unit: tons)

	2013	2014	2015	2016
Penicillins	59.50	61.96	67.25	83.56
Cephalosporins (total)	3.12	3.06	3.22	3.34
1st generation cephalosporins	(2.45)	(2.34)	(2.52)	(2.52)
2nd generation cephalosporins	(0.19)	(0.20)	(0.12)	(0.16)
3rd generation cephalosporins	(0.49)	(0.51)	(0.58)	(0.65)
Aminoglycosides	37.40	38.66	34.07	47.46
Macrolides	56.00	53.30	60.36	72.68
Lincosamides	35.88	36.61	23.65	15.62
Tetracyclines	286.74	275.83	276.24	280.66
Peptides	11.77	9.97	14.54	14.01
Other antibacterials	25.71	28.43	32.23	31.55
Sulfonamides	95.62	88.43	84.40	78.57
Quinolones	0.22	0.20	0.20	0.16
Fluoroquinolones	4.64	4.73	6.41	5.19
Thiamphenicols and derivatives	19.66	25.14	27.39	24.82
Furan and derivatives	0.00	0.00	0.00	0.00
Other synthetic antibacterials	14.98	13.92	13.32	12.07
Antifungal antibiotics	0.00	0.00	0.00	0.00
Total	651.24	640.25	643.28	669.68

* The figures in parentheses are included in the Cephalosporins (total).

5.3 Red Tractor templates for vets

All beef and lamb templates: https://assurance.redtractor.org.uk/templates/

5.3.1 Antibiotic collation

https://assurance.redtractor.org.uk/wp-content/uploads/2021/09/Antibiotic-Collation-.docx

5.3.2 HP-CIA Justification of use template

https://assurance.redtractor.org.uk/wp-content/uploads/2021/09/HP-CIA-Justification-of-use-template-.docx

5.3.3 Vet Health and Performance Review

https://assurance.redtractor.org.uk/wp-content/uploads/2021/09/Vet-Health-and-Preformance-Review.docx