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Antimicrobial stewardship guidelines for the Australian cattle feedlot industry

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Foreword

Welcome to the *Antimicrobial stewardship guidelines for the Australian cattle feedlot industry*.

Antimicrobials (antibiotics) are a vital tool in both human and animal medicine. In Australian feedlots, antimicrobials play an indispensable role in helping us manage the health and welfare of cattle under our care.

Antimicrobial resistance has become a concern of both medical and livestock policy makers, medical professionals, veterinarians, producers and the general community. It occurs when the bacteria causing people or livestock to be ill become resistant to antimicrobial treatment. This can be caused by overuse or inappropriate use of antimicrobials. Concerns about reduced antimicrobial effectiveness, coupled with fewer new antimicrobial technologies being discovered, means we must preserve the effectiveness of antimicrobials currently available.

The Australian Lot Feeders' Association is dedicated to preserving the effectiveness of antimicrobials, and to protecting human and animal health, by promoting responsible antimicrobial use. The Australian beef industry has a great reputation to uphold; previous surveillance has reported levels of antimicrobial resistance in Australian cattle that are either absent or very low.

The *Antimicrobial stewardship guidelines* provide a continuous improvement framework that will help lot feeders understand and ensure appropriate use of antimicrobials and therefore reduce the risk of antimicrobial resistance. These guidelines are aligned with Australia's First National Antimicrobial Resistance Strategy (Australian Government 2015).

The guidelines outline five stewardship principles which are collectively termed the '5Rs' - responsibility, review, reduce, refine and replace. These principles will help guide lot feeders toward best practice management use of antimicrobials and prevent overuse, which may contribute to the development of antimicrobial resistance. In summary they are:

1. **Responsibility:** Ensure everyone at the feedlot, including the consulting veterinarian, feedlot management and staff, nutritionist, and stock feed manufacturer recognises the need to preserve the effectiveness of antimicrobials and that antimicrobial stewardship becomes a priority through the formation of a management team that is responsible for developing and implementing an Antimicrobial Stewardship Plan for the feedlot.
2. **Review:** Regularly review and evaluate your compliance with your Antimicrobial Stewardship Plan and adopt a process of continuous improvement to ensure that antimicrobial use practices reflect contemporary best practice.
3. **Reduce:** Wherever possible, adopt preventative measures to reduce the need for medically important antimicrobials without compromising the health and wellbeing of the animals in your care.
4. **Refine:** Refine and continually improve your Antimicrobial Stewardship Plan by ensuring the correct antimicrobial is used for the correct disease diagnosis and that the antimicrobial is administered correctly (dose, route of administration, duration) and at the correct time. Monitoring these practices over time will help you make improvements in your treatment protocols and antimicrobial use patterns, and demonstrate best practice standards to stakeholders, trading partners and consumers.
5. **Replace:** Consider replacement of a medically important antimicrobial whenever available evidence supports the efficacy and safety of an alternative; again without compromising the health and wellbeing of the animals in your care.

Australian Lot Feeders' Association in conjunction with MLA, proudly presents the *Antimicrobial stewardship guidelines for the Australian cattle feedlot industry*. The guidelines will help demonstrate our industry's commitment to best practice management use of antimicrobials and align ourselves with national and international initiatives to preserve the effectiveness of antimicrobials for people and animals. I encourage you to adopt the framework within your business.

Tess Herbert

Australian Lot Feeders' Association President

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1.0 Introduction

1.1 Antimicrobials and resistance

People are sometimes challenged with pathogenic bacteria and develop disease when their immune system is overwhelmed. When this occurs, a doctor prescribes the person antibiotics (referred to as antimicrobials in these guidelines). These medicines treat the infection caused by the bacteria and aid the immune system to heal the patient. Just like humans, cattle sometimes acquire bacterial infections and may need to be treated with antimicrobials to control disease and return to health.

Antimicrobials are one of a number of tools available to feedlot managers to help ensure the health and welfare of animals in their care. The term 'antimicrobial' generally refers to medicines that act to selectively kill or inhibit the growth of bacteria. Antimicrobials generally rely on a functional immune system to work effectively.

Antimicrobials are used in both human and veterinary medicine (companion animals and livestock). In recent years, antimicrobial resistance has become an international 'One Health' priority, with concerns that certain classes of antimicrobials are losing their effectiveness to treat disease in both humans and animals. This concern is exacerbated by low rates of new antimicrobial discovery.

Antimicrobial resistance refers to the acquired ability of bacteria to survive in the presence of an antimicrobial that previously was able to kill or inhibit the growth of the bacteria. Bacteria can acquire resistance by the appearance of favourable mutations or by acquiring preselected genes for resistance from other bacteria.

Resistance of bacteria to antimicrobials is not just limited to humans, and has been documented in many species including dogs, cats, horses, birds, fish, wildlife and livestock. Even though any use of antimicrobials may facilitate antimicrobial resistance selection, overuse or misuse of antimicrobials in both human and veterinary medicine may increase the likelihood of antimicrobial resistance developing.

1.2 Current status of resistance

The Australian Pesticides and Veterinary Medicines Authority (APVMA) has maintained a conservative approach to the registration of antimicrobial agents for use in livestock. This has resulted in a limited number of antimicrobials available for use in feedlot cattle, necessitating a judicious approach to their use in order that they remain effective (see Appendix 1 for a list of antimicrobials used in Australian feedlots).

This conservative approach, combined with farm management practices and environmental conditions, has resulted in levels of antimicrobial resistance in Australian cattle that are either absent or very low (Abraham et al 2014; Barlow and Gobius 2008; Barlow et al 2015, 2017; Barton et al 2003; DAFF 2007).

Despite this, it remains essential to ensure that antimicrobials continue to be preserved for future use.

1.3 Antimicrobial stewardship

Stewardship describes practices that protect valuable resources that belong to everyone, for example the ocean, air, forests, rivers, and the broader environment.

Antimicrobial stewardship describes practices designed to reduce the need for antimicrobial use and to ensure that when antimicrobials are required, they are utilised in a way that maximises efficacy while minimising adverse effects including the development of antimicrobial resistance. Thus antimicrobial stewardship includes all those measures to refine, reduce and replace antimicrobial use.

In view of the global concern at the increasing public health crisis associated with antimicrobial resistance and the implementation of Australia's First National Antimicrobial Resistance Strategy (Australian Government 2015), it is important to ensure that all antimicrobials are used responsibly to preserve their effectiveness. This document presents a framework for antimicrobial stewardship, an approach to ensure the very best use of antimicrobial agents, and is designed for use by veterinarians and feedlot producers.

2.0 Grainfed beef integrity systems

The antimicrobial stewardship framework discussed in the following section aims to compliment the well-established regulatory bodies and systems servicing the feedlot industry to ensure the integrity of grainfed beef. These include:

- Australian Pesticides and Veterinary Medicines Authority (APVMA)
- Registered veterinarians
- National Livestock Identification System (NLIS)
- National Feedlot Accreditation Scheme (NFAS)
- Livestock Production Assurance (LPA) program
- National Residue Survey (NRS)

Antimicrobials for use in beef cattle are approved by the APVMA. All antimicrobials undergo a rigorous pre-approval process under which the safety to animals, humans and environment is assessed, and residues in edible beef products are monitored. The APVMA publishes withholding periods for all antimicrobials and maintains a list of export slaughter intervals for products used in cattle.

The feedlot industry is fortunate to be serviced by a dedicated group of registered veterinarians. These highly trained individuals make regular visits to feedlots to assess beef cattle health and welfare. All scheduled antimicrobials used in feedlots are prescribed by veterinarians. The antimicrobial will be labelled by the veterinarian in addition to the manufacturer's label and information insert, which contains directions for use, storage, precautions, restraints, withholding periods, disposal and other important information.

The National Livestock Identification System (NLIS) ensures traceability of cattle from feedlot arrival to dispatch. This program is critical to maintaining identity and antimicrobial treatment records on individuals in the feedlot, ensuring correct administration of antimicrobials and that export slaughter intervals and withholding period requirements are met.

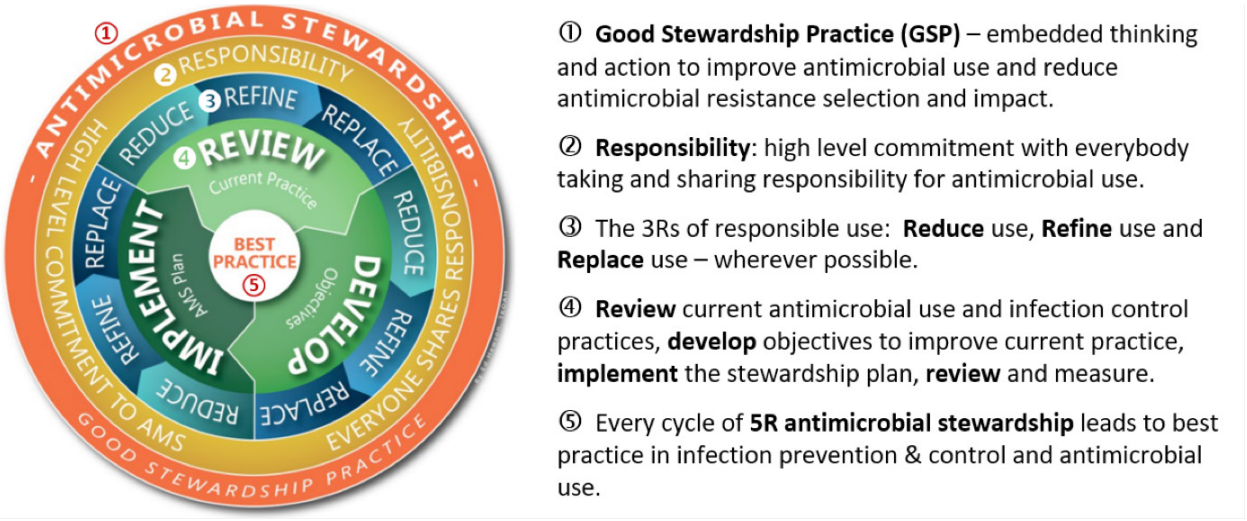
The Livestock Production Assurance (LPA) program is the Australian livestock industry's voluntary on farm assurance program covering food safety, animal welfare and biosecurity. It provides evidence of livestock history and on farm practices when transferring livestock through the value chain. An LPA National Vendor Declaration (NVD) is industry best practice for all livestock movements, including property to property, through saleyards, direct to feedlots and to processors. Every NVD signifies that cattle within a consignment are not within a withholding period or export slaughter intervals as set by APVMA or SAFEMEAT, following treatment with any veterinary drug or chemical.

The National Feedlot Accreditation Scheme (NFAS) is an independently audited (AUS-MEAT Limited) industry assurance scheme that underpins the quality, safety and integrity of grainfed beef. The scheme supports correct antimicrobial use through documented procedures for livestock identification, biosecurity, storage, inventory management, labelling, administration to animals and export slaughter interval and withholding period compliance. Beef labelled under the GF (Grainfed) or GFYG (Grainfed Young Beef) ciphers must have been sourced from an NFAS-accredited feedlot with appropriate delivery documentation.

The National Residue Survey (NRS) conducted by the Department of Agriculture and Water Resources randomly samples beef products at Australian abattoirs for antimicrobial residues. Over the last decade, compliance in the cattle program has been high (99.9–100%).

3.0 5R framework of antimicrobial stewardship – feedlots

The antimicrobial framework that captures the definition and goal is summarised in the following infographic.



① **Good Stewardship Practice (GSP)** – embedded thinking and action to improve antimicrobial use and reduce antimicrobial resistance selection and impact.

② **Responsibility**: high level commitment with everybody taking and sharing responsibility for antimicrobial use.

③ The 3Rs of responsible use: **Reduce** use, **Refine** use and **Replace** use – wherever possible.

④ **Review** current antimicrobial use and infection control practices, **develop** objectives to improve current practice, **implement** the stewardship plan, **review** and measure.

⑤ Every cycle of **5R antimicrobial stewardship** leads to best practice in infection prevention & control and antimicrobial use.

There are five core elements of an antimicrobial stewardship program, the 5Rs, which are:

1. Responsibility
2. Review
3. Reduce
4. Refine
5. Replace

The program is underpinned by Good Stewardship Practices (GSP) and is a commitment to antimicrobial resistance reduction at a local level, which over time leads to global reduction.

The antimicrobial stewardship program involves cycles of continuous improvement revolving around the 5Rs. A description of the 5Rs follows.

3.1 Responsibility

The appropriate use of antimicrobials is a shared responsibility between the prescribing veterinarian, who accepts responsibility for the decision to use an antimicrobial agent, and the feedlot management and staff, who are responsible for good animal care practices (including infection control and prevention), following all directions for use and implementing management changes over time. This approach safeguards the health and welfare of the animals while minimising the likelihood of any adverse impacts on individual animals, other livestock, or on public health due to bacterial disease or treatment involving antimicrobials.

It is crucial that everyone at the feedlot including the consulting veterinarian, feedlot management and staff, feedlot nutritionist, and stock feed manufacturers understand and support the need to preserve the effectiveness of antibiotics. Antibiotic stewardship therefore becomes a priority for everyone. Management supports the formation of a team to develop and implement an antimicrobial stewardship plan in consultation with the consulting veterinarian. The veterinarian is an integral part and driver of the team.

It is the responsibility of the consulting veterinarian to ensure that all veterinary products that are or could be used are listed on a 'prescribed drug list', and a treatment protocol is documented, detailing how animals will be treated for the various conditions that might be seen on the feedlot. This includes the treatment program (product, dose rate, frequency of dosing, route of administration), and the withholding periods and export slaughter intervals for the products used. Label restraints, 'off label' usage and any special directions are

included in this document. A file containing official labels of antimicrobials listed on the prescribed drug list is recommended for each feedlot. These protocols are to be documented by the veterinarian in consultation with the management team at the feedlot.

Correct storage conditions, records of people trained in the use of products and lists of people who have access to these prescription products are to be documented.

It is the responsibility of the feedlot to ensure that the prescribed drug list, treatment protocol and any special directions such as label restraints from the consulting veterinarian are adhered to. It is also important that the feedlot considers the importance of similar classes of antimicrobials used in human medicine. Medically important classes of antimicrobials can sometimes be shared between human medicine and animal agriculture (see Appendix 1 – Australian Strategic and Technical Advisory Group on antimicrobial resistance and World Health Organization importance ratings). Decisions on use of medically important antimicrobials must be risk and science-based and discussed between the feedlot and the consulting veterinarian.

The category of 'no human use' antimicrobials used by the Australian feedlot industry (ionophores and glycophospholipids) have no use in human medicine and do not have human risk ratings reported by the World Health Organization or Australian Strategic and Technical Advisory Group on AMR (Appendix 1). While it is important that 'no human use' antimicrobials are used according to their registered label directions and their efficacy is preserved, the recommendations of this document are targeted towards antimicrobial stewardship of medically important classes of antimicrobials.

3.2 Review

Antimicrobial stewardship initiatives should be reviewed regularly. A process of continuous improvement should also be adopted to evaluate compliance with initiatives and to ensure that medically important antimicrobial use practices reflect contemporary best practice.

A review of the current status of animal health, wellbeing and antimicrobial use should be undertaken. During the review, areas in need of improvement are identified and a plan is put in place to drive improvement. Outcomes of the antimicrobial stewardship plan are monitored and measured. Measurements should

include the quantity of each antimicrobial used and the quality of their use. The quality of use refers to the appropriateness of antimicrobial use, i.e. has the treatment protocol been followed?

◆ 3.2.1 Measurement: quantity of use

Medically important antimicrobial use should be recorded by the antimicrobial stewardship team and the records periodically analysed to determine the quantity of each antimicrobial agent (as mg or kg of antimicrobial active ingredient) used per year (or other unit of time).

The calculations for quantity of use of antimicrobials are detailed in the following tables.

Injectable or oral antibiotic use

Antimicrobial use (mg)	=	Animal mass (kg)	X	Daily dose (mg/kg BW/d)	X	Duration (d)

Animal mass	= number of animals X average body weight (BW)
Daily dose	= dose rate (mg/kg BW) X number of times administered per day
Duration	= number of days the daily dose is administered.

In feed antimicrobial use

Antimicrobial use (mg)	=	Inclusion rate in feed (mg/kg)	X	Feed consumed (kg)	X	Duration (d)

Inclusion rate	= mg/kg of feed
Feed consumed	= total quantity of feed consumed per day in kilograms
Duration	= number of days the daily dose is administered.

In order to reduce antimicrobial use, reducing the number of animals that require treatment will reduce the amount of antimicrobial agent used. Ensuring animals are treated for the correct number of days will ensure overuse does not occur from unnecessary applications, or that the risk of antimicrobial resistance is not increased by not treating for sufficient time to be effective in overcoming the infection.

Identifying individual cattle for treatment rather than treating a pen of cattle can reduce antimicrobial use considerably. The antimicrobial stewardship team question is “how can the selection of individual animals for targeted treatment be improved”.

The amount of antimicrobials used on a feedlot is affected by the herd size. If a feedlot doubles in capacity, then it is likely that the total use of antimicrobials will increase even if the percentage of animals treated decreases. Therefore a measure that focuses on use within the population in a defined time frame will more accurately describe total use e.g. milligrams of antimicrobial per kilogram of live weight received or kilogram of carcase sold for the month. This would give a standardised measure across the population that can be compared over time to evaluate changes in antimicrobial use.

◆ 3.2.2 Measurement: quality of use - appropriate use

To achieve a high level of quality of use, a crucial part of the antimicrobial stewardship program is dependent on a documented treatment protocol for the various conditions that are likely to be encountered. These detailed protocols are documented and prescribed by the consulting veterinarian.

The basic principle of assessment of quality is whether or not there is compliance with the prescribed treatment protocol.

In order to assess quality of use, it is necessary that the indication and treatment of each animal is recorded. The treatments can then be audited against the documented treatment protocol.

The following table is an approach to assessing quality of antimicrobial use:

Appropriate	
Optimal	Treatment protocol is in place and is followed at all times. Body weight is measured, indication is recorded, correct antimicrobial agent is used, dosage, administration route, duration and withholding period and export slaughter interval is complied with.
Adequate	Treatment protocol is in place, and is always followed. Body weight is measured, indication is recorded, correct antimicrobial agent is used, however, dosage, administration route or duration may not be optimal. Withholding period and export slaughter interval is complied with.
Inappropriate	
Suboptimal	Treatment protocol is in place but is not always followed. Indication is not recorded. Body weight is not measured. Withholding period and export slaughter interval is complied with.
Inadequate	Treatment protocol is in place but is not always followed. Indication is not recorded. Body weight is not measured. Non compliance for withholding period and export slaughter interval.
Unknown	
Non-compliant	Treatment protocol is not documented. Body weight is not measured. Indication is not recorded. Treatments are not recorded. Withholding period and export slaughter interval not recorded.

While it is generally not difficult to measure the quantity of antimicrobial agents used, the ability to measure the quality of use can be challenging. However, achieving a high level of quality of use of antimicrobials is an important antimicrobial stewardship goal.

3.3 Reduce

The use of medically important antimicrobials should be reduced wherever possible, without compromising the health and wellbeing of the animals in our care. There are a range of preventative measures which, when combined, ensure that infectious disease incidence and the need for antimicrobials is minimised. These include livestock procurement policy, preparation of animals prior to feedlot entry, vaccination, animal husbandry, precise nutrition, cattle handling and better diagnosis.

Examples of policies that may reduce the use of antimicrobials include:

- the purchase of yard weaned, pre-vaccinated and backgrounded cattle
- maximising the purchase group size
- minimising the number of purchase groups in a pen.

(Barnes et al. 2014; *Epidemiology and management of bovine respiratory disease in feedlot cattle - final report*. Meat & Livestock Australia Limited).

Vaccine use can protect cattle from some bacterial diseases as well as protozoal and viral diseases that compromise immunity and predispose cattle to secondary bacterial infection. A list of vaccine targets that are pertinent to feedlot cattle is provided in Appendix 2. To gain the greatest protection from vaccines, there are many advantages to applying them on farm prior to feedlot entry.

◆ 3.3.1 Biosecurity

Feedlot operations are already very familiar with the importance of biosecurity. Biosecurity involves using management and physical measures that are designed to reduce the risk of the introduction, development and spread of disease to, from and within the feedlot. The three fundamental elements of good biosecurity are described below, the application of each is essential to successful antimicrobial stewardship.

1. Primary prevention: external biosecurity (bioexclusion)

- minimising the number of sources of introduced animals
- isolation of sick animals before introduction
- provide clean water, feed and air
- cleaning and disinfection of transport vehicles to minimise the potential spread of disease.

2. Secondary prevention: internal biosecurity (biocontainment)

- early diagnosis of disease
- pen cleaning to minimise excessive manure build-up causing unacceptable levels of dust or mud
- processing hygiene and regular needle changes
- controlled drainage without pen-to-pen effluent movement
- once a novel pathogen is present, introduction of measures to eliminate or reduce transmission – guided by on farm microbiological risk assessment
- reduced stocking density and segregation in sick pens with increased access to feed and water
- enhanced animal comfort to improve recovery.

3. Tertiary prevention: individual animal resilience (adaptive capacity to changing environment)

- genetic selection
- vaccination
- backgrounding
- management (low stress handling) and animal husbandry
- nutritional management to enhance immunocompetence and achieve a positive energy and protein balance without inducing digestive illnesses
- pen management (stocking rate, water trough and bunk hygiene, pen manure management, shade).

3.4 Refine

Refined use means that the correct diagnosis results in the administration of the correct antimicrobial at the correct time, at the correct dose, via the correct route of administration and for the correct length of time. This information is recorded for analysis of both use and efficiency to guide future decisions on treatment protocols, antimicrobial use and allow quality of use to be assessed.

This is a continuous cycle of improvement: responsibility, review, reduce and refine.

◆ 3.4.1 Detection and diagnosis

Disease detection and diagnosis can be difficult in cattle and often disease has progressed substantially before any evidence is observed. However, early detection and diagnosis permit earlier interventions, resulting in improved treatment outcomes, reduced antimicrobial use and reduced antimicrobial resistance selection.

Bovine respiratory disease is one of the main infectious diseases affecting feedlot cattle and early detection may be difficult. Currently the selection of animals in the pen for further examination and diagnosis is done by pen rider observation. These skilled people use a system based around depression, appetite, respiratory nature and temperature.

It is important for antimicrobial stewardship plans to evaluate the relevance and appropriateness of emerging technologies to a given feedlot as they become commercially available and more cost-effective. These may include technologies for more rapid and accurate disease detection and diagnosis for bovine respiratory disease and other conditions.

◆ 3.4.2 Judicious use

To ensure that antimicrobials are used judiciously, it is important that the feedlot has a documented drug list (prescribed drug list) and a documented treatment protocol provided by the consulting veterinarian. Following the program as prescribed is also important to enable evaluation of the efficacy of the treatment and whether refinement of the treatment protocol is necessary.

◆ 3.4.3 Antimicrobial resistance surveillance

Antimicrobial resistance monitoring and surveillance is the yardstick whereby the successful implementation of antimicrobial stewardship principles is effectively measured. It is important that surveillance of pathogens and the antimicrobial sensitivity of these pathogens to antimicrobials on the prescribed drug list are regularly assessed.

For example, a surveillance programme could be undertaken during the typical months where cases of bovine respiratory disease occur (autumn and spring), involving post-mortem of both treated and untreated pen deaths and aseptic collection of lung tissue samples or swabs for culture and susceptibility testing. The feedlot veterinarian should develop, coordinate and implement the monitoring and surveillance program in conjunction with the feedlot manager. Samples should be sent to a certified diagnostic laboratory for pathological examination, culture and sensitivity. It is an important role for the consulting veterinarian to be involved in the interpretation of the results, and to ensure that they are used where applicable to further refine use.

3.5 Replace

The replacement of medically important antimicrobials should be considered whenever available evidence supports the efficacy and safety of an alternative. Over the last 20 years there has been substantial interest in finding alternatives to antimicrobials for use in cattle and other livestock species. Many products are promoted as replacements including probiotics, direct fed microbials, yeasts, various plant extracts and organic acids. However, rigorous scientific evaluation has not yet produced robust supporting evidence for the use of many of these products. Adoption of antimicrobial alternatives should therefore be carefully assessed to avoid unintended consequences of harm to animals, or increased need for medically important antimicrobials if they fail.

It is an important task of the antimicrobial stewardship team to identify and assess alternatives to medically important antimicrobials as they become available.

4.0 How to develop an antibiotic stewardship plan

The feedlot industry has considerable experience at maintaining high levels of animal health and wellbeing. Industry integrity systems and programs such as National Feedlot Accreditation Scheme, Livestock Production Assurance and the National Residue Survey, combined with the oversight of antibiotic prescribing and use by registered veterinarians are examples of programs designed to maintain the safety and integrity of grainfed beef. The National Livestock Identification System ensures traceability of all cattle throughout their life.

Step one

The first step is to recognise and value the benefits of preserving antimicrobials and make antimicrobial stewardship a priority. Form an inclusive team that includes the consulting veterinarian, feedlot management, feedlot nutritionist, and stock feed manufacturer. This antimicrobial stewardship team must foster a culture of everyone at the feedlot being on board, from pen cleaner to feedlot manager.

Step two

The next step is to ensure that there is a documented treatment protocol in place. This treatment protocol is a living document and should be reviewed regularly. The treatment protocol must be developed in conjunction with the consulting veterinarian and should cover diseases and conditions that are seen or are likely to be seen on the feedlot. The treatment protocol documents exactly how the animal should be treated and includes the dose rate, the route of administration, treatment duration, withholding period and export slaughter interval and any special instructions (e.g. only administer 10ml per injection site). Any 'off label' usage, special conditions or directions must be included in this document.

From this treatment protocol, a prescribed drug list is created and includes the product, drug name, dose rate, withholding period and export slaughter interval. A file with official labels of antimicrobials listed in the prescribed drug list is recommended for each feedlot.

In instances where prescription animal remedies are required to be included in the supplement, premix or finished feed a 'feed medication order' signed by the consulting veterinarian must be supplied to the supplier of the supplement, premix or finished feed. The product, drug name, dosage, treatment period, animals to be treated, withdrawal period and export slaughter interval must be included on the document. Any special usage conditions or restraints must also be included. Copies of the 'feed medication order' are retained by the veterinarian, feedlot, feedlot nutritionist and stock feed manufacturer.

Step three

The next step is to review the current use for each medically important antimicrobial. How much of each antimicrobial is used?

This should be expressed as 'mg of antimicrobial/kg live weight of inducted animals/month'. This is a relatively simple calculation to make using the following methods.

Injectable or oral antibiotic use

Antimicrobial use (mg)	=	Animal mass (kg)	X	Daily dose (mg/kg BW/d)	X	Duration (d)

Animal mass	= number of animals X average body weight (BW)
Daily dose	= dose rate (mg/kg BW) X number of times administered per day
Duration	= number of days the daily dose is administered.

In feed antimicrobial use

Antimicrobial use (mg)	=	Inclusion rate in feed (mg/kg)	X	Feed consumed (kg)	X	Duration (d)

Inclusion rate	= mg/kg of feed
Feed consumed	= total quantity of feed consumed per day in kilograms
Duration	= number of days the daily dose is administered.

Do the same calculation for each antimicrobial.

An alternative method is to calculate mg/kg of carcase weight produced.

This will give a monthly usage spread across the whole population. This will vary per month depending on the number of incoming cattle; however, over a production cycle, this will become very accurate.

There are many ways to express antimicrobial usage. These range from very simple methods to very complex and detailed methods. The method does not matter. What matters is use is monitored over time and plans are implemented to reduce usage without compromising health and wellbeing of the cattle.

Examine how well the treatment protocol is followed i.e. protocol compliance. The feedlot should develop a process to check if the indication for use of the correct antimicrobial, dose, route of administration, duration and withdrawal period is being followed on a regular basis. When non-compliance occurs, investigations should occur and training conducted where necessary.

Step four

Look for opportunities to change practices that may lead to reducing the need to use medically important antimicrobials e.g. improve selection of animals for examination and diagnosis. Review the approach and methods of pen riding and pen checking. Improve the accuracy of diagnosis by investigating the implementation of technologies to refine case definition and development treatment protocols around these case definitions.

Examine and review policies and practices such as procurement of cattle, vaccination, animal handling and husbandry practices. Review the risk factors associated with the diseases encountered on the feedlot and develop a plan to reduce these risks (Barnes et al. 2014; Epidemiology and management of bovine respiratory disease in feedlot cattle - final report. Meat & Livestock Australia Limited).

Step five

Develop a monitoring plan for the level of resistance in the feedlot. This is important and has several facets:

1. Collecting samples from untreated pen deaths and treated pen deaths and submit to diagnostic laboratories for culture and sensitivity testing. The consulting veterinarian should develop and oversee this monitoring and use the information to refine the treatment protocols
2. Use feedlot data to examine treatment success and antimicrobial response
3. Use abattoir health feedback data to monitor disease levels.

Step six

Once areas of improvement have been identified, set some objectives. An example might be to improve diagnosis of respiratory cases and only treat with antimicrobials those animals that actually require them.

Set a time frame to make progress towards the objective. For example three, six or 12 months.

This is a continuous review process.

An antimicrobial stewardship plan has three approaches to measuring outcomes.

1. **Quantitative** – how much antibiotic is being used?
2. **Qualitative** – how well is the treatment protocol being followed? Correct dose, route of administration, correct timing, correct duration and correct withdrawal period.
3. **Antimicrobial resistance surveillance** – how is antimicrobial resistance changing over time at the feedlot, including treatment success and antimicrobial response?

To ensure that antimicrobials will be effective into the future and to reduce the rate of development of antibiotic resistance, developing and implementing an antimicrobial stewardship program is a way forward. This is an ongoing approach that, when maintained, will continue to evolve and will produce positive outcomes for not only each feedlot and the feedlot industry but for society.

5.0 Recommendations

In order to progress with antimicrobial stewardship, there are a few key recommendations that should be considered.

- Engage a veterinarian who has expertise in feedlot production and medicine and develop an antimicrobial stewardship plan for your feedlot.
- Ensure that a 'prescribed drug list' and 'documented treatment protocol' has been developed by the veterinarian.
- Have an antimicrobial stewardship team. Include feedlot management and staff, the consulting veterinarian, feedlot nutritionist and stock feed manufacturer on this team. Inform and educate everyone about the importance of stewardship and their specific roles and responsibilities.
- Decisions on use of medically important classes of antimicrobials must be risk and science-based and discussed between the feedlot and the consulting veterinarian.
- Follow the 5Rs (responsibility, review, reduce, refine, replace)
  - develop a method of calculating the quantity of use of each antimicrobial
  - develop a method of measuring compliance with treatment protocols
  - use antimicrobials judiciously
  - adopt preventative practices and review alternatives that will reduce the need to use medically important antimicrobials
  - review the program regularly.
- Develop a plan for monitoring the level of resistance in the feedlot, including treatment success and antimicrobial response.
- Continue to uphold the integrity of grainfed beef through ongoing support of all integrity systems, especially LPA, NFAS, NLIS and NRS.

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Glossary

Antibiotic/antimicrobials: Antimicrobials are chemical agents that, on application to living tissue or by systemic administration, will selectively kill or prevent or inhibit growth of susceptible organisms. Antibiotics are a subset of antimicrobial agents that include antibacterial agents (including ionophores). It is now common practice by the Australian Department of Agriculture and Water Resources, Department of Health, the World Health Organization and other national and global bodies to use the terms 'antimicrobial' and 'antibiotic' interchangeably to mean agents that selectively kill or inhibit the growth of bacteria.

Antimicrobial resistance: Antimicrobial resistance refers to the acquired ability of bacteria to survive in the presence of an antimicrobial that previously was able to kill or inhibit the growth of the bacteria. Bacteria can acquire resistance by appearance of favourable mutations or by acquiring preselected genes for resistance from other bacteria.

Export slaughter interval (ESI) is the minimum time that should elapse between administration of a veterinary chemical to animals and their slaughter for export. ESIs manage differences between maximum residue limits (MRLs) allowed for chemicals in Australia and the MRLs of its trading partners.

Maximum residue limit (MRL) is the highest amount of an agricultural or veterinary chemical residue that is legally allowed in a food product sold in Australia whether it is produced domestically or imported.

Medically important antimicrobial: important classes of antimicrobials that are shared between human medicine and animal agriculture. See Appendix 1 for a list of those commonly utilised in beef cattle as defined by the World Health Organization (WHO, 2016) and Australian Strategic and Technical Advisory Group on antimicrobial resistance (ASTAG, 2015).

No human use antimicrobial (NHU): classes of antimicrobials with no use in human medicine. See Appendix 1 for a list of those commonly utilised in beef cattle as defined by the World Health Organization (WHO, 2016) and Australian Strategic and Technical Advisory Group on AMR (ASTAG, 2015).

Withholding period (WHP) is the minimum period which must elapse between last administration or application of a veterinary chemical product, including treated feed, and the slaughter, collection, harvesting or use of the animal commodity for human consumption. WHPs are mandatory for domestic slaughter and are on the label of every registered product.

Appendix 1: Antimicrobials that are commonly used in feedlots. An example of a product is included.

Commonly used AVPMA-approved antimicrobial agents used in feedlot cattle				
Antibacterial agent	Product name (example)	Drug class	Importance (ASTAG 2015)	Importance (WHO, 2016)
Ceftiofur	Excenel Excede	β lactam cephalosporin [3GC]	HIGH	CI[1]
Virginiamycin	Eskalin 500	Streptogramin	HIGH	HI
Trimethoprim[s]	Trisoprim 480 Trivetrin	Diaminopyrimidine	MED	HI
Cloxacillin	Orbenin eye ointment	β lactam penicillin	MED	HI
Tulathromycin	Draxxin	Macrolide	LOW	CI[1]
Tilmicosin	Micotil 300	Macrolide	LOW	CI[1]
Tylosin	Tylan 200	Macrolide	LOW	CI[1]
Erythromycin	Erymicin 200	Macrolide	LOW	CI[1]
Florfenicol	Nuflor LA	Phenicol	LOW	HI
Chlortetracycline	Aurofac 200	Tetracycline	LOW	HI
Oxytetracycline	Engemycin 100 Terramycin 200	Tetracycline	LOW	HI
Sulfadiazine [T+]	Trisoprim 480	Sulfonamide	LOW	HI
Sulfadimidine [T+/-]	Triprim	Sulfonamide	LOW	HI
Sulfadoxine [T+]	TMPS 240	Sulfonamide	LOW	HI
Amoxicillin	Moxylan RTU	β lactam penicillin	LOW	CI[2]
Penicillin (and salts)	Depocillin	β lactam penicillin	LOW	CI[2]
Flavophospholipol	Flaveco 40	Glycophospholipid	NHU	NHU
Lasalocid	Bovatec 20CC	Ionophore	NHU	NHU
Monensin	Rumensin	Ionophore	NHU	NHU
Narasin	Monteban 100	Ionophore	NHU	NHU
Salinomycin	Posistac 450	Ionophore	NHU	NHU

SUPERCRIPTS: S combination with a sulfonamide; T+/- with or without trimethoprim

Importance for human medicine (ASTAG 2015) classified as low, medium and high
Importance for human medicine (WHO, 2016) classified as **CI[1]:** Highest priority critically important antimicrobials; **CI[2]:** High priority critically important antimicrobials; **HI:** highly important antimicrobials; **I**: important antimicrobials; **NHU:** no human use.

ASTAG, *Importance Ratings and Summary of Antibacterial Uses in Humans in Australia Version 1.1.* 2015, Australian Strategic and Technical Advisory Group on AMR (ASTAG).

WHO, *Critically important antimicrobials for human medicine. 5th Edition.* 2016. World Health Organization (WHO).

Appendix 2: AVPMA-registered vaccines that are used in feedlots. An example of a product is included.

Cattle vaccines used in feedlot cattle registered by APVMA			
Immunogen	Product name (example)	Type	USE
Bacillus anthracis (Sterne 34F2 strain)	Anthrax vaccine	Bacteria	Rare
Bovine ephemeral fever virus	Ultravac BEF Vaccine	Bacteria	Rare
Bovine herpesvirus 1	Rhinoguard Bovilis MH + IBR	Virus	Common
Bovine pestivirus	Pestiguard	Virus	Occasional
Clostridium botulinum Type C	Ultravac Botulinum	Bacteria	Uncommon
Clostridium botulinum Type D	Ultravac Botulinum	Bacteria	Uncommon
Clostridium chauvoei	Clostridium 5-1 Tasvax 5-1	Bacteria	Common
Clostridium haemolyticum	Clostridium 8-1 Tasvax 8-1	Bacteria	Uncommon
Clostridium novyi Type B	Clostridium 5-1 Tasvax 5-1	Bacteria	Common
Clostridium perfringens Type B	Clostridium 8-1 Tasvax 8-1	Bacteria	Uncommon
Clostridium perfringens Type C	Clostridium 8-1 Tasvax 8-1	Bacteria	Uncommon
Clostridium perfringens Type D	Clostridium 5-1 Ultravac 5-1	Bacteria	Common
Clostridium septicum	Clostridium 5-1 Ultravac 5-1	Bacteria	Common
Clostridium tetani	Clostridium 5-1 Ultravac 5-1	Bacteria	Common
Leptospira borgpetersenii serovar Hardjo	Leptoshiel Vaccine	Bacteria	Uncommon
Leptospira interrogans serovar Pomona	Leptoshield Vaccine	Bacteria	Uncommon
Mannheimia haemolytica	Bovilis MH Bovilis MH+IBR. Bovi-Shield MH-One	Bacteria	Common
Moraxella bovis	Piliguard	Bacteria	Occasional